STOP TALKING AND TYPE: MENTORING IN A VIRTUAL AND FACE-TO-FACE ENVIRONMENTAL EDUCATION ENVIRONMENT

by

Elizabeth A. S. Bagley

A dissertation submitted in partial fulfillment of

the requirements for the degree of

Doctor of Philosophy

(Educational Psychology & Environment and Resources)

at the

UNIVERSITY OF WISCONSIN-MADISON

2011
To My Family

With All My Love and Gratitude
ACKNOWLEDGEMENTS

This work would not have been possible without the collaboration, support, and encouragement of many wonderful people. Without cooperation from the staff at the Massachusetts Audubon Society’s Drumlin Farm Sanctuary, especially Kris Scopinich and Robin Stuart, this study would not have happened. Thank you for giving virtual environmental education a chance. Throughout graduate school, I have had the great fortune of being surrounded by the members of the Epistemic Games Research Group. David Williamson Shaffer deserves special thanks and recognition for guiding me through the graduate school apprenticeship. Thank you to the past and present members of the group, especially Kelly Beckett, Gina Svarovsky, David Hatfield, Padraig Nash, Alecia Magnifico, Aran Nulty, Golnaz Arastoopour, Cynthia D’Angelo, Monica Germain, and Melissa Biagtan for helping me reach the finish line by reading parts and/or the whole of this dissertation in all its stages and for encouragement, support, and guidance during the writing of it.

I am grateful to my dissertation committee members: Cal DeWitt, Chuck Kalish, Asli Gocmen, and Lew Friedland for their insights, feedback, and participation in this process. Thank you to the administrative staff in the Educational Psychology Department and the Nelson Institute for Environmental Studies and the Wisconsin Center for Education Research for making my joint degree process possible. Thank you to my friends and family for cheering me on, reading drafts and providing feedback, and inspiring me to work towards a doctoral degree. Thank you, especially, to Rebecca Lorimer, Naomi Chesler, Krista Eastman, David Zaks, Leela Hazzah, Stephanie Dolrenry, and Lizabeth Fogel for providing me with guidance and support.
And, for their love and patience and support, deepest thanks to my husband, Justin Bagley, and my son, Ian.
# TABLE OF CONTENTS

**ACKNOWLEDGEMENTS** .................................................................................................................. ii

**TABLE OF CONTENTS** .................................................................................................................. iv

**CHAPTER 1: INTRODUCTION** ........................................................................................................ 1

  List of appendices .......................................................................................................................... 5

**CHAPTER 2: ENVIRONMENTAL EDUCATION IN THE 21<sup>ST</sup> CENTURY** ............................. 6

  Framework for Environmental Education ....................................................................................... 7

  Virtual environmental education .................................................................................................... 17

  Planning profession ......................................................................................................................... 20

  Urban Science as Virtual Environmental Education .......................................................................... 21

  Mentors develop environmental leaders ....................................................................................... 26

  Virtual Mentoring ............................................................................................................................ 27

  Quantity ........................................................................................................................................ 29

  Quality .......................................................................................................................................... 29

  Epistemic frames .............................................................................................................................. 29

  Impact .......................................................................................................................................... 30

  Engagement .................................................................................................................................. 30
Research Questions ................................................................. 32

CHAPTER 3: METHODS .................................................................. 34

Participants ............................................................................. 34

Intervention ............................................................................... 35

Game description ..................................................................... 37

Data collection .......................................................................... 43

Qualitative data analysis .......................................................... 44

Data coding ............................................................................... 45

Epistemic Network Analysis ....................................................... 51

CHAPTER 4: EMPIRICAL RESULTS .................................................. 54

Research Questions ................................................................ 54

Part 1: Comparing Mentor Discourse ........................................ 54

Section 1: Structural differences and semantic similarities between conditions .......... 55

Section 2: Mentor discourse compared by meeting .................................................. 58

Qualitative comparison of mentors’ discourse between meetings .............................. 58

Quantitative comparison of mentors’ discourse between meetings .......................... 61

Section 3: Mentor discourse compared by condition ............................................... 64

Qualitative comparison of mentors’ discourse between conditions .......................... 64

Quantitative comparison of mentors’ discourse between conditions ........................ 66
Part 2: Comparing Player Discourse ................................................................. 68

Section 1: Structural differences and semantic similarities between conditions .................................. 69

Section 2: Player discourse compared by meeting ................................................................................. 71

Qualitative comparison of players’ discourse between meetings ....................................................... 71

Quantitative comparison of players’ discourse between meetings ...................................................... 74

Section 3: Player discourse compared by condition .............................................................................. 76

Qualitative comparison of players’ discourse between conditions .................................................... 77

Quantitative comparison of players’ discourse between conditions .................................................. 78

Outcomes ........................................................................................................................................... 81

Interviews ............................................................................................................................................ 81

Final proposals .................................................................................................................................. 82

Engagement questions ....................................................................................................................... 86

CHAPTER 5: DISCUSSION .................................................................................................................. 88

Limitations ......................................................................................................................................... 92

CHAPTER 6: PRACTICAL ADVICE FOR ENVIRONMENTAL EDUCATORS .................................. 96

REFERENCES ................................................................................................................................. 101

Appendix 1: Recruitment materials used by the Massachusetts Audubon Society .................... 106

Appendix 2: Mentor Playbook Script ................................................................................................. 107

Appendix 3: Conservation Leadership Program—Final Agenda—August 16-20, 2010 .......... 134
CHAPTER 1: INTRODUCTION

Human actions are resulting in unprecedented changes to the Earth’s ecosystems, creating ever-increasing threats to the resources of the Earth and to the health and stability of its societies. Addressing these changes and threats requires informed global citizens who are aware of the things that surround them, appreciate things in all of their diversity, and care for what needs caring, restore what needs restoring, to create things that “move beyond what we already know in order to break beyond the boundaries of now to a more beautiful fabric of the future” (DeWitt, 2011).

There is little doubt about the urgent need for promoting change in attitudes and behavior, for encouraging people to appreciate and enjoy the world around them, and for equipping the decision makers of both present and future to adopt environmentally responsible approaches (Palmer, 1998). However, environmental problems and their impacts present a challenge for education and outreach because they are inherently complex, interdependent, and interrelated. Therefore, according to Palmer (1998, p. 277) our task as environmental educators in the twenty-first century is to “implement programs of education that inform our students about the complexities of the environment in which they are growing up; empower them to address environment and development issues in their own lives; and provide them with opportunities to be inspired by the joys, wonder and mysteries of the natural world and human achievement”. However, debate continues around the world on how to best educate people about the environment and on how to identify the most successful ways of approaching environmental education in practice (Palmer, 1998).
For the past several decades, scholars and practitioners have attempted to integrate various dimensions of environmental thinking into a variety of environmental education frameworks (Sauve, 1999; Berkowitz et al., 2005). One widely used environmental education framework was introduced by Lucas (1979) and expanded by Palmer (1994; 1998). Palmer’s environmental education framework consists of three overlapping circles of education through, about, and for the environment and has been applied in a variety of different settings. For example, her framework has been applied to a visit a nature center, an urban planning challenge, an ozone depletion lesson, and a litter prevention and control activity (Palmer, 1994). One common aspect among those activities is their existence in the physical environment (e.g. students physically visited a nature center). However, not all young people have access to the physical spaces Palmer wrote about, and virtual environments may be well-positioned to provide more high-quality environmental education opportunities to more young people.

Virtual environmental education experiences have the potential to allow young people to explore complex concepts in simulated form with lower logistical overhead. In simulations, complex social and environmental problems that are too expensive, dangerous, or difficult for players to solve in the real world can be appropriately scaffolded in a dynamic model, giving young people opportunities to more easily interpret the interconnections in the model and develop professional thinking. Virtual environments also have the potential to simplify logistics by providing students with interactions with a variety of virtual non-player characters (NPCs) which could lower the logistical overhead and make the virtual environment more widely available.
This paper examines a virtual environmental education environment called *Urban Science*. Urban Science is based on a professional practicum because according to Schon (1987) and Shaffer (2005), professional practica are good models for learning: they are designed for novices to take action in a supervised setting and then to reflect on the results with peers and mentors. The mentors facilitate the novices’ work in the practicum by scaffolding tasks the novices are not yet ready to undertake and help them reflect on that work. Following this practicum model, Urban Science is designed to let mentors and players interact through planned *reflection meetings* where the mentor helps players discuss previously completed activities and plan next steps in the project.

This dissertation focuses on whether and how, through these reflection meetings, *Urban Science*, creates opportunities for young people to develop a combination of the skills, knowledge, values, identity, and epistemology of environmentally literate urban planners. Specifically, this dissertation looks at whether virtual interactions between learners and mentors in a simulation for environmental learning are or are not similar to interactions between learners and mentors in person using the same simulation.

To do this, the dissertation examines two conditions of Urban Science, one with virtual mentors and one with face-to-face mentors, and asks the following questions:

1. Was the mentors’ discourse during the reflection meetings different between the two conditions?
2. Was the players’ discourse during the reflection meetings different between the two conditions?
3. Were the players’ outcomes different between the two conditions?

4. Was the players’ level of engagement different between the two conditions?

The four research questions are addressed in the following six chapters. Chapter One, this chapter, provides an overview of the dissertation. Chapter Two describes an environmental education framework and provides theoretical support for the development of the environmental education epistemic game, Urban Science. Chapter Two suggests that virtual environmental education experiences like Urban Science can build environmental literacy and establishes the metrics used to compare virtual and face-to-face mentoring in the context of Urban Science. Specifically, three metrics are examined to determine whether the mode of mentoring communication changes the quantity of the discourse, the quality of the discourse, or the impact on players’ learning outcomes and engagement.

Chapter Three describes the setting and the activities for both conditions of Urban Science and discusses the three types of data that were collected, segmented, coded, and analyzed. Chapter Four presents empirical results comparing and contrasting qualitative and quantitative evidence from a face-to-face and a chat condition of Urban Science to examine the quantity and quality of the mentors’ and players’ discourse and the impact on players’ learning outcomes and engagement. Chapter Five discusses the implications and limitations of the empirical results. Chapter Six draws on empirical evidence, design research, literature, and assessment methodologies from the preceding chapters and provides recommendations for best practices in virtual environmental education.
The following appendices are included to provide specific details about the empirical study (Appendices 1-5) and publications that informed the current work.

**List of appendices**

1. Recruitment materials used by the Massachusetts Audubon Society
2. Script used by the mentors in both conditions of Urban Science
3. Intake and exit interview questions used in both conditions of Urban Science
4. Sample final proposal provided to the players in both conditions of Urban Science
5. Description of the applying Epistemic Network Analysis to qualitative data
6. Published Masters’ paper about an Urban Science pilot study: *Promoting civic thinking through epistemic game play*
7. Ethnography (in review) of professional urban planning practices: *The Epistemography of an Urban and Regional Planning Practicum: Appropriation in the Face of Resistance*
CHAPTER 2: ENVIRONMENTAL EDUCATION IN THE 21ST CENTURY

With population and per-capita consumption both on the rise, scientists believe humans’ impact on the Earth is no longer sustainable (Rockstrom et al., 2009). According to the United Nations Millennium Ecosystem Assessment in 2005, “Human activity is putting such strain on the natural functions of Earth that the ability of the planet’s ecosystems to sustain future generations can no longer be taken for granted.”

As humans’ capacity to alter the environment reaches unprecedented levels, the urgency of training environmentally literate citizens—people who will help ensure an ecologically and economically sustainable environment (Rydberg, 2011)—has never been greater. It has likewise never been more difficult. In an increasingly urbanized society with technology-mediated lifestyles, people find themselves further from the sources of their resources and less connected to the biological and non-human physical world.

This chapter examines one way of teaching environmental literacy by describing an environmental education framework in which students think about what the world is like, what it should be like, and what they can do to change it. Though environmental education has traditionally taken place in the physical environment, this chapter suggests that a virtual environment also can provide opportunities for young people to develop environmental literacy. Specifically, this chapter suggests that the epistemic game, Urban Science, extends the environmental education framework into a virtual environment and creates opportunities for young people to develop a particularly powerful form of environmental literacy.
**Framework for Environmental Education**

Environmental education fosters environmental literacy\(^1\). Environmental education has the task of addressing wide-ranging, dynamic, content that is characterized by highly complex inter-relationships. In 1970, the IUCN/UNESCO International Working Meeting on Environmental Education in the School Curriculum formulated and adopted an influential definition of environmental education:

Environmental education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness among man, his culture, and his biophysical surroundings. Environmental education also entails practice in decision-making and self-formulation of a code of behavior about issues concerning environmental quality. (IUCN, 1970)

Since there are a number of different perspectives on the root causes of environmental problems, there are also various perspectives on the definition of environmental education. For example, Gough (1987, p. 63) argued that teaching environmental education involved rethinking of all of education because “*the present system of education has been built upon understandings of reality, nature, and human nature that can no longer be taken for granted.*” Robottom and Hart (1993, p. 38) similarly challenged the definition of environmental education and argued that “*the field of formal education is characterized by the materialistic Western world view that developed from the scientific revolution and replaced intrinsic values with instrumental values*”.

However, despite the differences in ideological perspectives, since the first international definition of environmental education in 1970, a broad consensus has emerged on the principles, goals, and objectives of environmental education (Palmer, 1998). The generally accepted

---

\(^1\) There are undoubtedly other ways to develop environmental literacy, but they are beyond the scope of this paper.
principles largely reflect the outcomes of the Tbilisi Conference of 1977, whose Final Report set out the three goals of environmental education:

1. To foster clear awareness of, and concern about, economic, social, political, and ecological inter-dependence in urban and rural areas;
2. To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;
3. To create new patterns of behavior in individuals, groups and society as a whole towards the environment. (UNESCO, 1977)

During the past decades, in its diverse fields of application, environmental education has given rise to a wide range of conceptions, from the broadest to the narrowest (Sauve, 1999). Some feel that the environment is “everything that surrounds us” and humans are an environment (McInnis, 1972). Others feel, however, that environmental education is closely linked with the teaching of ecology or environmental sciences (Sauve, 1999). Thus, competing frameworks of environmental education exist based on positivist, interpretivist, and critical perspectives (Robottom and Hart, 1993). For example, Sauve’s framework (1999) asserts that environmental education consists of three interrelated spheres of personal and social development. In his framework, the “sphere of identity” is at the center of the diagram and is where a person develops by clarifying her own characteristics, capacities, and limits. The central sphere is surrounded and supported by the “sphere of otherness” where people interact with others and people develop a sense of belonging and sense of responsibility and the “sphere of relations” which is concerned with other living beings and the biophysical elements and phenomena of ecosystems.
Berkowitz et al. suggest a more complicated framework for ecological literacy that involves the overlap and interaction between subjects of study (five key ecological systems) and ways of knowing (seven dimensions of ecological thinking), linked by areas of overlap and by the additional emphasis on understanding how ecological science and society interact. According to Berkowitz et al., the five overlapping ecological systems components emphasize “the dynamic pathways by which literacy, awareness, and self-efficacy contribute to and also benefit from acquisition of practical wisdom and skills through action” (p. 230, 2005).

Despite these competing frameworks, however, it has generally been accepted since the 1970s that education related to the environment can be categorized as education through, about, and for the environment (Lucas, 1979; Hart & Nolan, 1999; Rickson, 2001; Jenkins, 2003; Hicks & Holden, 2007). Lucas’ (1979) simple description reinforces the wildly different purposes that environmental education often serves\(^2\) including programs that provide opportunities to explore nature in the outdoors, information about conservation and environmental issues, and opportunities to gain knowledge and skills that can be used to defend, protect, conserve, or restore the environment. According to Palmer (1998, p. 10), “the fact that such a variety of approaches exists is a reflection of the opportunities there are for innovation, and the number of viewpoints seeking expression.”

\(^2\) Though this paper does not examine the different purposes environmental education serves, it is worth noting that in environmental education as in most domains, the same content can be taught using a variety of methods and modes.
In order to make Lucas’ (1979) *through, about, and for* the environment categories more tangible for environmental education practitioners, Palmer\(^3\) (1994; 1998) developed rich descriptions of each category. For example, she asserted that educating *through* the environment involves using the environment as a medium for inquiry and discovery and as a source of material for realistic activities in all subjects. Palmer argues that educating *through* the environment enables students to develop knowledge and understanding as well as investigation and communication skills. In addition, personal experiences, investigations, and problem-solving *through* the environment provide students with opportunities for reflection and the development of critical awareness and concern.

Education *about* the environment encourages students to understand the environment and their complex relationships with it. Education *about* the environment develops students’ knowledge and encourages students’ appreciation and promotion of desired values. Palmer suggests that one way to ensure that the environmental knowledge is tied to desired values and attitudes is by presenting students with real issues and problems that have a reference point in their own lives.

Education *for* the environment encourages students to explore their personal response to and relationship with the environment and environmental issues. Education *for* the environment provides opportunities for students to go beyond the acquisition of skills and knowledge to develop values necessary for the development for sustainable and caring use of the environment.

---

\(^3\) Joy Palmer has published widely on environmental education and the development of environmental thinking and awareness (Palmer 1994; 1998; 2001; 2003; 2004; 2005), and her writings are considered key by the Campaign for Environmental Literacy, a leader in the environmental literacy field.
(Palmer, 1994). Thus, the aim of the education through, about, and for the environment framework is to develop skills, knowledge, and values which lead to a personal environmental ethic where students’ actions and influences on collective action positively benefit the environment.

Nested within the through, about, and for the environment categories is the science-ethics-praxis triad which, according to DeWitt (1998), depicts a way of thinking, with each of its three points illuminating and illuminated by the other two. Dewitt (1998) argues that the triad develops environmental literacy by “representing a way of life in which accomplishment is sought in the company of scientific and ethical knowledge. It pictures a sustained and dynamic interaction among science, ethics, and praxis as requisite for integrity in individual lives, in community, and in the wider world.” Palmer (1998) argues that environmental learning cannot be truly meaningful and worthwhile without science, ethics, and praxis intertwined with the through, about, and for the environment categories.

According to Dewitt (1998), the three points of the triad operate in dynamic interaction depending on “what we know and understand and know about ourselves and the world (science), what we believe we should do (ethics), and what we in fact do and how we respond to our successes and failures (praxis).” For example, when put into practice in the environmental education framework, science exists at the intersection of education about and education through the environment where students begin to understand their world and its workings through direct experiences and accumulated knowledge. Ethics exists at the intersection of education about and education for the environment where students gain from their experience and culture an understanding of what constitutes right living in the world. And, praxis exists at the intersection
of education for and education through the environment where students gain an interactive and coherent understanding of the world and learn how to respond to successes and failures. In short, the science-ethics-praxis triad tells students what the world is like, what ought to be in the world, and what an individual must do.

The aim of the education through, about, and for the environment framework is to develop skills, knowledge, and values needed to become environmentally literate (Palmer, 1994; 1998) while the nested science-ethics-praxis triad tells students what the world is like, what ought to be in the world, and what an individual must do (DeWitt, 1998). DeWitt (1998) asserts that “pursuit of integrity through this dynamic interaction enables development of a worldview that degrades neither us nor the world.” However, how can environmental education practitioners ensure that students are developing “a worldview that can achieve and sustain quality in land and life” (DeWitt, 1998)?

One way to develop environmental education activities is to design them to teach a particular worldview that is already dedicated to achieving and sustaining “quality in land and life”. Lave and Wenger (1991) argue that communities of people who share a common body of knowledge, a set of skills, a value system, and a set of decision-making processes are communities of practice. Certain types of professional communities of practice, for example, have developed unique ways of doing, knowing, being, caring and warranting. Shaffer calls the unique combination of linked and interrelated skills, knowledge, values, identity, and epistemology an epistemic frame (Shaffer, 2007) and argues that each profession is organized by a particular epistemic frame appropriate for solving the problems of the profession.
In defining the epistemic frame elements of a given profession, an epistemic frame articulates the ways of doing, knowing, being, caring, and warranting of a particular profession. According to Shaffer, skills are the things that people within a profession do, knowledge is the understandings that people in the profession share, identity is the way that members of the profession see themselves, values are the beliefs that members of the profession hold, and epistemology is the warrants that justify actions or claims as legitimate within the profession. Put in more concrete terms, ecologists act like ecologists, identify themselves as ecologists, are interested in ecology, and know about complex, interdependent natural cycles, biotic and abiotic environmental features, and other technical domains. These skills, affiliations, habits, and understandings are made possible by looking through, about, and for the environment in a particular way: by thinking like an ecologist. The same is true for other professionals like engineers, computer scientists, mathematicians, and science journalists, but for different ways of thinking and with different epistemic frames. In other words, novices develop epistemic frames by enacting the science, ethics, and praxis triad while learning through, about, and for the
environment in their professional domain.

Palmer’s (1994) vision of environmental education is compatible with epistemic frames. In her *Handbook of Environmental Education*, Palmer (1994) describes an environmental education curriculum that used the environmental education framework to build environmental education framework adapted from Palmer (1994).

Figure 1. Environmental education framework adapted from Palmer (1994).
literacy in 12th grade students. The students role-played as members of a town council and were tasked with exploring a fictitious town (based on a real town near their school) and envisioning its environmental, social, and industrial issues in the year 2000. The students worked in groups of nine and received a folder containing a description of the town (including information about a disused canal, spaces that needed to be protected, and spaces that had restrictions on development), a map, planning guidelines (e.g. industrial, housing, retail, agriculture, tourism, recreation, motorway, environment), suggestions from the local district council, an article on how to develop a neighborhood, extracts from the county council’s real development plan, population review and projection up to 2001, and visitor figures for the area.

The groups listened to a talk given by a representative of the real local council purporting to come from the fictitious town, and each group’s town development plan was judged by experts including the district council planning officer and the county council economic development officer.

Palmer asserted that the curriculum could be considered environmental education because it was education through, about, and for the environment. For example, the curriculum was education through the environment because it used the idea of a growing town to develop thinking on urban problems. It was education about the environment because it was about planning in an urban area. And, the curriculum was education for the environment because it considered the impact of the growing town on the environment. (Figure 2)

The science-ethics-praxis triad was central to developing the epistemic frame of a town council member (though it should be noted that Palmer did not specify the skills, knowledge,
values, identity, or epistemology that make up a town council member’s epistemic frame). The curriculum included science by having the students carry out planning processes. Students dealt with ethics by balancing human and environmental needs. And, the science and ethics students learned were put into practice when they were asked to present a town development plan.

Figure 2: Palmer’s (1994) description of an environmental education experience for high school students.
While the curriculum Palmer described has the potential to teach environmental literacy, there are two main constraints associated with that curriculum. First, the system students interacted with was not dynamic, and therefore, could not accurately model the complex interconnections inherent in the urban system. Second, developing the materials and finding the experts to judge the students’ town development plans requires a certain level of access that may not be widely available, especially in under-resourced schools. To address those two constraints, environmental education practitioners have started exploring learning opportunities in virtual worlds.

**Virtual environmental education**

There is a growing body of research that suggests that video games (used in both formal and informal environments) can support the learning of environmental science concepts (Bagley & Shaffer, 2009; Barab & Dede, 2007; Kloper & Squire, in press). For example, in a virtual aquatic park called Taiga World, students are assigned tasks, such as making the water in the river safer for aquatic life, that require them to know about water quality, including pH, dissolved oxygen, and turbidity (Thomas et al., 2009). In another example, players in Resilient Planet explore an underwater ecosystem and construct arguments about the causes of various phenomena, such as the monk seal population reduction or the health of the ecosystem (Squire, 2009). Further, Gaber (2007), Adams (1998), and Teague and Teague (1995) argue 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.
Of course, virtual environments have constraints. Virtual environments offer simulations of reality and do not provide opportunities for young people to smell, taste, touch, or see the physical environment. Even with opportunities to visualize a virtual experience in a 3-D environment, the sensory fidelity is lower in a virtual environment. Further, young people do not interact with or impact real people in virtual environments which may result in lowered engagement and inconsistent learning outcomes. However, while there are disadvantages to learning in a virtual environment (including many more not discussed here), virtual environments allow young people to explore complex concepts in simulated form with lower logistical overhead.

One affordance of virtual environments is their potential to allow young people to solve simulations of real-world problems and learn real-world skills, knowledge, and values in a virtual world. In the simulations, complex social and environmental problems can be appropriately scaffolded in a dynamic model, giving young people opportunities to more easily interpret the interconnections in the model and develop professional thinking. Since models are abstractions of reality, variables are intentionally left out in order to simplify the system, allowing players to discover the missing connections needed to accurately convey the real interactions and deal with specific questions more fully. In other words, the model simulates problems that are too expensive, dangerous, or difficult for players to solve in the real world by scaffolding some of the professional vision to make it possible for the players to get a handle on the complex problems.

Palmer (1998) argues that environmental education is not as successful as it could be at developing environmentally literate citizens because widespread implementation of quality
environmental education programs is logistically problematic. Even with a complex model available, the logistical overhead involved with identifying experts with adequate experience to judge students’ work and teaching students the skills they need in order to run the model is extremely high. Virtual environments have the potential to simplify logistics by providing students with interactions with a variety of virtual non-player characters (NPCs). In virtual environments, the NPCs play the role of mentors, community members, colleagues in a fictitious firm, or any number of other roles. The NPCs’ performance can be automated, lowering the logistical overhead and making the virtual environment more widely available.

One type of virtual environment designed specifically for young people to explore complex concepts in simulated form with lower logistical overhead is the epistemic game. In epistemic games, novices inhabit a virtual environment in which they learn the epistemic frame—the skills, knowledge, identity, values, and epistemology—of a particular profession by simulating professional training. Novices are supported by peers and mentors and by simulations that scaffold some of the skills and knowledge necessary for young people to build professional epistemic frames. Mentors in epistemic games facilitate cycles of real-world learning through frequent and strategically-placed reflective conversations with the novices (called “players” in epistemic games) about their authentic tasks. Mentors model a professional epistemic frame by asking players to reflect on what worked, what did not work, and why and scaffolding a way of seeing and solving problems that the players can adopt (Nash & Shaffer, 2010).

Modeling an epistemic game on a profession that uses combinations of skills, knowledge, values, identity, and epistemology to address environmental problems is one way to build
environmental literacy. One, though by no means the only, profession that environmental education practitioners could use to build an epistemic game is the urban planning profession.

**Planning profession**

According to the American Planning Association (2011), professional planners work with the complex, interrelated components inherent in urban systems and develop 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”. Planners are trained to understand how to discern and balance the often conflicting needs of stakeholders with the natural and built environment. They understand how cities work as ecological systems so they can take control of the vital links between human actions and environmental quality and work for an ecologically and economically sustainable future.\(^4\) Planners use skills, knowledge, identity, values, and epistemology specific to the professional practice of planning to deal equitably with all biotic and abiotic components involved in planning decisions.\(^5\) Thus, the type of urban planning epistemic frame described above is a useful model for developing environmental literacy.

As in many professions (Schon, 1987), urban planners often develop their professional epistemic frame in a graduate-level planning practicum. Professional practica are environments designed for novices to take action in a supervised setting and then to reflect on the results with peers and mentors. The mentors facilitate the novices’ work in the practicum and reflect on that

---

\(^4\) It is worth noting that this description assumes the ideal work environment. In reality, planners’ work is often restricted by ordinances (some quite outdated) which have the potential to affect the quality and extent of their work.

\(^5\) A more thorough discussion of the professional practices of planners can be found in Shaffer (2006) and Bagley and Shaffer (2009).
work by scaffolding tasks the novices are not yet ready to undertake. During the practicum, mentors model particular behaviors, demonstrate and describe the profession’s way of seeing and solving problems, and help novices mobilize the connections between specific epistemic frame elements in order to build the epistemic frame of the profession (Shaffer, 2005). Thus, by playing, for example, an epistemic game based on the epistemic frame of professional planners, young people can potentially engage in the complex compromises and decision-making processes that shape their social and physical realities and become environmentally literate in the process.

**Urban Science as Virtual Environmental Education**

Urban Science is an epistemic game designed to simulate an urban planning practicum experience (Bagley, 2010) in a virtual environment, and this section suggests that Urban Science includes activities for education *through, about, and for* the environment and creates opportunities for students to develop science, ethics, and praxis in order to build a professional urban planning epistemic frame consisting of a combination of the skills, knowledge, values, identity, and epistemology needed to be environmentally literate. This section also explores the similarities between the environmental education curriculum Palmer (1998) described and Urban Science.

Traditionally, education *through* the environment meant that students were learning in the physical environment as described in Palmer’s (1998) example. However, as described above, virtual environments have the potential to simulate problems that are too expensive, dangerous, or difficult for players to solve in the real world by scaffolding some of the professional vision to make it possible for the players to get a handle on the complex problems. Virtual environments
also have the potential to lower the logistical overhead, making the virtual environmental education more widely available. Previous research on Urban Science has shown that (a) the game is effective in developing ecological understanding for students, and (b) the time players spend reflecting with mentors is a key part of that process (Bagley and Shaffer, 2009; Beckett and Shaffer, 2005; Nash and Shaffer, 2008).

In Urban Science, players have opportunities to learn through the environment when they use iPlan, a custom-designed geographic information systems (GIS) tool that models the planning site and allows players to visualize proposed land use changes. Through using iPlan as a medium for inquiry, players are able to investigate the complex tradeoffs in an urban environment and discover that altering one variable within the complex system affects other variables, reflecting the messy, interdependent, ecological relationships present in the modern city. Players can gain skills through problem-solving in the environment when they use iPlan to create preference surveys, grapple with the neighborhood’s complexity, and justify conclusions in their final proposals.

Players have opportunities to learn about the environment and our complex relationships with it while playing Urban Science. They can develop knowledge about the site when they conduct background research and take a virtual site visit where they hear from virtual stakeholders who have strong opinions about the future of the neighborhood. Players can develop values and attitudes when they create preference surveys to understand more clearly what attributes stakeholders desire and compile their information into a comprehensive final proposal that meets the community’s needs. Thus, players have the potential to gain knowledge and values
about the environment as a result of addressing real issues and problems that have a reference point in their own lives.

Players have opportunities to learn for the environment when they consider the impact of development alternatives on the environment and the stakeholders and suggest alternatives. Through interacting with the virtual stakeholders, players can develop values as they learn about and try to balance the economic, social, political, and ecological interdependence in the urban area. Players’ guided reflection with expert mentors is designed to provide the kind of mentoring that professional urban planners experience in their training that pushes players to consider ethical ramifications of their decisions. Thus, by using the idea of a changing city to develop thinking of urban problems, Urban Science players are well-positioned to learn through, about, and for the environment.

In addition, Urban Science, players have opportunities to engage with the triad of science, ethics, and praxis. Novices need to develop a particular epistemic frame to think like an environmentally conscious urban planner, and they have an opportunity to develop their ecological epistemic frame by enacting the science, ethics, praxis triad. For example, players can use science when they follow the planning process to learn about the environmental tradeoffs involved with land use decisions. They can address ethics as they balance human and environmental needs while completing the preference survey and final plan. At the end of the game, they have opportunities to put their scientific knowledge and ethics into practice when
they submit a final plan and proposal. (Figure 3)

**Figure 3. Environmental education framework with examples of Urban Science activities showing that Urban Science fits into the environment education framework.**

Despite existing in a virtual world, Urban Science aligns with Palmer’s (1998) environmental education curriculum and the environmental education framework (Table 1) and has the potential to give players opportunities to interact *through, about, and for* the environment and have opportunities to develop science, ethics, and praxis in order to build a professional
urban planning epistemic frame consisting of a combination of the skills, knowledge, values, identity, and epistemology needed to be environmentally literate.

**Table 1**

*Description of the components of the environmental education framework and a comparison between Palmer’s example and Urban Science showing that Urban Science aligns with the environmental education framework.*

<table>
<thead>
<tr>
<th>Framework</th>
<th>Description</th>
<th>Palmer example</th>
<th>Urban Science example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Through</strong></td>
<td>Using the environment as a medium for inquiry and discovery</td>
<td>Using the idea of a growing town to develop thinking on urban problems</td>
<td>Using the idea of a changing city to develop thinking on urban problems</td>
</tr>
<tr>
<td><strong>About</strong></td>
<td>Lessons focusing on real issues and problems in the environment</td>
<td>Planning in an urban area</td>
<td>Planning in an urban area</td>
</tr>
<tr>
<td><strong>For</strong></td>
<td>Exploring personal responses to and relationships with environmental issues</td>
<td>Considering the impact of a growing town on the environment</td>
<td>Considering the impact of a changing city on the environment</td>
</tr>
<tr>
<td><strong>Science</strong></td>
<td>Understanding the world and its workings through direct experiences and accumulated knowledge</td>
<td>Carrying out the planning process</td>
<td>Carrying out the planning process</td>
</tr>
<tr>
<td><strong>Ethics</strong></td>
<td>Understanding what constitutes right living in the world</td>
<td>Balancing human and environmental needs</td>
<td>Balancing human and environmental needs</td>
</tr>
<tr>
<td><strong>Praxis</strong></td>
<td>Opportunities to gain an understanding of what individuals can do to address environmental issues</td>
<td>Presenting a town development plan</td>
<td>Submitting a final city plan and proposal</td>
</tr>
</tbody>
</table>

The close alignment of Urban Science to the traditional environmental framework suggests that virtual environmental education is possible. Further, learning in a virtual environment like Urban Science may be desirable because virtual environments can expand the
range of what players can realistically do and thus also the problems they can address, the possible collaborations they can participate in, and the communities they can inhabit. Learning in a virtual environment can give players a chance to see how the world—or at least some piece of it—works under the guidance of a mentor. The virtual environment of Urban Science can give players a chance to experience their own efficacy in the face of complex problems by showing them what it is like to be one of the people who make decisions that shape the world around them (Shaffer, 2006). In short, Urban Science is a virtual environment education experience that has the potential to give players opportunities to figure out what the world is like, what ought to be in the world, and what an individual must do.

In all of the environmental education experiences described above (e.g., Palmer’s town development curriculum, the urban planning practicum, and Urban Science), mentoring is part of the experience, yet it is unclear whether mentoring in a virtual environment rather than in a face-to-face environment changes anything.

Mentors develop environmental leaders

The important role of mentoring in fostering environmental literacy has been widely documented by researchers and historians (Cronon, 1996; Meine, 2004; Palmer, 1998). For example, as a student at the University of Wisconsin-Madison, John Muir had a moment of clarity while standing under a locust tree outside of North Hall. During an impromptu botany lesson, Milton Griswold informed Muir that the locust tree was a member of the same plant family as the pea. Muir (1913) later wrote that “That fine lesson charmed me and sent me flying to the woods and meadows in wild enthusiasm.”
Similar stories exist for extraordinary environmental leaders including Gaylord Nelson, Aldo Leopold, and Rachel Carson (Roush, 1992) among others, and Caldwell and Carter (1993) argue that in order to nurture future environmental leaders, everyone needs to find their own “Milton Griswold”. Fortino (2007) suggests that a mentor in environmental education can utilize the wonders of nature to “guide the student to pursue intelligent and constructive actions”. However, one question to consider is whether it matters if the novice’s experience with the mentor is in the physical or in a virtual environment.

**Virtual Mentoring**

Kirk and Olinger (2003) argue that “as society looks to technology as a vital resource in everyday life, one cannot help but to imagine the conveniences that are presented by mentoring in the virtual sense.” Echoing Kirk and Olinger (2003), Bierema and Merriam (2002) suggest that virtual mentoring extends traditional mentoring contexts. Bierema and Merriam (2002) define virtual mentoring as “a computer mediated, mutually beneficial relationship between a mentor and a protégé which provides learning, advising, encouraging, promoting, and modeling that is often boundaryless, egalitarian, and qualitatively different than traditional face-to-face mentoring”. They argue that e-mentoring is boundaryless in that it opens the possibility for interactions that cross geographical and cultural boundaries, a potentially powerful affordance of virtual mentoring in environmental education since many environmental problems exist across geographical and cultural boundaries. In addition, according to Harrington (1999), virtual mentoring provides people from rural or remote areas with opportunities that would otherwise be unavailable with traditional mentoring.
Bierema and Merriam (2002) also suggest that virtual mentoring is egalitarian in that it has the potential to cross barriers of race, gender, geography, age, and hierarchy that are rarely crossed in traditional mentoring contexts. They argue that since computer-mediated interactions can offer a context for interactions between diverse parties, virtual mentoring holds “the potential to erode some of the traditional power dynamics that tend to structure mentoring relationships” (Bierema & Merriam, 2002, p. 220).

Virtual mentoring also has the potential to offer more sophisticated mentoring because the mentors’ responses can be automated. With professionally-trained mentors communicating with students through a chat program, the environmental educator might be relieved from addressing domain-specific questions. Additionally, the cost of virtual mentoring is potentially lower than the cost of face-to-face mentoring because one virtual mentor can likely mentor more novices than a face-to-face mentor.

However, some are skeptical of virtual mentoring and argue that when communication goes electronic, the richness associated with face-to-face conversation diminishes and a considerable amount of information is lost (Bierema and Merriam, 2002). Brennan and Lockridge (2006) argue that in chat-based interactions, mentors have no access to the young people’s body language, tone of voice, or the variety of other signals that can only be detected in a shared physical environment, and as a result, miscommunication can occur. However, Whittaker (2003) found that people communicated clearly and easily over a wide variety of media, including those with relatively low band-width like virtual chat programs.
It is unclear whether the constraints of virtual mentoring in environmental education, namely the possibilities for lost information and miscommunication, outweigh the affordances. Therefore, since there are practical and theoretical reasons to explore virtual mentoring in environmental education, this study explores whether having mentors communicate with players through a virtual chat program rather than face-to-face changes anything about the players’ experience by measuring the quantity, quality, and impact of the reflection meeting discourse content, learning outcomes, and level of engagement in two conditions of Urban Science.

**Quantity**

In discourse analysis, word counts are widely used to quantify discourse because higher word counts are often correlated with higher quality discourse (Pennebaker et al., 2007). However, word counts are most often paired with qualitative analyses or more rigorous quantitative methods to more fully understand the complexities of the discourse. For example, Schneider et al. (2002) used word counts to compare online and face-to-face focus group participants’ discourse. Their word count comparison showed that online focus group participants tended to contribute fewer words to their discussions than the face-to-face focus group participants. Their qualitative analysis expanded that finding by showing that participants were less likely to explain their opinions or to provide detailed insight into the thinking that led them to their conclusions.

**Quality**

*Epistemic frames.* The quality of the mentor and player discourse can be measured by exploring ways in which particular qualitative characteristics of their discourse are representative
of professional thinking. One way to qualitatively categorize the professional characteristics of discourse is to use epistemic frame theory.

As described in more detail above, epistemic frame theory suggests that each profession has a distinct epistemic frame that consists of “the combination –linked and interrelated—of skills, knowledge, identity, skills, and epistemology” (Shaffer, 2007, p. 160). Central to epistemic frame theory is its explicit focus on the linkages between epistemic frame elements. Skills are always linked to some form of knowledge, values, identity, and epistemology (and each of the other elements are, in turn, associated with all the others); however, they are not always linked to the same ones, or in the same ways. Thus, Shaffer (2010) argues that modeling the structure of the links between epistemic frame elements can be used to measure the quality of discourse in an epistemic game.

**Epistemic Network Analysis.** The structure of the links between epistemic frame elements in qualitative data can be modeled using an emerging technique called Epistemic Network Analysis (ENA). ENA is used to quantify epistemic frames (Shaffer, et al., 2009) by adapting social network analysis framework to instead map sociocognitive elements. The ability to quantify the state of an epistemic frame at a given point allows researchers to compare epistemic frames in diverse social circumstances (e.g. different individuals, groups of individuals, or individuals) over time (Bagley & Shaffer, 2009; Nash & Shaffer, 2010).

**Impact**

**Engagement.** One reason games are used in education is because they are engaging to young people (Gee, 2003; 2007, Shaffer, 2007). However, there has been little research
measuring how engagement during game play affects an individual’s personal beliefs or attitudes. Therefore, in this study, engagement was measured using a validated measure developed for use into a text-based narrative world (e.g. a novel) by Green and Brock (2000).

Research on engagement in narratives suggests that the extent to which one becomes engaged, transported or immersed in a narrative influences the narrative’s potential to affect subsequent story-related attitudes and beliefs (Busselle and Bilandzic, 2008). Green and Brock (2000) argue that engagement can be measured by quantifying the extent to which individuals are absorbed into a story or transported into a narrative world.

Green and Brock conceived of transportation as a convergent process, where all mental systems and capacities become focused on events occurring in the narrative (e.g. being lost in a story; Nell, 1988). The first consequence of transportation is that parts of the world of origin become inaccessible. For example, a transported reader may not notice others entering the room. Second, transported readers may experience strong emotions and motivations, even when they know the events in the story are not real (Gerrig, 1993). For example, when transported into narratives with unhappy endings, transported individuals are likely to engage in what Gerrig (1993) termed anomalous replotting: “actively thinking about what could have happened to change an outcome” (p.177).

Green and Brock (2000) write about transportation into a text-based narrative world (e.g. a novel), but they argue that transportation is not limited to the reading of written material. Rather, narrative worlds are broadly defined with respect to modality; the term “reader” may be construed to include listeners, viewers, or any recipient of narrative information. Whether the
narrative is fictional or nonfictional, the same processes involved in transportation are theorized to occur. In addition, Bangert-Drowns and Pyke (2001) suggest that electronic educational media such as tutorials, simulations, interactive activities, and websites, though not often thought of as texts, are increasingly a preferred means of information for young people. Thus, Green and Brock’s (2000) principles of transportation may be useful in measuring the impact of a virtual experience like Urban Science on players’ level of engagement.

**Research Questions**

The aim of this study is to determine whether having mentors communicate with players through a virtual chat program rather than face-to-face changes anything about the players’ experience. That is, the study examines whether the urban planning *epistemic frame* developed equivalently in both conditions as a way of assessing whether the *science, ethics, praxis triad* was constructed equivalently in both conditions. That having been said, the goal of this particular study is not to not judge the specific merits of the particular epistemic frame developed: a question which has been examined before (Bagley & Shaffer 2009; Bagley 2010), and presumably will and should be the subject of future research.

Specifically, this study examines virtual chat versus face-to-face conditions during Urban Science and asks:

1. Was the mentors’ discourse during the reflection meetings different between the two conditions?
2. Was the players’ discourse during the reflection meetings different between the two conditions?
3. Were the players’ outcomes different between the two conditions?

4. Was the players’ level of engagement different between the two conditions?
CHAPTER 3: METHODS

This chapter explains how the metrics described in the Theory chapter were implemented by first describing the setting and the activities for both conditions of Urban Science and then discussing the three types of data that were collected, segmented, coded, and analyzed. Data were collected from the following sources: (1) discourse data from the reflection meetings, (2) matched-pair and engagement question responses from the player interviews, and (3) players’ final proposals.

Participants

21 high school aged players (11 females, 10 males) recruited by outreach specialists at the Massachusetts Audubon Society’s Drumlín Farm Wildlife Sanctuary played a 10-hour version of Urban Science as part of a week-long Conservation Leadership Program in August 2010 (recruitment materials in Appendix 1). The education specialists recruited young people who had previously participated in at least one Massachusetts Audubon Society program, though not necessarily a program at Drumlín Farm Wildlife Sanctuary. Thus, players had experience with Massachusetts Audubon Society programming, but they had no prior experience with urban planning.

The two mentors (called planning consultants) in the game were a graduate student (the author) and a Drumlín Farm education specialist. Both mentors underwent a one-day training that covered the urban planning profession, the game’s activities, and preferred mentoring strategies. In addition, the mentors met before each session to plan for the day’s activities and after each session to reflect on those activities. The mentors’ main role was leading team
meetings and responding to player questions and is described in more detail in the game description section. The mentors were given a script to follow, called the game’s playbook, and they were instructed to keep the conditions as similar as possible (script in Appendix 2).

**Intervention**

The data for this study were collected from two conditions of Urban Science, an epistemic game designed to simulate an urban planning practicum experience (Bagley, 2010). In the game, players were assigned to one of two conditions, face-to-face or chat. In each condition, players were then assigned to one of three stakeholder teams (People for Greenspace, Madison Developers’ Consortium, or Northside Neighbors), and each team worked with one of the two mentors. From 9:00-12:00 on Tuesday, Wednesday, and Thursday, 11 players interacted face-to-face with their mentors in the room. From 12:30-3:30 on Monday, Tuesday, and Wednesday, 10 different players interacted with their mentors through an online, internal chat program. There were two adults physically in the room with the players in the chat condition. Players were told that those adults, both education researchers, were in the room to help with technical problems, and that questions dealing with the game should be sent to the virtual mentors. Everything else about the two games was the same (or as close to the same as possible) (Table 2).

<p>| Table 2 |
| List of Urban Science activities and duration of each activity. |</p>
<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video</td>
<td>15</td>
</tr>
<tr>
<td>Intake interview</td>
<td>15</td>
</tr>
<tr>
<td>Staff page</td>
<td>15</td>
</tr>
<tr>
<td>Virtual site visit, site</td>
<td>60</td>
</tr>
<tr>
<td>Activity</td>
<td>Duration</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>assessment</td>
<td></td>
</tr>
<tr>
<td>Reflection meeting</td>
<td>15</td>
</tr>
<tr>
<td>iPlan practice</td>
<td>15</td>
</tr>
<tr>
<td>Reflection meeting</td>
<td>15</td>
</tr>
<tr>
<td>Target identification matrix</td>
<td>30</td>
</tr>
<tr>
<td>Preference survey</td>
<td>60</td>
</tr>
<tr>
<td>Preference survey feedback</td>
<td>15</td>
</tr>
<tr>
<td>Reflection meeting</td>
<td>15</td>
</tr>
<tr>
<td>Stakeholder assessment</td>
<td>75</td>
</tr>
<tr>
<td>Reflection meeting</td>
<td>15</td>
</tr>
<tr>
<td>New teams, final plan</td>
<td>45</td>
</tr>
<tr>
<td>Reflection meeting</td>
<td>15</td>
</tr>
<tr>
<td>Final proposal</td>
<td>60</td>
</tr>
<tr>
<td>Reflection email</td>
<td>15</td>
</tr>
<tr>
<td>Reflection meeting</td>
<td>15</td>
</tr>
<tr>
<td>Exit interview</td>
<td>30</td>
</tr>
</tbody>
</table>

When players were not playing Urban Science, they were participating in outdoor activities with Massachusetts Audubon Society Drumlin Farm Wildlife Sanctuary education specialists. The activities both groups participated in were similar and were unrelated to the redevelopment site players explored during Urban Science. For example, with guidance from the Drumlin Farm Wildlife Sanctuary education specialists, players used mobile mapping devices to document the location of invasive species within the Sanctuary for conservation managers. Players also toured the Sanctuary grounds, removed large amounts of invasive species, and met
with local environmental leaders. More specific details about the activities and the timing of the activities are available in Appendix 3.

**Game description**

In Urban Science, players redesigned the Northside neighborhood, an ecologically-rich area in Madison, WI. The game began with the players arriving at the computer lab at Drumlin Farm Wildlife Sanctuary. This lab served as the office of the fictional urban planning firm Urban Design Associates. Players were greeted by a Drumlin Farm education specialist and were instructed to watch a corporate video about Urban Design Associates. Players were given login and password information for the company-specific intranet portal.

The game began with the players signing in to the company-specific intranet portal. Upon signing in, the players checked their email inboxes and received emails from fictitious virtual characters, referred to as non-player characters or NPCs, including the principal planner (named Curt) and community facilitator (named Maggie). Players were also introduced to their mentor (either through the internal chat program or face-to-face) who informed players that they were available to answer questions and that they would hold six reflection meetings throughout the game.

After meeting their mentors, the players received an email message from the community facilitator asking the planning interns to take an online intake interview which included open-ended questions about science, technology, and urban planning (Appendix 4). After completing their intake interviews, players received an email asking them to create a staff page on the company’s website. Players were then directed to read the City Council’s Request for Proposals...
and acted as planning liaisons for one of three fictitious stakeholder groups concerned with the
development of the Northside neighborhood: People for Greenspace, Madison Developers’
Consortium, or Northside Neighbors. The players’ teams were referred to as “stakeholder
teams,” and both mentors worked with the same stakeholder teams in both conditions (e.g., Rose
(pseudonym) worked with the Northside Neighbors stakeholder teams in both the face-to-face
and chat conditions).

Players conducted a virtual site visit of the Northside neighborhood, during which they
interviewed NPCs representing stakeholders in the community to learn about the types of issues
they cared about. For example, one stakeholder, Patty, a member of the People for Greenspace
group said:

I’m here today because I’m concerned about the development plans for the north side and
how they’ll affect the sandhill cranes in the area. The marshlands are the natural home to
these magnificent birds, and several of the local business-minded individuals would like
to take those homes away from the birds to make way for homes and businesses for
humans. I feel very uncomfortable giving them the go-ahead to do that. The sandhill
cranes need a certain amount of space to establish nesting sites, and those development
plans would impinge on the cranes’ natural territory. In fact, according to several
members of the Audubon society, the space allocated to the marshland may not be large
enough for the cranes to establish enough nests to maintain the population. I was hoping
you’d find a way to cut back the already existent housing and industrial zoning to make
space for the cranes. I know the cranes don’t pay taxes, but the people like myself who
live here do, and we appreciate being this close to nature.

Players recorded the virtual stakeholders’ opinions in their planning notebooks and
completed a site assessment, a brief summary of the important features of the site annotated with
insights gathered from stakeholders. After completing their site assessments, each team held a
reflection meeting where the mentor asked players about the site and discussed the stakeholder
groups’ requests.
During each of the reflection meetings, the mentors asked a series of four questions (the first two questions were asked to each player, and the last two questions were addressed to the entire team):

1. What did you just finish doing?
2. What did you find out during that activity?
3. With the information we have, what should we do next?
4. What additional information do we need to do that?

The mentors were instructed to listen to the responses before interjecting, and after players responded to questions two and four, the mentor revoiced (Cazden, 2001) and extended the players’ responses to include specific epistemic frame elements pre-determined to be important for that specific point in the game. If the players did not mention the pre-determined epistemic frame elements, the mentor was instructed to fill in the gaps using the playbook script.

For example, after players answered the first two questions during the virtual site visit reflection meeting, the mentors were instructed to refer to the script and say:

So if I can summarize, it sounds like you collected some data about the site. You found out about its history, and also what some of the people there care about. They seem to care about two types of things: social issues and environmental issues. You also started to learn how we do things here at UDA: our supervisor Maggie often sends instructions in emails, and you can get help from professional resources, colleagues, and mentors.

The mentors asked the next set of questions after all of the team members agreed with the mentor’s assertion, and the revoicing after the fourth question transitioned the players into the next activity. For example, after the players answered the fourth question during the virtual site visit reflection meeting, the mentors were instructed to refer to the script and say:
So we need to try to collect more data. Ideally, we would find out more specific data about what the stakeholders want. For example, how many more jobs would make them happy?

We have a special tool at UDA called iPlan. Using iPlan, we can make experimental land use changes and see the projected effects of those changes on issues that the stakeholders care about.

Maggie has probably already looked at your site assessments and sent you some instructions on what to do next.

Though the first reflection meeting was chosen to highlight the mentors’ revoicing, all of the other reflection meetings followed the same structure while focusing on different content.

To propose land use changes, players used iPlan, an interactive GIS model of the planning site that helped them assess the ramifications of those changes. In iPlan, players could change land use designations for the parcels, units of land held by a single owner. Land use codes, including “Retail”, “Manufacturing”, “Open Space”, “Commercial”, and a variety of options for housing were represented on the map in a unique color.

The iPlan model also included graphs representing social and environmental indicators important to the neighborhood. For example, the issues that were impacted by land use changes included: greenspace (acres), housing (units), jobs (number), neighborhood character (0-10 index), sales (thousands of dollars/month), sandhill crane nesting sites (number), traffic (car trips/day), water quality (parts per billion of carbon tetrachloride), and water runoff (parts per million of nitrates).

As players changed the land uses of parcels, the graphs dynamically updated, showing the projected impact of the land use changes on the social and environmental conditions of the neighborhood. For example, if players chose to change the land use from a wetland to high-
density housing units, the possible number of sandhill crane nesting sites and overall water quality would decrease while the amount of available housing units and projected traffic would increase. Any single change to the physical representation of the Northside neighborhood resulted in possible changes to its nine indicator values. Through using iPlan, in other words, players saw a physical representation of the Northside neighborhood, the land use allocations for the street, and the consequences of their proposed land use changes. After engaging with iPlan, each team held a reflection meeting where the mentor asked players about their work and discussed the projected social and environmental relationships in the model.

Using iPlan, players worked in their stakeholder teams to construct preference surveys. Similar to the planning practicum (Bagley, 2010), in Urban Science each preference survey was a set of possible planning alternatives, captured and represented in an iPlan map. The combinations of different land use decisions making up those alternatives were 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 Northside Neighbors—or how many additional square feet of parks were needed for the support of the People for Greenspace.

Once completed, players submitted their preference surveys to their stakeholder group. The virtual stakeholder responses were generated based on comparisons between stakeholder group thresholds for particular quality indicators (e.g., where the group might want more than a certain quantity of sales or less than a certain amount of traffic) and the value for those indicators
was calculated from the players’ preference survey plans. When a plan satisfied a given stakeholder’s threshold, the stakeholder provided positive feedback. When a plan did not satisfy the threshold, negative feedback was provided. Once the appropriate feedback for a particular stakeholder group was generated, it was then embedded in an email message from the community facilitator to the player, with the feedback shown as a series of short comments ostensibly gathered during a stakeholder focus group meeting. For example, one player working with the People for Greenspace received the following feedback from a stakeholder named Patty:

    This plan doesn’t give over nearly enough space for sandhill crane nesting. Areas this cramped won’t permit a stable population and the birds will either resettle elsewhere in the country or die out. It would be disastrous for Madison to lose these cranes. They’re a direct connection between the people that live here and the nature around them. Without them, we’d be living in a concrete jungle. I won’t approve this plan until there’s adequate space for crane nesting.

Next, each team held a reflection meeting to reflect on their stakeholders’ feedback and completed a stakeholder assessment form, an online tool used to summarize the stakeholder feedback. After completing the stakeholder assessment, the teams reflected on the process of aggregating stakeholder feedback from multiple preference surveys.

New planning teams (with one player from each stakeholder planning team) were formed to draft a final plan, and the new teams held a reflection meeting where they shared information about their stakeholder groups with their new colleagues. Each player then created a final plan using iPlan to attempt to address the needs of all of the stakeholder groups. Land use choices made in these final plans were then contextualized and justified by each player in a final proposal which was organized in four sections: 1. Introduction/goals, 2. Recommendations, 3. Justifications, and 4. Limitations. While completing the final proposals, all players had access to
a sample final proposal (Appendix 4) which highlighted the professional norm of communicating goals, challenges, recommendations, justifications, and limitations and contained criteria for the kind of proposal that might succeed in the planning profession.

Before finishing the game, each team held a reflection meeting to reflect on the game activities and discuss if or how the game might apply to their towns. All players then took an online exit interview in which they answered open-ended questions about science and urban planning in text boxes and answered 5-point Likert-scale questions (1 = strongly disagree, 4 = strongly agree) about their level of engagement during the game.

Data collection

Three sources of data were collected in both the face-to-face and chat conditions of Urban Science: (1) players’ intake and exit interview responses, (2) players’ final proposals, and (3) mentors’ and players’ reflection meeting discourse. Discourse data from the first four reflection meetings were used because players switched from their stakeholder teams into their final plan teams after the fourth reflection meeting which meant that the player:player and player:mentor relationships had changed.

In both conditions, the online portal recorded the players’ intake and exit interview responses as well as their final proposals. In the chat condition, all of the players’ and mentors’ reflection meetings were recorded by the online portal. In the face-to-face condition, the reflection meetings were audio recorded and transcribed. All records were de-identified by replacing references to usernames (names used to sign into the online portal) with pseudonyms, such that the resulting data set contained no identifying information about the participants.
Qualitative data analysis

During the intake interviews, players were asked a series of eight questions related to their computer use in order to ensure that players in both conditions were starting with similar computer competency baselines (Appendix 4).

Players were asked six four-point Likert-scale (1=strongly disagree, 4=strongly agree) questions during the exit interview (Table 3) to measure their level of engagement during the game. As described in the Theory chapter, the questions were adapted from Green and Brock’s (2000) narrative questionnaire to fit the virtual internship environment rather than the literary environment from which they originate. The mean scores for each of the six questions were calculated within each condition, and t-tests were used to compare the responses between conditions.

Table 3

Exit interview questions used to measure engagement. The questions were adapted from Green and Brock’s (2000) narrative questionnaire to fit the virtual internship environment rather than the literary environment from which they originate.

<table>
<thead>
<tr>
<th>Question number</th>
<th>Question text</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>While I was in the internship, I could easily picture the events in it taking place.</td>
</tr>
<tr>
<td>E2</td>
<td>I could picture myself in the internship.</td>
</tr>
<tr>
<td>E3</td>
<td>I was mentally involved in the internship while it was going on.</td>
</tr>
<tr>
<td>E4</td>
<td>After finishing the internship, I found it easy to put it out of my mind.</td>
</tr>
<tr>
<td>E5</td>
<td>I wanted to learn how the internship would turn out.</td>
</tr>
<tr>
<td>E6</td>
<td>I found my mind wandering while doing the internship.</td>
</tr>
</tbody>
</table>

Responses from a matched-pair question in the intake and exit interviews were analyzed to determine whether the players’ interview outcomes were different between conditions. The matched-pair question asked players to consider possible solutions to improving the water quality in a lake or river:
The town of Maple Ridge, MI [Forest Hill, CO]⁶ is concerned about high levels of nitrates and carbon tetrachloride in their lakes [rivers]. What could they do to clean up their lakes [rivers] if they care most about reducing the level of nitrates (NO₃⁻) [carbon tetrachloride (CCl₄)]? 

The matched-pair interview responses were coded (using the codes described below) and scored on a 0-2 scale, in which a zero indicated an incorrect response, one indicated a partially correct response, and two indicated a correct response.

Players’ final proposals were analyzed to determine whether the players’ final proposals were different between conditions. The final proposals, including the sample final proposal available to all players, were segmented by section and coded using the codes described below.

Mentor and player discourse from the first four reflection meetings were analyzed to determine whether the discourse was different between conditions. The reflection meetings were segmented by conversational turn and coded using the codes described below.

**Data coding.** The matched-pair interview question, final proposals, and reflection meeting discourse were coded using a set of 21 codes (Table 4). The codes were developed by using the American Planning Association’s (2011) description of what professional planners know, do, and care about and by using epistemic frame theory as a guide for categorizing professional thinking. A set of representative excerpts were chosen from the full data set, and grounded theory (Strauss & Corbin, 1998) was used to develop a more specific set of qualitative codes representing aspects of urban planning expertise.

The examples provided in Table 4 are exemplars for the specific category they are highlighting; however, the examples may also be coded for other categories (e.g. the E1 example

---

⁶ Text in brackets denotes the matched-pair text.
is also coded for V1, S5, K1, and K2). In Table 4, the code labels are drawn from epistemic frame theory which suggests that there are particular categories of discourse to examine when coding professional thinking (Shaffer, 2010). For example, labels starting with E were epistemological categories in the coding system, labels starting with S refer to skills codes, K refers to knowledge codes, V refers to values codes, and I refers to identity codes). Although these super-ordinate categories do not play a role in the analysis that follows, they were retained for consistency with previous work (described in the appendices) on which this study was based.

Similarly, following epistemic frame theory, the analyses that follow explore the patterns of co-occurrence among the epistemic frame elements, rather than the prevalence of one category in isolation over another.

**Table 4**

*Urban Science coding scheme including the code label, description, and example for the 21 codes used to code the matched-pair interview question, final proposals, and reflection meeting discourse.*

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1: Justification considers and describes stakeholders with voices</td>
<td>Using people’s concerns (sometimes conflicting) to justify a decision as a planner would (e.g. a compromise or a resolution)</td>
<td>…But it’s also really important for us to try to meet everybody’s needs and from what I heard from just these two different groups, you guys have some pretty different needs, right? So we have people who want to really preserve greenspace and people who want to develop and have more housing and more things like that, so we’re going to have to come up with some compromises, right?</td>
</tr>
<tr>
<td>E2: Justification considers and describes stakeholders</td>
<td>Using the concerns/needs of environmental stakeholders as a planner would (e.g. needs of animals, plants, habitat, water or</td>
<td>I do not think the amusement park should build on this wetland even if they will create a new one elsewhere. A new man-made wetland would lack</td>
</tr>
</tbody>
</table>
without voices | air quality) Using the concerns/needs of future generations as a planner would | the complex interactions and relationships existing in the current wetland…I do not think a created wetland could suffice to cover the damage to the inhabitants and surrounding habitats caused by the destruction of the original wetland.

| E3: Justification considers and describes decisions using objective data (not stakeholder opinions) | Using objective data (not stakeholder opinions) to justify a decision as a planner would | By reducing the number of factories and increasing the number of wildlife sanctuaries, both the CCl4 and NO3 levels should decrease.

| V1: Serving the public interest | Seeing one’s job and/or responsibility as representing the concerns and meeting the needs of others | Well one issue is how are the changes going to affect the people and also the wildlife living in the city. Most people would feel like that’s an important thing to keep in the back of your mind. 

Do you think your stakeholders will approve?

| V2: Multiple perspectives | Seeing one’s job and/or responsibility as taking into account different residents’ preferences and/or perspectives about a site Seeing one’s job and/or responsibility as being aware of/being able to identify bias (personal and stakeholders’ bias) | Saeed is having difficulty selling houses due to the lack of jobs. He has suggested that we increase job opportunities in the area. Gabe reports that the total number of sales in businesses are down, making it hard to start new businesses. Having more people visit should help increase sales. Natalie says that the levels of nitrates and carbon tetrachloride are above acceptable levels, but we could safely change the limits…

| V3: Environmental concerns | Seeing one’s job and/or responsibility as representing environmental concerns | They should not be allowed to harmfully affect the lives of others and the cleanliness of the environment.

| S1a: Explicit use | Numbers, even if they are present | I want 50 more housing units.
<table>
<thead>
<tr>
<th>S1b: Implicit use of data</th>
<th>More/less, acceptable/unacceptable, higher/lower (even if the term is by itself)</th>
<th>I want more housing units. Higher. I decreased housing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1c: Information, data, research</td>
<td>Explicitly refers to information, data, or research</td>
<td>I need more information/data. Look at the graphs.</td>
</tr>
<tr>
<td>S1d: Data source</td>
<td>Explicitly mentions a source of data</td>
<td>I listened to stakeholder feedback. I learned from the virtual site visit that… iPlan</td>
</tr>
<tr>
<td>S2: Hypothesis generation and testing</td>
<td>Ability to hypothesize projected impacts and tradeoffs of multiple scenarios Ability to test hypotheses (e.g. social and environmental) in a closed environment (using iPlan)</td>
<td>I believe that this will allow the character index to go up after a period of time by allowing new people to come into the area. That is why I have left the current character index untouched.</td>
</tr>
<tr>
<td>S3: Identifying goals</td>
<td>Ability to identify stakeholders’ goals for the site including using terms like unacceptable, acceptable, more, less (most often found in the site assessment, stakeholder assessment) Ability to state the goals the planner was aiming for in a proposed urban plan (most often found in the preference survey, final proposal)</td>
<td>My goals in this proposal were the following: - to increase the crane nesting sites - to increase the water quality - to have minimal traffic - to have a high sale ($$$) - to have a good neighborhood character 75 is acceptable They want more [where we assume “they” refers to stakeholders] I need the number of crane nesting sites to be higher</td>
</tr>
<tr>
<td>S4: Justifying recommendations</td>
<td>Ability to justify specific recommendations and/or action to others [If players justify why their stakeholders want something, that doesn't count as S5 because it's]</td>
<td>By increasing the amount of housing and jobs with retail areas, people can open business and also move into the area. This will bring in new individuals into the area which allows for the areas growth in terms of</td>
</tr>
<tr>
<td><strong>S5: Compromise</strong></td>
<td>Ability to explicitly mention that a compromise is being/was made</td>
<td>I believe that I can improve on my judgment when creating city plans in which I need to compromise with other groups in order to satisfy the needs of everyone. I think that this time, I was more biased towards being more business and industrial and I think ignored people who wanted more greenspace…</td>
</tr>
<tr>
<td><strong>K1: Social impact of decisions on communities</strong></td>
<td>Identifying and measuring social impacts or issues such as: neighborhood character index, character index, housing, jobs, sales, traffic</td>
<td>By increasing the amount of housing and jobs with retail areas, people can open business and also move into the area. This will bring in new individuals into the area which allows for the areas growth in terms of diversity. I believe that this will allow the character index to go up after a period of time by allowing new people to come into the area. That is why I have left the current character index untouched.</td>
</tr>
<tr>
<td><strong>K2: Environmental impact of decisions on communities</strong></td>
<td>Identifying and measuring environmental impacts or issues such as: sandhill crane, nesting sites, carbon tetrachloride, CCl4, nitrates, NO3, greenspace, water quality, water runoff, runoff, ppb, ppm, marshes, air quality, habitat quality, habitat</td>
<td>Natalie says that the levels of nitrates and carbon tetrachloride are above acceptable levels, but we could safely change the limits.</td>
</tr>
<tr>
<td><strong>K3:</strong></td>
<td>Ability to identify and/or describe the possible consequences and/or Cities and people affect their surroundings and almost everything</td>
<td></td>
</tr>
</tbody>
</table>
| Interconnectedness | tradeoffs of hypotheses and/or decisions [the tradeoffs can be social, environmental, or socio-economic]  
Ability to discuss constraints of the model (iPlan) or the planning process | they do. The pollution that cities and factories bring, as well as the cars that people are driving. The urbanization takes away from coastal areas, natural forest, and many other environments. |
| K4: Following an existing process or strategy | Virtual site visit, site assessment, preference survey, iPlan, target identification matrix, matrix, TIM, stakeholder assessment, final proposal, recommendations, justifications, limitations, map, target, professional resource, request for proposals, final plan, plan (if used as a noun), urbanization | I learned from this experience that a city planner must take into consideration a lot of opinions including their own. I did not know about such pressures before. Also, I learned about the multistep process planners go through to plan a city from asking for opinions all the way until proposing a final plan. This gives me new appreciation for the work of people which have planned any city I go to. |
| K5: Knowledge of land use codes | Land use, land use code, zoning, parcel  
R1, R2, R3, R4, single family, duplex, multi-family  
C1, C1-R3, C1-R4, C2, retail, office  
M1, M2, manufacturing, industry, factory  
OS, OS-R, OS-W, open space, open space recreational, wetland | Changing the wetlands to recreational space, so that there are less cranes and more leisure space for parks and such.  
Changing R1 into R3 so that there are more houses within eachother and more surrounding space.  
Changing M2 into C1 or C2 so that there is more retail and offices. |
| I1: Planner identity | Planner, Company, UDA, Urban Design Associates | So let me rephrase a little bit what it sounds like we’re saying, so, being a planner you have to do a bunch of things… |
| I2: Intern identity | Internship, Intern, Staff  
Players’ typed staff pages are coded for I2 | I wrote it on my staff page.  
…it’s really helpful for Maggie to know how your internship is going… |
While coding the data, the coder read each excerpt separately and applied one code (presence = 1, absence = 0) at a time. The validity of the coding process was checked through an inter-rater reliability analysis in which an educational psychology researcher working in a non-planning domain was trained on the coding scheme and independently coded 150 randomly selected excerpts of the data. Correlation among the codes assigned by both the primary and secondary coders were checked, and all codes had a Cohen’s Kappa greater than 0.6 (Landis & Koch, 1977).

The qualitative analyses in the following Results chapter measure the quantity, quality, and impact of mentoring in both conditions and explores whether players and mentors were talking about different epistemic frame elements in different ways between the conditions. The qualitative analyses uncovered several themes in the reflection meeting discourse data (e.g. discourse about stakeholders’ desires), and ENA was used to triangulate the qualitative data and examine how the themes unfolded and whether or not they unfolded similarly or differently across conditions.

**Epistemic Network Analysis**

Epistemic Network Analysis (ENA) measures relationships among epistemic frame elements within an epistemic network (Shaffer et al., 2009), and this quantitative method was used to triangulate the qualitative findings. For a worked example describing using ENA on the qualitative data, please refer to Appendix 5.

ENA was applied to the players’ final proposal data and the mentor and player reflection meeting discourse data. Since ENA is an emerging technique, the variables and equations used in
the ENA calculations for Urban Science are defined here. In ENA, the urban planning epistemic frame is characterized by individual epistemic frame elements $f_1 \ldots f_n$. Any participant discourse $p$ has data, $D^p_t$, which contains evidence that at time $t$, participant $p$ used one or more elements of the urban planning epistemic frame. As described above, each segment of coded qualitative data was represented as a vector with ones or zeroes representing presence or absence, respectively, of each of the 21 codes. To construct an epistemic network from $D^p_t$, each coded vector was converted into an adjacency matrix, $A^{p,t}$, for participant $p$ at time $t$ which calculated the frequencies of co-occurrence among the epistemic frame elements (1).

\[ (1) \ A^{p,t}_{i,j} = 1 \text{ if } f_i \text{ and } f_j \text{ are both in } D^p_t \]

The adjacency matrix $A^{p,t}_{i,j}$ was then used to create a cumulative adjacency matrix, $F^p$. The four sections of the coded final proposals were aggregated by individual mentor or player resulting in one unit of analysis for each individual. The coded reflection meeting data were aggregated by topic using the four questions asked during each meeting as the topics. That aggregation resulted in 16 units of analysis for each individual (four questions asked during four meetings). Thus, the cumulative adjacency matrix for participant $p$, $F^p$ was calculated by aggregating the adjacency matrices $A^{p,t}$ by final proposal section or reflection meeting question (2).

\[ (2) \ F^p = \sum A^{p,n} \]

To control for the variation in excerpt length, the cumulative adjacency matrices were normalized by dividing each value by the square root of the sum of squares (3).

\[ (3) \ nF^p = F^p / \sqrt{\sum (F^p)^2} \]
A classical multi-dimensional scaling (MDS) algorithm was then applied to the final proposal and reflection meeting adjacency matrices in order to identify the dimensions that captured the most variance in the data. In this paper, the first and second dimensions (the dimensions that captured the most variance in the data) are plotted. The plots with the reflection meeting data were created from adjacency vectors that included both the mentor and player reflection meeting data. The final proposal plot was created from adjacency vectors from the players’ final proposals and the sample final proposal.
CHAPTER 4: EMPIRICAL RESULTS

Research Questions

This paper examines two conditions of Urban Science and measures the quantity, quality, and impact of mentoring in those conditions. It addresses the following research questions:

1. Was the mentors’ discourse during the reflection meetings different between the two conditions?
2. Was the players’ discourse during the reflection meetings different between the two conditions?
3. Were the players’ outcomes different between the two conditions?
4. Was the players’ level of engagement different between the two conditions?

The small size of the samples (N = 2 mentors, N = 21 players) means that the following analyses are fundamentally qualitative. Where possible, quantitative analyses are used, and results are reported as means with standard errors. In some cases, inferential statistics are also computed; however, as with any small-scale study, the results are not generalizable to other populations. Following Shaffer and Serlin (2004), the purpose of such significance tests is to show that additional observations made under the same conditions would show similar results.

Part 1: Comparing Mentor Discourse

Analysis of mentor discourse during the reflection meetings is composed of three sections. The first section uses word counts, following Schneider et al. (2002) as described in the Methods and Theory chapters above, to analyze the similarities and differences in mentor
discourse between conditions. The second section uses qualitative excerpts and quantitative methods including Epistemic Network Analysis (ENA), as described in the Methods section, to analyze the differences in mentor discourse among the reflection meetings. The third section uses qualitative excerpts and quantitative methods including ENA to analyze the similarities in mentor discourse between the two conditions.

Section 1: Structural differences and semantic similarities between conditions

An initial analysis used word counts to examine structural similarities between the face-to-face and chat conditions. The mean word counts were computed for each mentor during each reflection meeting (a total of three data points for four meetings in each condition, for a total of 24 data points). Across all reflection meetings, mentors in the face-to-face condition used significantly more words (mean = 2857, standard deviation (SD) = 755, p\textsuperscript{7} < 0.05) during interactions with their teams than mentors in the chat condition (mean = 1244, SD= 327). Further, within each reflection meeting, the mentors also used more words in the face-to-face condition than in the chat condition (see Figure 4).

\textsuperscript{7} The paired Mann-Whitney U test was also significant: z = -3.776, p < 0.05.
Figure 4. Mentors’ reflection meeting mean word counts with standard error. This graph shows that the mean word counts for all of the meetings were greater in the face-to-face condition than in the chat condition.

An examination of the discourse of one mentor, Elise (pseudonym), working with the “People for Greeenspace” stakeholder team in both conditions showed that during Reflection Meeting 1, Elise used nearly three times more words in the face-to-face (1284 words) condition than in the chat condition (433 words). For example, Table 5 shows that in both conditions, Elise asked players the same question. She used more words in the face-to-face condition (66 words) than in the chat condition (12 words); however, although there were more words in the face-to-face condition, the main topic was similar across the two conditions. In the chat condition, she said, “So, with the information that we have, what should we do next?” Similarly, in the face-to-

---

8 Of course, standard error bars as presented here should be interpreted with caution, especially with data derived from small samples: even when standard error bars do not overlap, there may be no statistically significant difference. In this example, each bar represents the mean of three points, so significance testing of the individual meetings was not possible.
face condition, Elise said: “[I]f you have information about the site, what do we do now as planners? What’s our next step?”

Table 5
*Excerpt from Elise’s discourse during Reflection Meeting 1 for the People for Greenspace stakeholder team showing that, when asking players what they should do next (colored orange), she used more words in the face-to-face condition than in the chat condition.*

<table>
<thead>
<tr>
<th>Chat (word count = 12)</th>
<th>Face-to-face (word count = 66)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>So, with the information that we have, what should we do next?</strong></td>
<td>Well so what does that mean okay, I don’t want you to look at the calendar and just tell me what the calendar says ok. I really want you to think like planners ok. <strong>I want you to think about what, if you have information from your stakeholders, if you have information about the site, what do we do now as planners? What’s our next step?</strong></td>
</tr>
</tbody>
</table>

Although the main discourse elements were similar (asking about next steps), Elise provided additional information in the face-to-face condition to contextualize her request: she addressed a player’s concern about the calendar, made explicit references to the players as “planners”, and used the term “stakeholders”. In her face-to-face excerpt, Elise also repeated herself and used features of face-to-face talk, including filler words (Tannen, 1982) such as “well”, “so”, and “okay” which contributed to the higher word count. Thus, there are a number of reasons why the word count was greater in the face-to-face condition than in the chat condition.

For the face-to-face condition, the word count in Reflection Meeting 1 was higher than Reflection Meetings 2, 3, and 4. Therefore, there may have been differences between the meetings that would make comparing meetings between conditions problematic. Thus, the next section examines only the face-to-face condition to explore whether there were differences
between the meetings that need to be accounted for before analyzing similarities and differences between conditions.

Section 2: Mentor discourse compared by meeting

This section analyzes qualitative examples from Elise’s “People for Greenspace” meetings and Rose’s “Northside Neighbors” meetings in the face-to-face condition to examine the differences between meetings. This section also uses Epistemic Network Analysis (ENA), as described in the Methods section, to quantitatively analyze the differences in mentor discourse between meetings.

Qualitative comparison of mentors’ discourse between meetings. Reflection Meetings 1 and 2 were held after the virtual site visit and iPlan practice activities, respectively. During Reflection Meeting 1, mentors were instructed to discuss collecting data, site history, stakeholder opinions about social and environmental issues, and professionalism. In contrast, during Reflection Meeting 2, mentors were instructed to discuss ways of using a model (iPlan) to project social and environmental impacts and interconnectedness. Despite the different focus of the meetings, the mentors were instructed to ask players the same question, “With the information we have, what should we do next?” Unsurprisingly, when Elise asked her People for Greenspace team that question in both meetings, she discussed different topics (Table 6).

Table 6

<table>
<thead>
<tr>
<th>Meeting 1: Stakeholders’ desires</th>
<th>Meeting 2: Generating hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>So we know <strong>what the goals are for the stakeholders</strong> but we don’t really know specifically what they want, right? We don’t</td>
<td>It sounds like to me, that <strong>because iPlan can measure the projected social and environmental probability changes, it makes</strong></td>
</tr>
</tbody>
</table>
know the specifics of it yet so that might be one thing we might want to know next so if I can wrap it all up again, **we need to collect more data** it sounds like. **We need to figure out if we actually know what people want**, like 24 said, because we might just be getting a bunch of opinions. **We need to know how much of the different issues people really care about** and um, yeah, like how many more jobs would make them happy, do we know that? No, we don’t know, do they want 2 more jobs or do they want 1000?

In Reflection Meeting 1, Elise discussed epistemic frame elements related to the stakeholders’ desires such as the value of serving the public interest (V1) and the stakeholder research players conducted during the virtual site visit (S1c). For example, Elise asked players to think about, “…**what the goals are for the stakeholders...**” She encouraged them to learn more about the stakeholders’ desires by “**collect[ing] more data...We need to figure out if we actually know what people want...We need to know how much of the different issues people really care about.**”

In contrast, in Reflection Meeting 2, Elise discussed epistemic frame elements related to generating hypotheses such as the tradeoffs of different hypotheses (K3), using data (S1b), and testing hypotheses (S2). For example, Elise discussed the use of iPlan to project social and environmental impacts by saying, “**because iPlan can measure the projected social and environmental probability changes, it makes you test ways of making the site work for the stakeholders without actually bringing in bulldozers.**” She explained the interconnectedness of the system by telling players that “**it’s a complex system...changing one parcel impacts more than one indicator.**”
The other mentor, Rose (pseudonym), also discussed different topics during Reflection Meetings 1 and 2. Like Elise, Rose asked her Northside Neighbors team the following question in both meetings, “With the information we have, what should we do next?” and discussed different topics (Table 7).

Table 7
Rose’s face-to-face data from question three during Reflection Meetings 1 and 2 showing (with bolded text) that she discussed stakeholders’ desires during Reflection Meeting 1 and generating hypotheses during Reflection Meeting 2.

<table>
<thead>
<tr>
<th>Meeting 1: Stakeholders’ desires</th>
<th>Meeting 2: Generating hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>… Because we don’t live there, right, so we’re not gonna know what’s needed in the neighborhood. So it’s really important for us to go out there and get the perspective of the people who are actually living there and going to be using the space are needed. …Different opinions, people can be passionate about what they believe in …Yeah, have some sort of compromise. So part of what our job is gonna be is that we’re gonna have to find that sweet spot that everyone can feel comfortable with, that they’re being heard, getting what they’re wanting, but also understanding that some stuff has to go in order for that to happen, right?</td>
<td>… So basically what, do you guys think we can say that what iPlan allows us to do is actually change things virtually without actually changing them, but still see the effect that these changes are going to have, does that make sense? …Ok, so you’re gonna be able to change the things and know what the outcome is without even doing it, because we’re not gonna go down and all of a sudden start banging down apartment buildings and stuff. We may decide that’s what we need to be able to do to create greenspace, but we need to be sure that that’s what is going to make the difference, right? …No, so there were some tradeoffs there, too…</td>
</tr>
</tbody>
</table>

In Reflection Meeting 1, Rose discussed epistemic frame elements related to the stakeholders’ desires such as the social impact of decisions on communities (K1), the value of serving the public interest (V1), and discussing the stakeholder research players conducted during the virtual site visit (S1c). For example, in Reflection Meeting 1, Rose encouraged players to learn about the stakeholders’ desires by “go[ing] out there and get[ting] the perspective of the people who are actually living there and going to be using the space are
needed.” She reminded players that “people can be passionate about what they believe in” and that players would have to work to “find that sweet spot that everyone can feel comfortable with, that they’re being heard, getting what they’re wanting, but also understanding that some stuff has to go in order for that to happen.”

In contrast, in Reflection Meeting 2, Rose talked about epistemic frame elements related to identifying goals (S3), using data (S1b), generating hypotheses such as testing hypotheses (S2), and the tradeoffs of different hypotheses (K3). In Reflection Meeting 2, Rose discussed using iPlan to virtually change the site without “banging down apartment buildings.” She described iPlan’s ability to help players generate hypotheses by saying that, “what iPlan allows us to do is actually change things virtually without actually changing them, but still see the effect that these changes are going to have...you’re gonna be able to change the things and know what the outcome is without even doing it, because we’re not gonna go down and all of a sudden start banging down apartment buildings and stuff.” She also mentioned that iPlan allows players to see tradeoffs.

In the face-to-face condition, the mentors referred to different epistemic frame elements during Reflection Meeting 1 than during Reflection Meeting 2. In order to examine if these excerpts are quantitatively different, the following sub-section uses a statistical technique to explore whether the pattern described above is a fair sample of the properties of the data as a whole.

**Quantitative comparison of mentors’ discourse between meetings.** The differences in mentor references to epistemic frame elements during Reflection Meetings 1 and 2 can be seen
quantitatively as well. For example, using the mean counts for seven epistemic frame elements in the mentors’ discourse shows differences in the topics of the reflection meetings, as displayed in Table 8.

Table 8

<table>
<thead>
<tr>
<th>SKIVE element</th>
<th>Description</th>
<th>Reflection Meeting 1</th>
<th>Reflection Meeting 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>Serving the public interest</td>
<td>6.33</td>
<td>2</td>
</tr>
<tr>
<td>S1c</td>
<td>Information, data, or research</td>
<td>5</td>
<td>2.33</td>
</tr>
<tr>
<td>S1b</td>
<td>Implicit use of data</td>
<td>2.33</td>
<td>4.67</td>
</tr>
<tr>
<td>S3</td>
<td>Identifying goals</td>
<td>2</td>
<td>1.33</td>
</tr>
<tr>
<td>S2</td>
<td>Hypothesis generation, testing</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>K3</td>
<td>Tradeoffs of hypotheses</td>
<td>0</td>
<td>5.67</td>
</tr>
</tbody>
</table>

The co-occurrence of the epistemic frame elements can be measured using ENA in order to provide a picture more indicative of professional expertise. In Reflection Meeting 1 (RM1), the mentors’ discourse included epistemic frame elements related to stakeholders’ desires, and in contrast, in Reflection Meeting 2 (RM2) the mentors’ discourse included epistemic frame elements related to generating hypotheses. The different patterns of co-occurrence during RM1 and RM2 are illustrated by the locations of the mentor means in Figure 5. Because MDS does not preserve the directionality, the specific dimensions shown in Figure 5 are not interpretable, and are not labeled on the graph. However, relative position in space is still meaningful in that points closer together in the high-dimensional space have more similar patterns of co-occurrence than points farther apart. Multi-dimensional scaling produces a lower-dimensional representation that accounts for 13.34% of the variance in the first dimension and 10.21% of the variance in the second dimension. The means are different between the meetings along the first dimension.
(mean RM1 = 0.54, mean RM2 = 0.12, p < 0.05) and the second dimension (mean RM1 = 0.07, mean RM2 = 0.41, p < 0.05). Since there are only a total of six points in each meeting, such results must be viewed as exploratory rather than confirmatory.

**Figure 5. Mentors’ discourse (means).** The mean of six mentor points per meeting (face-to-face and chat condition together) in the high-dimensional space created from the mentor and player data (standard error bars on both dimensions). This graph shows that Reflection Meeting 1 had different patterns of co-occurring epistemic frame elements than Reflection Meeting 2.

The patterns of co-occurrence of epistemic frame elements in mentor discourse were different during Reflection Meeting 1 than during Reflection Meeting 2, and those differences are reflected qualitatively in mentor excerpts and patterns of co-occurring epistemic frame elements and quantitatively in the ENA analysis. The next section further explores Reflection Meetings 1 and 2 by comparing the reflection meeting content between both conditions.
Section 3: Mentor discourse compared by condition

This section provides a qualitative analysis of Elise’s comments during “People for Greenspace” meetings in both conditions to illustrate the similarities between the chat and face-to-face conditions. This section also uses ENA to quantitatively analyze each meeting in each condition in order to explore the similarities in mentor discourse between conditions.

Qualitative comparison of mentors’ discourse between conditions. During Reflection Meeting 1, in both conditions Elise talked about stakeholders’ desires. For example, in both conditions, Elise asked players if they trusted the stakeholders to know what is best for the site. In the chat condition she asked, “Do we trust the stakeholders?” and in the face-to-face condition she asked, “Do you trust the stakeholders…” As in Section 1, Elise’s discourse in the face-to-face condition contained similar content to her discourse in the chat condition, but her face-to-face discourse contained additional filler (Tannen, 1982) words (“like”) and repetition of the same concepts: “Do you guys trust that the stakeholders know what’s best for the site? Do you trust the stakeholders, like do you think they know what’s best?” (Table 9).

Table 9
Excerpt from the People for Greenspace stakeholder teams’ Reflection Meeting 1 showing (with color coding) that in both conditions, Elise covered similar content.

<table>
<thead>
<tr>
<th>Chat</th>
<th>Face-to-face</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do we trust the stakeholders to know what's good for the site?</td>
<td>...do you guys trust that the stakeholders know what’s best for the site? Do you trust the stakeholders, like do you think they know what’s best?</td>
</tr>
</tbody>
</table>

During Reflection Meeting 2 in both conditions, Elise talked about the practice of generating hypotheses with data or through the use of an interactive model (Table 10). For example, in both conditions she informed the players that “iPlan measures the projected social and environmental impacts of zoning changes.” In both conditions, she continued by talking
about iPlan’s ability to “test ways of making the site work for the stakeholders without bringing in actual bulldozers” and ended that portion of Reflection Meeting 2 by reminding players in both conditions that the site “is a complex system, which means that changing one parcel impacts more than one indicator.” She also informed players in both conditions that “there may be trade-offs with every change.” As in Section 1, Elise’s discourse in the face-to-face condition contained similar content to her discourse in the chat condition, but her face-to-face discourse contained additional filler (Tannen, 1982) words (“well”, “so”) and verbal acknowledgements of what the players already said or knew: “...but what all of you were saying is...you all recognize that.” (Table 10).

Table 10
Excerpt from the People for Greenspace stakeholder teams’ Reflection Meeting 2 showing (with color coding) that in both conditions, Elise covered similar content.

<table>
<thead>
<tr>
<th>Chat</th>
<th>Face-to-face</th>
</tr>
</thead>
<tbody>
<tr>
<td>Because <strong>iPlan measures the projected social and environmental</strong> impacts of zoning changes, it allows you to <strong>test ways of making the site work for the stakeholders without bringing in actual bulldozers</strong>. You discovered that one characteristic of the site is that it is a complex system, which means that changing one parcel impacts more than one indicator. <strong>There may be trade-offs with every change.</strong></td>
<td>Because <strong>iPlan can measure the projected social and environmental</strong> probability changes, it makes you <strong>test ways of making the site work for the stakeholders without actually bringing in bulldozers</strong>. Well you discovered one characteristic of the site, especially, but what all of you were saying is <strong>that it’s a complex system</strong>… That means that changing one parcel impacts more than one indicator and I think that you all recognize that. <strong>So there may be tradeoffs with every single change.</strong></td>
</tr>
</tbody>
</table>

Thus, the qualitative analyses in this section show that Elise addressed similar topics during Reflection Meetings 1 and 2 in both conditions. In order to examine if these excerpts are quantitatively different, the following sub-section uses ENA to explore whether the pattern
described above extends to the other mentors and is a fair sample of the properties of the data as a whole.

**Quantitative comparison of mentors’ discourse between conditions.** Elise addressed similar content during Reflection Meetings 1 and 2, and therefore, had similar patterns of epistemic frame co-occurrence, during Reflection Meetings 1 and 2 in both conditions. The similar patterns of epistemic frame co-occurrence in both conditions are illustrated by the locations of the mentor points (means) for each condition in Figure 6. Points closer together in the high-dimensional space have more similar patterns of co-occurrence than points farther apart.

![Mentors' discourse with means](image)

**Figure 6. Mentors’ discourse with means.** All mentors’ data from reflection meetings with means showing that regardless of the communication mode, the mentors covered similar content during the reflection meetings. The distance between conditions for Reflection Meeting 4 may be attributed to the fact that in the chat condition, the meeting was at the end of the day and the meeting was cut short because players had to leave.
Meeting-by-meeting, t-tests on ENA-generated discourse means for both chat and face-to-face conditions showed no significant differences (Table 11). In other words, the variance between the meetings was larger than the variance between the conditions.

**Table 11**

*Means, number of mentor points in the mean (N), and standard deviations (SD) for each meeting and each condition with the results of paired t-tests. There were no significant differences between the means of the conditions (p > 0.05).*

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Dimension</th>
<th>Chat – Mean (N, SD)</th>
<th>Face-to-Face – Mean (N, SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.59 (3, 0.04)</td>
<td>0.49 (3, 0.06)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.03 (3, 0.04)</td>
<td>0.1 (3, 0.05)</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0.05 (2, 0.25)</td>
<td>0.16 (2, 0.1)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.44 (2, 0.07)</td>
<td>0.4 (2, 0.03)</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0.39 (3, 0.08)</td>
<td>0.32 (3, 0.55)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.18 (3, 0.14)</td>
<td>0.21 (3, 0.16)</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0.56 (3, 0.08)</td>
<td>0.32 (3, 0.16)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-0.09 (3, 0.1)</td>
<td>0.02 (3, 0.19)</td>
</tr>
</tbody>
</table>

The mentors’ patterns of co-occurrence of epistemic frame elements were similar during Reflection Meetings 1 and 2, and those similarities can be seen qualitatively in mentor excerpts and quantitatively in the ENA analysis. In other words, regardless of the communication mode, the mentors covered similar content during the reflection meetings.

This part of the results chapter analyzed the mentors’ discourse during the reflection meetings. The first section used word counts to analyze the similarities and differences in mentor discourse between conditions and showed that the mentors used more words in the face-to-face
than in the chat condition. The second section used qualitative excerpts and quantitative methods including ENA to analyze the differences in mentor discourse among the reflection meetings and argued that the mentors referred to different epistemic frame elements during Reflection Meeting 1 than during Reflection Meeting 2. The third section used qualitative excerpts and quantitative methods including ENA to analyze the similarities in mentor discourse between the two conditions and showed that there was no difference in content between the conditions. The next section asks the same questions for the players.

**Part 2: Comparing Player Discourse**

Analysis of player discourse during the reflection meetings is composed of three sections. The first section uses word counts to analyze the similarities and differences in player discourse between conditions. The second section uses qualitative excerpts and quantitative methods including ENA to analyze the differences in player discourse among the reflection meetings. The third section uses qualitative excerpts and quantitative methods including ENA to analyze the similarities in player discourse between the two conditions.

To ensure that players in both conditions started the game with similar levels of computer competency, the intake interview included eight questions asking players how frequently they used computers for specific tasks (e.g. reading blogs, checking E-mail, online shopping, etc.). There were no significant differences between the players in both conditions for seven of the eight questions (p > 0.05). However, when asked “How often do you use computers for: Instant messaging, reading blogs, etc.?” the players in the face-to-face condition reported significantly higher rates (mean = 3.4) than players in the chat condition (mean = 2.4, p < 0.05).
Section 1: Structural differences and semantic similarities between conditions

An initial analysis used word counts to examine structural similarities between the face-to-face and chat conditions. The mean word counts were computed for each player during each reflection meeting (a total of 21 data points for four meetings for a total of 84 data points). Across all reflection meetings, players in the face-to-face condition used significantly more words (mean = 1048, SD= 276) to during the reflection meetings than players in the chat condition (mean = 585, SD= 155, p < 0.05). Further, within each reflection meeting, players also used more words in the face-to-face condition than in the chat condition (see Figure 7).

![Players' reflection meeting mean word counts](image)

Figure 7. Players' reflection meeting mean word counts with standard error. This graph shows that the mean word counts for all of the meetings were greater in the face-to-face condition than in the chat condition.

An examination of the discourse of one team, players who worked with the “People for Greeenspace” stakeholders, in both conditions showed that during Reflection Meeting 1, players talked twice as much in the face-to-face condition (307 words) than in the chat condition (145 words). For example, Table 12 shows that in both conditions, players used more words in the...
face-to-face condition than in the chat condition to discuss learning about the stakeholders’ desires while completing the virtual site visit. They used more words in the face-to-face condition (104 words) than in the chat condition (40 words); however, although there were more words in the face-to-face condition, the main discourse elements were similar across the two conditions. In the chat condition, one player listed the social and environmental issues that the stakeholders cared about by saying, “People care about wetlands (habitats for sandhill cranes), greenspaces, water quality, and reduction of traffic.” Similarly, in the face-to-face condition, one player discussed the social and environmental issues stakeholders cared about by saying that “it seemed like the wetlands and also like the culture and the community was also really important.”

Table 12
Excerpts from individual players’ discourse during Reflection Meeting 1 for the People for Greenspace stakeholder team showing that, when Elise asked the players what they had just finished doing in Reflection Meeting 1, players used more words in the face-to-face condition than in the chat condition to discuss learning about the stakeholders’ desires (colored orange) while completing the virtual site visit.

<table>
<thead>
<tr>
<th>Chat (word count = 40)</th>
<th>Face-to-face (word count = 104)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I finished the virtual site assessment, and am experimenting with iPlan…People care about wetlands (habitats for sandhill cranes), greenspaces, water quality, and reduction of traffic. Character is diverse people, natural beauty and wetlands, local businesses, parks, and community events.</td>
<td>Um, well, I just finished the virtual site visit and did my site assessment and I found that a lot of the stakeholders cared about the wetlands there. They thought that was a very important thing to the Northside, but based on like the descriptions and stuff given as well like not from like the people but like just the overall description it seemed like the wetlands and also like the culture and the community was also really important and I think that yeah. They like they wanted a way to like keep up the culture and stuff without having to hurt the birds.</td>
</tr>
</tbody>
</table>

Although the main discourse elements were similar (talking about stakeholders’ desires), the player’s excerpt from the face-to-face condition was more disjointed and included features of
face-to-face talk such as using the words “like”, “um”, and “well”, which contributed to the higher word count.

Because the reflection meetings in the face-to-face condition had higher word counts than the chat condition, the next section examines data from the face-to-face condition to explore whether there were differences between the meetings that need to be accounted for before analyzing similarities and differences between conditions.

Section 2: Player discourse compared by meeting

This section analyzes qualitative examples from the “People for Greenspace” and “Northside Neighbors” meetings in the face-to-face condition to examine the differences between meetings. This section also uses ENA, as described in the Methods section, to quantitatively analyze the differences in player discourse between meetings.

**Qualitative comparison of players’ discourse between meetings.** Reflection Meetings 3 and 4 were held after the preference survey and stakeholder assessment activities, respectively. During Reflection Meeting 3, mentors were instructed to encourage their teams to discuss generating hypotheses about changes that could meet stakeholder desires about social and environmental impacts. In contrast, during Reflection Meeting 4, mentors were instructed to encourage their teams to analyze stakeholder feedback data in order to recommend changes that would please the stakeholders. Despite the different focus of the meetings, the mentors were instructed to ask players the same question, “What did you learn during [previous activity]?” Unsurprisingly, when Elise asked the People for Greenspace team that question in both meetings, the players’ answers focused on different topics (Table 13).
Table 13
Players’ in the face-to-face condition People for Greenspace team data from question two during Reflection Meetings 3 and 4 showing (with bolded text) that they discussed trying to meet stakeholders’ desires using iPlan during Reflection Meeting 3 and reported data during Reflection Meeting 4.

<table>
<thead>
<tr>
<th>Meeting 3: Meeting stakeholders’ desires using iPlan</th>
<th>Meeting 4: Reporting data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ah well, I just did the preference survey and I got back feedback and some of it was good and some of it was bad. Patty was very happy with the number of nesting sites but I think Krista was really upset that I had so much traffic but the one thing I didn’t get was Maven, he’s like I lowered the carbon tetrachloride to 2 parts per billion and he said this is completely unacceptable and I was like, it’s 2. So I’m not really sure… Try our best to lower what’s too low, I mean try to lower whatever’s too high and try to heighten whatever’s too low basically… Because when you make space for wetlands for like wetlands businesses go down and then traffic goes up.</td>
<td>Because some things, we didn’t get anything as low as they wanted it so we just have to try and make it lower or higher. In this case lower and higher for greenspace… And we also need to carefully alter, like, make changes necessary to cut down on traffic car emissions.</td>
</tr>
</tbody>
</table>

In Reflection Meeting 3, the players in the People for Greenspace team discussed epistemic frame elements related to using a model to meet the stakeholders’ desires, such as using data (S1b) from the stakeholders (S1d) and discussing the social (K1) impacts of their decisions on communities. For example, one player discussed the feedback he received from the People for Greenspace stakeholders by telling Elise that his preference survey feedback informed him that “Patty was very happy with the number of nesting sites, but I think Krista was really upset that I had so much traffic but the one thing I didn’t get was Maven, he’s like I lowered the carbon tetrachloride to 2 parts per billion and he said this is completely unacceptable…”
In contrast, in Reflection Meeting 4, though players still used data (S1b) and discussed the social impact of their decisions on communities (K1), they talked frequently about epistemic frame elements related to reporting data such as hypothesis generation and testing (S2). For example, when answering Elise’s question, one player did not mention specific instances of trying to meet stakeholders’ desires using iPlan and instead reported what the team learned in general terms by saying that “we didn’t get anything as low as they wanted it so we just have to try and make it lower or higher.” The player continued by telling Elise that the team needed to “make changes necessary to cut down on traffic.”

Another team of players, the Madison Developers’ Consortium, also discussed different topics during Reflection Meetings 3 and 4. Like players in the People for Greenspace team, players in the Madison Developers’ Consortium focused on different topics in Reflection Meetings 3 and 4 (Table 14).

Table 14

| Players’ in the face-to-face condition Madison Developers’ Consortium team data from question two during Reflection Meetings 3 and 4 showing (with bolded text) that they discussed trying to meet stakeholders’ desires using iPlan during Reflection Meeting 3 and reported data during Reflection Meeting 4. |
|---------------------------------|---------------------------------|
| Meeting 3: Meeting stakeholders’ desires using iPlan | Meeting 4: Reporting data |
| [I]f everyone agreed the carbon tetrachloride levels, that it had to be raised, just Natalie, and maybe we would consider raising it more instead of leaving it like this. If everyone is only concerned about jobs, we don’t have to put in factories. We only just have retail areas. | The amount of jobs that are acceptable could be above 1098, and the amount of nitrates must be above 12, and the amount of sales must be above 5128, and the amount of traffic must be above 205,643. |

In Reflection Meeting 3, the players in the Madison Developers’ Consortium team discussed epistemic frame elements related to using a model to meet the stakeholders’ desires,
such as using data (S1b) from the stakeholders (S1d) and discussing the social impacts of their decisions (K1). For example, one player discussed the information she learned from the Madison Developers’ Consortium stakeholders by telling Elise that “If everyone agreed the carbon tetrachloride levels, that it had to be raised...we would consider raising it more instead of leaving it like this.” She also talked about how through using iPlan, she knew that “If everyone is only concerned about jobs, we don’t have to put in factories. We only just have retail areas.”

In contrast, in Reflection Meeting 4, though the players still discussed the social impacts of their decisions (K1), they talked about epistemic frame elements related to reporting data such as generating and testing hypotheses (S2). For example, in Reflection Meeting 4, when answering Elise’s question, one player did not mention stakeholders’ desires and instead reported the stakeholders’ thresholds that team learned about by saying that “The amount of jobs that are acceptable could be above 1098, and the amount of nitrates must be above 12, and the amount of sales must be above 5128, and the amount of traffic must be above 205,643.”

In the face-to-face condition, the players referred to different epistemic frame elements during Reflection Meeting 3 than during Reflection Meeting 4. In order to examine if these excerpts are quantitatively different, the following sub-section uses a statistical technique to explore whether the pattern described above is a fair sample of the properties of the data as a whole.

**Quantitative comparison of players’ discourse between meetings.** The differences players references to epistemic frame elements during Reflection Meetings 3 and 4 can be quantitatively as well. For example, using mean counts for four epistemic frame elements in the
players’ discourse shows differences in the topics of the reflection meetings, as displayed in Table 15.

Table 15  
**Mean counts for references to epistemic frame elements in the players’ discourse during Reflection Meetings 3 and 4 showing that the topics of the reflection meetings (as expressed in the coding) were different. The darker colors correspond to higher mean counts.**

<table>
<thead>
<tr>
<th>SKIVE element</th>
<th>Description</th>
<th>Reflection Meeting 3</th>
<th>Reflection Meeting 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1b</td>
<td>Implicit use of data</td>
<td>3.67</td>
<td>1.67</td>
</tr>
<tr>
<td>S1d</td>
<td>Data source</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>K1</td>
<td>Social impact</td>
<td>2.67</td>
<td>3</td>
</tr>
<tr>
<td>S2</td>
<td>Hypothesis generation, testing</td>
<td>0.33</td>
<td>4.33</td>
</tr>
</tbody>
</table>

These differences can be further analyzed by using ENA to measure the co-occurrence of epistemic frame elements which provides a picture more indicative of professional expertise. In Reflection Meeting 3 (RM3), the players’ discourse included epistemic frame elements related to using a model to meet the stakeholders’ desires, and in contrast, in Reflection Meeting 4 (RM4) the players’ discourse included epistemic frame elements related to reporting data. The different patterns of co-occurrence during Reflections Meetings 3 and 4 are illustrated by the locations of the mean player points in Figure 8. Points closer together in the high-dimensional space have more similar patterns of co-occurrence than points farther apart. Since players’ points are plotted in is the same space as the mentors’ points above, the percentages of variance that the dimensions account for is also the same (Dim1 = 13.34%, Dim2 = 10.21%). Analyzing for quantitative similarity, this analysis shows the meetings are different along the first dimension (mean RM3 = -0.22, mean RM4 = -0.08, p < 0.05) and the second dimension (mean RM3 = -0.08, mean RM4 = -0.19, p < 0.05).
The mean of all player points per meeting (face-to-face and chat condition together) in the high-dimensional space created from the mentor and player data (standard error bars). This graph shows that Reflection Meeting 3 had different patterns of co-occurring epistemic frame elements than Reflection Meeting 4.

The players’ patterns of co-occurrence of epistemic frame elements were different during Reflection Meeting 3 than during Reflection Meeting 4, and those differences are reflected qualitatively in player excerpts and patterns of co-occurring epistemic frame elements and quantitatively in the ENA analysis. The next section further explores Reflection Meetings 3 and 4 by comparing the reflection meeting content between both conditions.

Section 3: Player discourse compared by condition

This section provides a qualitative analysis of players’ comments during “People for Greenspace” meetings in both conditions to illustrate the similarities between the chat and face-
to-face conditions. This section also uses ENA to quantitatively analyze each meeting in each condition in order to explore the similarities in player discourse between conditions.

**Qualitative comparison of players’ discourse between conditions.** During Reflection Meeting 3, in both conditions players discussed addressing stakeholders’ desires using a model (Table 16). For example, in both conditions, players talked about their experiences using iPlan to address the stakeholders’ desires and specifically mentioned Maven’s⁹ (one of the stakeholders) disapproval of their plans. In the chat condition, one player asked “Why Maven was mad?” and in the face-to-face condition a player also struggled with Maven’s feedback and told the team that “Maven called their plans completely unacceptable.” As in Section 1, the players’ discourse in the face-to-face condition contained similar content to the discourse in the chat condition, but the face-to-face discourse contained additional filler (Tannen, 1982) words (“like”, “so”, “well”).

**Table 16**  
*Excerpts from the People for Greenspace stakeholder teams’ Reflection Meeting 3 showing (with color coding) that in both conditions, players discussed similar content.*

<table>
<thead>
<tr>
<th>Chat</th>
<th>Face-to-face</th>
</tr>
</thead>
<tbody>
<tr>
<td>I just sent my 2nd map in also I see why Krista still doesn’t like traffic but why is Maven mad we cannot get it lower than 2…I found that CCl4 needs to be lower and thus we must lessen M1 and M2 areas.</td>
<td>Like for example, if you heighten up one thing and another thing goes down. So, it’s sort of hard, well, I managed to even out most things, but for some reason, they [stakeholders] weren’t really like happy…Maven called our plans completely unacceptable…</td>
</tr>
</tbody>
</table>

During Reflection Meeting 4 in both conditions, players talked about the practice of reporting data (Table 17). For example, in both conditions, players announced that, “I found that” or “We got a more exact idea” indicating that they had data to report to the team. In the chat condition, one player reported that she learned that “the stakeholders have high demands”.

---

⁹ Apparently Maven, the advocate for clean water, had expectations that were difficult to meet.
Similarly, in the face-to-face condition, one player reported that the team had a better idea of “what they [stakeholders] wanted”.

Table 17
Excerpts from the People for Greenspace stakeholder teams’ Reflection Meeting 4 showing (with color coding) that in both conditions, players discussed similar content.

<table>
<thead>
<tr>
<th>Chat</th>
<th>Face-to-face</th>
</tr>
</thead>
<tbody>
<tr>
<td>I found that the stakeholders have high demands and that to accomplish the goals you must meet all of the concerns equally thus creating a compromise but still giving something to everyone…</td>
<td>Well, we got a more exact idea of what they [stakeholders] wanted so we can know how to replan I guess?…</td>
</tr>
</tbody>
</table>

Thus, players addressed similar content during Reflection Meetings 3 and 4 in both conditions. In order to examine if these excerpts are quantitatively different, the following subsection uses a statistical technique to explore whether the pattern described above extends to the other players and is a fair sample of the properties of the data as a whole.

Quantitative comparison of players’ discourse between conditions. Players addressed similar content during Reflection Meetings 3 and 4, and therefore, had similar patterns of epistemic frame co-occurrence, during Reflection Meetings 3 and 4 in both conditions. The similar patterns of epistemic frame co-occurrence in both conditions are illustrated by the locations of the player points (means) for each condition in Figure 9. Points closer together in the high-dimensional space have more similar patterns of co-occurrence than points farther apart.
Figure 9. Players' discourse with means. All players’ data from reflection meetings with means showing that regardless of the communication mode, the players discussed similar content during the reflection meetings.

Meeting-by-meeting, t-tests on ENA-generated discourse means for both chat and face-to-face conditions showed no significant differences, with one exception (Table 18). The t-test comparing the first dimension of each condition in Reflection Meeting 1 did show a significant difference (p < 0.05). However, the difference between the conditions may be due to the higher number of words mentors in the face-to-face used when leading the meeting. The difference could also be attributed to players in the chat condition becoming familiar with the online meeting style. However, overall, the variance between the meetings was larger than the variance between the conditions.
Table 18

Means, number of player points in the mean (N) and standard deviations (SD) for each meeting and each condition with the results of paired t-tests. All of the p-values, excluding the comparison of the first dimensions for Reflection Meeting 1 are greater than 0.05 which means that there were no significant differences between the means of the conditions.

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Dimension</th>
<th>Chat – Mean (N, SD)</th>
<th>Face-to-Face – Mean (N, SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.13 (10, 0.26)*</td>
<td>-0.12 (10, 0.12)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-0.17 (10, 0.18)</td>
<td>-0.13 (10, 0.25)</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>-0.27 (7, 0.18)</td>
<td>-0.18 (9, 0.14)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.04 (7, 0.2)</td>
<td>0.15 (9, 0.27)</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>-0.15 (9, 0.24)</td>
<td>-0.3 (8, 0.13)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-0.01 (9, 0.29)</td>
<td>0.13 (8, 0.13)</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>-0.07 (7, 0.22)</td>
<td>-0.09 (10, 0.17)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-0.19 (7, 0.24)</td>
<td>-0.18 (10, 0.3)</td>
</tr>
</tbody>
</table>

The players’ patterns of co-occurrence of epistemic frame elements were similar during Reflection Meetings 3 and 4, and those similarities are reflected qualitatively in player excerpts and quantitatively in the ENA analysis. In other words, regardless of the communication mode, the players discussed similar content during the reflection meetings.

This part of the results chapter analyzed the players’ discourse during the reflection meetings. The first section used word counts to analyze the similarities and differences in player discourse between conditions and showed that the players used more words in the face-to-face than in the chat condition. The second section used qualitative excerpts and quantitative methods including ENA to analyze the differences in player discourse among the reflection meetings and argued that the player s referred to different epistemic frame elements during Reflection Meeting
3 than during Reflection Meeting 4. The third section used qualitative excerpts and quantitative methods including ENA to analyze the similarities in player discourse between the two conditions and showed that there was no difference in content between the conditions.

The results above suggest that there is no difference in discourse quality between the face-to-face and chat conditions. However, it is unclear whether the differences in discourse quantity described above affected the players’ learning outcomes or engagement. Therefore, the next section analyzes whether the differences in word count correspond with learning outcome or engagement differences, and further whether the two conditions were measurably similar in terms of learning outcomes, final proposal content, and level of engagement.

**Outcomes**

**Interviews.** As described in the Methods section, during the intake and exit interviews, players in both conditions answered the following matched-pair question:

The town of Maple Ridge, MI [Forest Hill, CO] is concerned about high levels of nitrates and carbon tetrachloride in their lakes [rivers]. What could they do to clean up their lakes [rivers] if they care most about reducing the level of nitrates (NO₃) [carbon tetrachloride (CCl₄)]?

Players in both conditions significantly increased their scores (0-2 scale) from the intake to the exit interview (chat condition: mean intake = 0.2, mean exit = 1.4, p < 0.05; face-to-face condition: mean intake = 0.27, mean exit = 0.91, p < 0.05). For example, in the face-to-face condition, during the intake interview, one player suggested, “They could try to clean it out.” During the exit interview, the same player provided a much more specific, scientifically accurate answer, “Get rid of big factories in surrounding areas because that lowers the level on CCl4 and N03.”
Further, while both conditions significantly increased their scores from the intake to the exit interview, as Figure 10 shows, there was no significant difference between the two conditions in either the intake or the exit interviews (mean intake chat = 0.2, mean intake face-to-face = 0.27, p > 0.05; mean exit chat = 1.4, mean exit face-to-face = 0.91, p > 0.05). Thus, the communication mode with the mentors did not affect the players’ learning outcome on this particular matched-pair interview question.

**Figure 10. Players’ mean scores for the matched-pair interview question.** Mean scores for the matched-pair interview question in both conditions (with standard error bars) showing that the communication mode with the mentors did not affect the players’ learning outcomes.

**Final proposals.** Though the players’ learning outcomes increased from the intake to the exit interview on the matched-pair question described above and there were no differences in learning outcomes between the conditions, the next logical question to ask is “Were the players’
final proposals different between conditions and if so, how?” While the final proposals cannot be used as a proxy for learning since players only completed them at the end of the game, they can be used to examine whether the players in both conditions connected similar epistemic frame elements and thus learned similar content and professional norms during the game.

Each final proposal was qualitatively analyzed to determine if there were differences between the conditions. The qualitative analysis showed that when writing the recommendations section in both conditions, Players 15 and 24 both used and cited sources for their data, justified recommendations, and discussed the tradeoffs and social and environmental impacts of their recommendations (Table 19). For example, Player 15 in the chat condition found that “increasing the number of wetlands improved the number of cranes and character value.” Similarly, Player 24 in the face-to-face condition recommended “Changing some of the unused areas with no roads or houses into wetlands for the Sandhill Cranes to nest.”
Table 19
Final proposal recommendations section from Player 15 and Player 24 showing the similarities. Terms that appeared in both players’ final proposals are colored according to the following color scheme: **wetlands and cranes**, **manufacturing** (M2), **water quality** (CCl4), **sales**, **housing**.

<table>
<thead>
<tr>
<th>Player 15, chat condition</th>
<th>Player 24, face-to-face condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on all of the information I collected and my work with iPlan, I recommend the following changes:</td>
<td>Based on all of the information I collected and my work with iPlan, I recommend the following changes:</td>
</tr>
<tr>
<td><strong>Changing the M2</strong> to C1-R4 increased the character value while increasing the <strong>water quality</strong>. This also provided an increase in <strong>sales</strong> to the people.</td>
<td>Changing some of the unused areas with no roads or houses into <strong>wetlands</strong> for the Sandhill <strong>Cranes</strong> to nest</td>
</tr>
<tr>
<td>Converting the <strong>housing</strong> to recreational land helped provide <strong>greenspace</strong> while improving the character value.</td>
<td>Adding more retail in place of 1 family homes to help <strong>sales</strong> and help people have more jobs</td>
</tr>
<tr>
<td>Increasing the number of <strong>wetlands</strong> improved the number of <strong>cranes</strong> and character value.</td>
<td><strong>Get rid of any Manufacturing</strong> so that there is <strong>no CCl4 emitted</strong>, but adding retail (as said before) to keep jobs up</td>
</tr>
<tr>
<td>Keep most of the <strong>housing</strong> while changing some into retail in order to increase Traffic.</td>
<td>Add Open space in areas near the <strong>wetlands</strong> and in parks to increase <strong>greenspace</strong>.</td>
</tr>
</tbody>
</table>

Thus, the qualitative analyses in this section show that players addressed similar content in their final proposals in both conditions. In order to examine if these excerpts are quantitatively different, the following sub-section uses ENA to explore whether the pattern described above extends to the other players and is a fair sample of the properties of the data as a whole.

Players from both conditions addressed similar content in their final proposals and therefore, had similar patterns of epistemic frame co-occurrence in their final proposals. Using ENA as described above, the final proposals were projected into a high-dimensional space created from data from all of the players’ final proposals and the sample final proposal. Similar
patterns of epistemic frame co-occurrence in both conditions are illustrated by the locations of the mean player points for each condition in Figure 11. Points closer together in the high-dimensional space have more similar patterns of co-occurrence than points farther apart. The first dimension accounts for 20.33% of the variance and the second dimension accounts for 16.38% of the variance. The means are similar between both conditions along the first dimension (mean chat = -0.1, face-to-face = 0.1, p < 0.05) and the second dimension (mean chat = 0.01, mean face-to-face = -0.02, p < 0.05). Figure 11 also shows that Player 15’s final proposal is located near Player 24’s final proposal suggesting that the qualitative similarity between the two final proposals described above was also captured in similar had similar patterns of epistemic frame co-occurrence. In other words, Figure 11 shows that regardless of the condition, the players covered similar content in their final proposals.

Figure 11. Players’ final proposals projected into a high-dimensional space. This projection was created from all players’ final proposals showing that the patterns of co-occurrence were similar in the final proposal content between the two conditions. Small points represent individual final proposals while large points are the means for each condition with standard error bars.
The qualitative analysis showed that the points close together in the high-dimensional space were derived from similar qualitative data, and that players in the face-to-face and chat conditions connected similar epistemic frame elements while writing their final proposals. Consequently, these results suggest that mentor communication mode (face-to-face or chat) did not affect the players’ written explanation of professional planning content in the final proposals.

**Engagement questions.** In order to measure engagement in the exit interviews, six questions were adapted from Green and Brock’s (2000) narrative questionnaire which is an instrument used to measure (1 = strongly disagree, 4 = strongly agree) the level of engagement that readers have in a book (Appendix 4). There was no significant difference between the two conditions on these measures of engagement (Figure 12). In fact, on average, the players chatting with mentors online were slightly more engaged in the game than the players who were talking with mentors face-to-face—although that difference was not statistically significant.
Figure 12. Players’ mean scores for the exit interview engagement questions (with standard error bars). This graph shows that there was no significant difference between the two conditions on these measures of engagement.

These results suggest that virtual mentoring can be just as effective as face-to-face mentoring at getting players to discuss specific topics during reflection meetings, complete quality final proposals, correctly answer exit interview questions, and stay engaged. The larger significance of these results is explored in Chapter 5.
CHAPTER 5: DISCUSSION

As humans’ capacity to alter the environment reaches unprecedented levels, there is little doubt about the urgent need for promoting change in attitudes and behavior, for encouraging people to appreciate and enjoy the world around them, and for equipping the decision makers of both present and future to adopt environmentally responsible approaches (Palmer, 1998). This thesis examined the viability of virtual environmental education as a potential step for providing more youth with the opportunity to better understand their complex world, and perhaps, more effectively act to sustain it. An important question to address, therefore, is what aspects of environmental education can remain effective in a virtual environment?

Just as John Muir’s botany lesson charmed him and “sent [him] flying into the wood and meadows in wild enthusiasm,” environmentally-focused virtual experiences have the potential to inspire the next generation of environmental leaders. Using transportation principles (Green and Brock, 2000), this study showed that players were engaged in Urban Science. One promise of virtual environmental education is that it could be no less motivating and engaging to youth than traditional environmental education.

Urban Science improved players’ ability to address environmental problems as professional urban planners would. As their responses to a matched-pair interview question showed, players used more scientific language and gave more specific recommendations for addressing an environmental problem after playing the game. In other words, Urban Science successfully equipped players with an urban planning epistemic frame.
Urban Science extends the traditional environmental education framework into a virtual environment by providing occasions for players to experience activities through, about, and for the environment and by creating opportunities for students to develop science, ethics, and praxis in order to build a professional urban planning epistemic frame. The close alignment of Urban Science to the traditional environmental framework suggests that virtual environmental education is possible and even desirable.

Learning in a virtual environment like Urban Science is desirable because virtual environments can expand the range of what players can realistically do and thus also the problems they can address, the possible collaborations they can participate in, and the communities they can inhabit. Learning in a virtual environment gives players a chance to see how the world—or at least some piece of it—works under the guidance of a mentor. In short, Urban Science is a virtual environmental education experience that gives players opportunities to figure out what the world is like, what ought to be in the world, and what an individual must do.

This study extends the research on virtual environmental education by showing that even when the mentoring interactions in Urban Science were mediated through chat, virtual environmental education still worked. This study examined two conditions of Urban Science, one with virtual mentors and one with face-to-face mentors. There were no significant differences in either players’ level of engagement or learning outcomes. Despite concerns that virtual mentors might be unable to fully communicate with novices, players in the chat condition were as engaged as those with face-to-face mentoring. Not only were players in both conditions similarly engaged, they derived similar benefits from playing the game. The gains from intake to exit interviews were similar in both conditions, suggesting that having virtual mentors did not
adversely affect those players’ learning outcomes. Further, players’ performed equally well within each game condition. The players’ final proposals reflected similar professional thinking in both conditions. In sum, players were engaged, produced professional documents, and learned professional ways of problem solving, whether their mentors were in the room with them or not.

In other words, it appears as though players in both conditions of Urban Science developed the same epistemic frame and thus constructed a similar science, ethics, praxis triad while learning through, about, and for the environment. Due to the small sample size and the qualitative nature of the data, this study did not measure the quality of the epistemic frame developed and did not directly compare the quality of that epistemic frame to variance in outcome measures. However, in terms of the domain content (in qualitative terms and by the environmental education framework), it appears that the epistemic frames were similar.

Those results were possible because the mentoring in both conditions was the substantively similar. Mentors, whether face-to-face or virtual, used similar professional discourse to guide players through the game. Their mentoring led players in both conditions to likewise use similar professional discourse. While both mentors and players used more words during reflection meetings in the face-to-face condition, the quality of the discourse was similar between conditions, suggesting that word count may not be a good indicator in judging quality. In other words, the co-occurrence of epistemic frame elements within the discourse for both the mentors and the players in each reflection meeting followed similar patterns respectively. These results suggest that the key function of the mentors, to communicate professional ways of thinking, was not diminished in the chat condition.
Bierema and Merriam’s (2002) suggest that the richness associated with face-to-face conversation often diminishes when communication goes electronic. However, the mentors in this study were instructed to follow a script while leading reflection meetings. Therefore, the similar efficacy of the mentoring in each condition may seem less surprising. The players’ discourse, however, was similar between conditions without the benefit of scripts to follow, which suggests that if the mentors follow a script while leading reflection meetings, virtual mentoring can be just as effective as face-to-face mentoring at getting players to discuss specific topics, and thus build professional ways of thinking. Further, it is possible that what is lost in the limited communication medium of chat is either peripheral to the professional substance of the conversation or is provided somewhere else in the game. After all, the conversation between John Muir and Milton Griswold took place underneath a locust tree in the physical environment. The rich game context, including detailed instructions and feedback from the NPCs, models and templates for professional products in the professional resources (e.g., sample final proposal), and, of course, the experience of interacting with a sophisticated, virtual model of the physical and social environment, all supported the virtual mentoring. Nevertheless, that virtual mentoring can succeed equally as well as face-to-face mentoring with the same supports suggests that even the human interactions in a mentoring relationship can work virtually.

Overall, these results suggest that Urban Science was successful and is worth playing because players in both conditions were engaged, showed gains on a near-transfer interview question, and wrote final proposals that mirrored the model they were given. Though the far-transfer exit interview questions did not show gains in either condition, these results strengthen previous claims made about the impact of Urban Science on players’ outcomes including the
development of a professional epistemic frame and improved ecological thinking (Bagley and Shaffer, 2009).

Since using more words did not impact the quality of the players’ professional discourse during the reflection meetings, the exit interviews outcomes, the quality of their final proposals, or their level of engagement, mentoring via chat is a viable method for mentoring in the context of epistemic games. A bolder interpretation of the results suggests that since mentoring in virtual and face-to-face conditions produced similar effects on players, epistemic mentoring could be automated and still retain the quality of interactions and players’ level of engagement. If the epistemic mentoring is automated, epistemic games like Urban Science could become more widely available to young people giving them the opportunity to help the world “move beyond what we already know in order to break beyond the boundaries of now to a more beautiful fabric of the future.”

**Limitations**

The study presented is, of course, limited. First, the small sample size means that any conclusions are limited to what the sample population did in the context of the epistemic game. Thus, following Shaffer and Serlin (2004), the purpose of the significance tests presented in this paper were to show that additional observations made under the same conditions would show similar results.

Second, while this study showed that the mode of communication used by the mentors did not affect the players’ content, outcomes, or engagement, this evidence does not support
claims about why mentoring is important in epistemic games. Future studies will examine the important role of mentors in epistemic games.

Third, though the players were asked a number of questions related to environmental science during the interviews, this paper uses only one near-transfer matched-pair interview question to highlight players’ environmental science learning gains and the similarities of those gains between conditions. Three far-transfer matched-pair interview questions were not included in the analysis because both conditions showed no outcomes gains between the intake and the exit interviews. The lack of far-transfer gains may be attributed to the short time frame (three days) between the interviews and/or the high quality of answers provided by the players during the intake interview. After all, the players’ previous exposure to environmental science concepts through Massachusetts Audubon Society programs may have situated them well to accurately answer the Urban Science intake interview far-transfer questions. Future work will explore formative and summative assessments used to capture the players’ environmental science learning trajectories and outcomes. Future work may also seek to collect longitudinal data regarding players’ environmental behaviors after playing Urban Science. However, though players developed environmental literacy while playing the game, they may not necessarily become environmental stewards exhibiting environmentally-conscious behaviors after 10 hours of game play.

Fourth, Urban Science was designed to foster environmental literacy by building the epistemic frame of urban planners. It was not designed as an all-encompassing, one-stop-shop environmental science curriculum, and it can and should not supplant the reality within which humans live and work. Therefore, in an ideal environmental education setting, Urban Science
would be paired with outdoor field and civic-oriented components enabling young people to imagine and build the types of cities needed to sustain and inspire future generations. And, as with any experience that requires an Internet connection, access to Urban Science is restricted to places that have computers with Internet connectivity.

Fifth, for this study, Urban Science was part of a Conservation Leadership program that involved outdoor field activities described in more detail in Appendix 3. Since this study focused on whether the virtual activities were diminished by having virtual mentors, this study did not consider whether the gains players made were due to Urban Science, to the outdoor activities, or to the combination of the game and the activities. Therefore, future work may explore the relationship between activities in the virtual and physical space.

Epistemic frame theory and ENA also presents their own set of limitations. Shaffer et al. (2009) have asserted that “the evolution of the epistemic network graph depends partly on the specific point in the experience, the conditions the students experience (some situations may be more likely to evoke statements of values, for example, or identities), and the changing nature of the students’ actual epistemic network as it develops through these experiences.” Thus, by focusing solely on the reflection meetings, interviews, and final proposals, this study tells only part of the story. Further research can examine the epistemic frame development at additional time points and under a wider range of conditions. Future work can also use epistemic network analysis to examine the causal connections between a mentor’s discourse and the players’ discourse and epistemic frame development. ENA is a technique under development, and more recent advances in the science of ENA could shed a different light on the topics at hand. Future work will use more sophisticated ENA techniques to perhaps reanalyze this data further. As
automated coding is developed, there may be opportunities to conduct comparative studies using this data set.

Despite these limitations, these findings—and future studies investigating virtual mentoring—can inform ways to provide young people with opportunities to think like professionals under the guidance of a trained, possibly automated, mentor.
CHAPTER 6: PRACTICAL ADVICE FOR ENVIRONMENTAL EDUCATORS

This chapter draws on empirical evidence, design research, literature, and assessment methodologies from the preceding chapters and provides recommendations for best practices for environmental educators interested in exploring virtual environmental education.

The preceding chapters suggest that virtual environmental education is a promising way to engage young people in the world’s complex environmental challenges for two main reasons. First, virtual environmental education provides young people with opportunities to solve simulations of authentic, real-world problems that would otherwise be logistically or developmentally inaccessible or too risky. Virtual environmental education can scaffold complex social and environmental problems in a dynamic model to provide young people with a professional vision that makes it possible for them to address complex problems.

Second, virtual environmental education has the potential to simplify logistics by providing students with interactions with a variety of virtual non-player characters (NPCs). In virtual environments, the NPCs play the role of mentors, community members, colleagues in a fictitious firm, or any number of other roles. Providing students with NPC interactions can potentially expose them to different perspectives on the causes of and solutions to environmental problems. The NPCs’ performance can be automated, lowering the logistical overhead and making the virtual environment more widely available. In other words, young people do not
necessarily need to interact with “Milton Griswold” underneath a locust tree in order to learn about the environment\textsuperscript{10}.

Some environmental educators will no doubt shy away from virtual environmental education. Rather than abandoning traditional environmental education, educators could use virtual environmental education to supplement traditional or project-based instruction. For example, virtual environmental education could be used at the beginning of a curricular unit to build engagement, at intervals for formative assessment, and in conclusion for summative assessment. Educators might also consider augmenting their environmental education activities with extended virtual activities, like Urban Science, that allow students to grapple with sophisticated models with face-to-face or virtual mentors’ guidance.

Urban Science is currently being run by environmental educators at the Massachusetts Audubon Society as part of their Conservation Leadership Program. However, there are also commercially available computer games that could augment the traditional environmental education classroom by providing young people with opportunities to engage with authentic environmental issues. One example is SimCity, a game that lets players redesign a city. The game incorporates several complex simulations, and in order to make the city successful, players 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.

\textsuperscript{10} By asserting that Milton Griswold is not needed, I am not asserting that there is no place for face-to-face mentors in the physical environment. Rather, I am suggesting that environmental education can work without Milton Griswold standing under the tree.
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, the game is based on the unrealistic epistemic frame of a mayor with God-like power and does not provide players with professional mentors to guide them through the unfamiliar city development process. As a result, players work as virtual urban despots, calling on Godzilla to squash their city. Therefore, in order to use SimCity to teach environmental education, teachers could provide players with a more specific, realistic epistemic frame and plan the important role of professional mentoring in the players’ experience.

But whether SimCity is the best example of a game about a way of thinking that matters in the world is less important than recognizing that the combinations of skills, knowledge, values, identity, and epistemology players develop while playing games matter. For example, educators using games for learning should consider not just what kinds of things players do and learn in a game but also about what justifies those actions. How do you know in a game when you have made a good decision or a bad one? What kind of evidence is available to base your decision on, and how are you supposed to evaluate that evidence (Mislevy, 2006)?

Those are the types of questions epistemic game designers address while designing games like Urban Science. Epistemic game designers begin by determining which combination of professional skills, knowledge, identities, values, and epistemology to model. Once the
profession and the profession’s epistemic frame is determined, the next step in the design phase involves studying a professional practica and creating a game *storyboard* that describes the key activities of the practicum: the *actions* that professionals-in-training take in the practicum, and the occasions for *reflection* between professionals-in-training and their mentors (Schon 1987).

In the specification phase, the storyboard is then expanded into a *frameboard* that describes, for each activity: (a) the *activity of the players* in the game; (b) the *activity of the mentors*, including key dialogue moves or talking points; (c) the expected *work product, output, or action* of the players; (d) the *criteria for evaluation* of the work product or output; (e) the *expected elements of the epistemic frame* of the profession; and (f) the *sources of evidence* that will be used to determine whether the elements of the epistemic frame are used in that context. For example, if an important knowledge epistemic frame element involves understanding the interdependence in a natural system, epistemic game designers include activities where players will gain that knowledge, reflect on that knowledge with peers and mentors, and provide evidence that they gained the knowledge.

In the build out phase, the specific elements of the game are built from the frameboard, including simulations, models, and other professional tools that may require technical development; NPC responses, requests for information, and feedback; and summative assessments. And finally, during the implementation phase, instructions for the epistemic mentors are formalized in a playbook, and the mentors are trained before implementing the game with students. Figure 13 outlines the process of designing, specifying, building, and implementing an epistemic game.
In the 21st Century, environmental educations practitioners have opportunities to augment their instruction with virtual experiences and to connect those virtual experiences to real life to give students the motivation and expertise to tackle other issues they face in life. Games like Urban Science may help young people—and thus help all of us—identify and address the many environmental challenges in an increasingly complex, and increasingly urban, world.
REFERENCES


Appendix 1: Recruitment materials used by the Massachusetts Audubon Society

Free Conservation Leadership Program - August 16-20, 2010

Drumlin Farm’s Conservation Leadership Program is being offered to youths entering grades 9 through 12. The program runs from 8:45am-4:00pm each day.

**What will you do & learn in a Conservation Leadership Program at Drumlin Farm?**

- Explore different habitats around the sanctuary and choose an area for further study
- Learn conservation planning skills by conducting a Rapid Ecological Assessment at Drumlin Farm
- Develop leadership skills by designing and working on a variety of projects to restore habitats at Drumlin Farm
- Explore with Mass Audubon staff and scientists—studying different species including plants, insects, amphibians, and birds
- Play a computer simulated “internship” with a regional planning firm where you get to choose where the “green space” should be
- Share what you have learned with others in the community.

After the program, we’ll ask you what worked well and what we need to change. In return, we are offering this program to you for FREE!

**To Register:** email Kris Scopinich, Education Manager at kscopinich@massaudubon.org with your name, and contact information. You can also call Kris at 781-259-2221.

*This program is partially funded through a grant from the National Science Foundation.*

Appendix 2: Mentor Playbook Script

Urban Science Playbook: Session 1

Pre-Game

SET PHASE TO 0

SEND FIRST EMAIL

ROOM MONITOR HANDS OUT WELCOME LETTERS WITH URL, LOGIN AND PASSWORD INFORMATION

Set up a computer to the projector to show video

Download video at http://www.epistemicgames.org/video/uda_5.wmv

9:00: UDA introduction

Players log onto computers.

Planning consultants [room monitor] welcome players, introduce selves, chat protocol.

Welcome to Urban Design Associates! My name is Elizabeth, and I'll be your planning consultant. I'm here to help you with your work at UDA.

CHAT: I'll be available through this chat program throughout the entire game, so please ask me any questions at any time.

LIVE: I'll be available to help you throughout the entire game, so please ask me any questions at any time. I'll be recording our conversations so that I can see how well I do at answering your questions.

Before we get started, we’re going to watch a video about the company.

Players watch video as a firm.

Please check your inbox. There should be some messages waiting for you from our supervisors Curt and Maggie.

Players receive welcome emails. They are directed to the Intake Interview.

9:15: Intake interview

Players take Intake Interview.

If players are lost: Did the emails ask you to do anything?

If players want to know why they are doing the interview: Maggie mentioned to me that the intake interviews help us understand a little bit about you. So, please go ahead and fill it out. Let me know if you have any problems, and don't worry if you don't know the
answers. If you don't know the answer, say that you don't know and move on. Don’t guess.

I hope the interview is going well. Maggie and Curt are in charge, so look for their emails when you aren’t sure what to do.

If players have not received emails: Have you had a chance to check your inbox? Have you opened ALL of the emails in your inbox?

If players chat during interview: Please complete the interview on your own.

**9:30: Staff page creation**

Thanks for filling out your intake interview, please start writing your staff bio page.

Players receive Staff page email from Maggie.

Players create staff pages.

*Use the other bios as models.*

*This is a professional planning environment so present yourself professionally.*

If you’re finished with your staff bio page, please read through the other UDA employees’ bios.

If you’ve completed your staff bio, feel free to check out the professional resources (on the right hand side of the screen), too.

**UNLOCK EMAIL**

**9:45: Virtual site visit**

Players receive RFP, SA, and VSV emails from Curt and Maggie.

*Curt and Maggie both have a lot of things they'd like you to know about and the only way they can communicate with you is through email. Look at them one at a time so that they don't get too overwhelming, and as always, ask me if you have any questions.*

If they ask about deleting email: You can't delete email. At UDA, we like to keep a record of all of the professional communication between employees.

**What is the RFP asking for?**

The Madison City Council is asking for proposals from experienced planners to revise the neighborhood plan for the Northside neighborhood. One planning firm will be awarded a contract to create a redevelopment plan for the area.

**Background**

The Northside neighborhood, bordered by Commercial Avenue on the south and Wheeler Road on the north, is one of Madison’s most economically and culturally diverse areas. With a strong identity as the “Gateway to Madison,” the neighborhood contains a mix of housing, businesses, parks and wetlands, and arts and entertainment spaces. While the neighborhood is visited by many residents of Madison, the City Council believes that a new plan for the Northside could improve the neighborhood and the quality of
life for those who live there. Any new plan, however, will have to continue Madison’s tradition of balancing the needs of the city and its residents with protection of the environment.

Requirements

1. Proposed plans must focus on both economic development and housing concerns for the area. Proposals must also analyze changes in water quality—specifically carbon tetrachloride (CCl4), water runoff—specifically nitrates (NO3), sandhill crane nesting sites, jobs, greenspace, housing, sales, traffic, and neighborhood character index that would result from changes to the neighborhood.

2. All plans must describe how their plans will address the needs of citizens, businesses and the environment. Successful plans will clearly explain how proposed changes support future development of the neighborhood to address these needs.

Players conduct VSV.

*In the virtual site visit, open the map and click on the people icons. Information about the people should pop up. Click on the text, not the icon.*

Read the text and take notes about the people in your notebook so that you can use that information in your site assessment. Take good notes, especially about what the stakeholders care about. There is an example in the professional resources menu (on the right).

A stakeholder is a person who cares about the site, or more specifically, a person who holds a stake in the future of the community. A stakeholder might live or work in the neighborhood.

*If you get lost on the map, close and re-open it.*

10:15: Site assessment

Players write site assessment.

You have been asked to write a site assessment. The site assessment is a report about the neighborhood that helps Maggie understand what the stakeholders care about. It helps planners make sure that they create plans that people will support.

*There is an example in the professional resources menu (on the right).*

For urban planners, serving the public interest (listening to what the stakeholders have to say) is REALLY important.

*Spending time really trying to understand what the stakeholders want and why they want the things they want will help you come up with a plan that they'll support.*

The stakeholders will really appreciate that you’re taking time understand their concerns.

*Please reply to Maggie’s Virtual Site Visit email with your site assessment. Make sure you reply to her original “Virtual Site Visit” email. Her inbox gets crowded, and replying to that email will help her find your site assessment.*
Site Assessment Example Email
Hi Maggie,

Here's my Site Assessment:

While on my virtual site visit, I learned about the following concerns from stakeholders in the Construction Associates of Madison:

a. David seemed to care about the amount of sales. I think I should try to increase this to help them out.

b. Becky also wants more traffic so she can sell more houses.

c. Rachel would like to increase the allowable level of nitrates and carbon tetrachloride in the neighborhood so that she can build more houses with beautiful lawns.

The Northside’s character is created by:

a. The culturally diverse people who live there.

b. The incredible variety of the wildlife and environments for them to live in.

–George

Players send site assessment by replying to Maggie’s email and receive acknowledgment email from Curt.

10:45: Same page meeting

Same page meeting 1: Virtual Site Visit, Site Assessment

Take homes

1. Using Data
   a. **Collect data**: Ability to collect data using various methods including by individually reading background material and collaborating with teammates

3. Identifying Goals
   a. **Stakeholders have concerns**: Ability to identify that stakeholders have concerns
   b. **Stakeholders have nonspecific concerns**: Ability to identify that stakeholder concerns are not always specific
   c. **Identifying goals**: Identifying goals involves collecting data in multiple ways

4. Collaborating
   a. **Sharing data**: Ability to share data with others
   b. **Draw conclusions**: Ability to draw conclusions with team members during a team meeting
   d. **Listen to others in the planning process**: Process of finding out what to do/getting help

7. Social impact of planning decisions on communities
   a. **Social impact of planning on communities**: Ability to use in words or actions understanding how the current land use configuration has specific social effects on the community

8. Environmental impact of planning decisions on communities
   a. **Environmental impact of planning on communities**: Ability to use in words or actions understand how the current land use configuration has specific effects on the environment

11. Terms of art
   a. Knowing specific planning terms of art like land use codes, preference survey, stakeholders, etc.
Hey team. Let’s talk about your virtual site visit and site assessment and get onto the “same page”. I’d like to hear from everyone.

### Ask each individual these questions:

<table>
<thead>
<tr>
<th>Take home</th>
<th>Listen for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect data</td>
<td>Learned about the Northside site and what its stakeholders care about.</td>
</tr>
<tr>
<td>Listen to others in the planning process</td>
<td>Process of finding out what to do/getting help (collaboration)</td>
</tr>
<tr>
<td>Stakeholders have concerns</td>
<td>Specific stakeholder concerns</td>
</tr>
<tr>
<td>Social impact of planning on community</td>
<td>How site impacts lives of stakeholders</td>
</tr>
<tr>
<td>Environmental impact of planning</td>
<td>How site impacts environment</td>
</tr>
<tr>
<td>Sharing data</td>
<td>Everyone participates</td>
</tr>
</tbody>
</table>

### Follow up questions

**How did you start?**

**What worked/what didn’t and why?**

**What did you find out when you conducted your virtual site visit?**

So if I can summarize, it sounds like you collected some data about the site. You found about its history, and also what some of the people there care about. They seem to care about two types of things: social issues and environmental issues. You also started to learn how we do things here at UDA: our supervisor Maggie often sends instructions in emails, and you can get help from professional resources, colleagues, and mentors.

### Ask each team these questions:

<table>
<thead>
<tr>
<th>Take home</th>
<th>Listen for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Represent others</td>
<td>We should try to make the site more like how the stakeholders want it.</td>
</tr>
<tr>
<td>Stakeholders have concerns, represent others</td>
<td>They tell us what is good for them</td>
</tr>
</tbody>
</table>

With the information we have, what should we do next?

Do we trust the stakeholders to know what’s good for the site?
What else do we need in order to get that done? | Stakeholders have nonspecific concerns | Need to learn more, specifically what the stakeholders want.
---|---|---
Identifying goals | Need to find out how to change the site, and how hard/easy it will be to do so.

So we need to try to collect more data. Ideally we would find out more specific data about what the stakeholders want. For example, how many more jobs would make them happy?

We have a special tool at UDA called iPlan. Using iPlan, we can make experimental land use changes and see the projected effects of those changes on issues that the stakeholders care about.

Maggie has probably already looked at your site assessments and sent you some instructions on what to do next.

UNLOCK SITE ASSESSMENT LOCK

11:00: iPlan practice

Players get iPlan email from Maggie.

Players learn how to use iPlan.

Make one change and then look at the graphs.

iPlan shows how land use choices might impact the things that people care about.

Questions to ask during iPlan practice:

Are you finding any relationship between land use codes and the graphs?

What are you finding? What happens in iPlan when you change OS-W (wetlands) to R4 (high density housing)?

Does the size of the parcel have an effect on the amount of change in the graphs?

I'm wondering what land use changes you could make to increase jobs. Any hypotheses?

There is a legend that tells you what the land-use codes stand for that pops up when you click the land use codes button on the top right.

Don’t forget to submit your map using the button on the top left.

11:15: Same page meeting

Same page meeting 2: iPlan
Take homes

1. Using Data
   c. Collect data: Ability to analyze multiple sources of data using a variety of methods including through using a simulation and by reading text

2. Using a simulation (iPlan) to explore a complex system
   b. Hypothesis testing: Ability to test hypotheses in a closed simulation environment

4. Collaborating
   a. Sharing data: Ability to share data with others
   b. Draw conclusions: Ability to draw conclusions with team members during a team meeting
   c. Ask questions: Ability to ask questions of team members to obtain specific information that will benefit the entire team
   d. Listen to others in the planning process: Process of finding out what to do/getting help

6. Envisioning alternatives/identifying tradeoffs
   b. Identify consequences: Ability to identify the possible consequences of decisions

7. Social impact of planning decisions on communities
   b. Social impact of land uses: Ability to use in words or actions understanding how changing any of the ways land is used has social impacts (for better or for worse)
   c. Measuring social impacts: Identifying and measuring social impacts such as housing units, number of jobs, sales revenue, and the character of the neighborhood

8. Environmental impact of planning decisions on communities
   b. Environmental impact of land uses: Ability to use in words or actions understanding how changing any of the ways the land is used impacts the environmental balance (for better or for worse).
   c. Measuring environmental impacts: Identifying and measuring environmental impacts such as water quality, air quality, and habitat quality for specific species.

9. Interconnectedness of cities
   a. Cities impact environmental issues: Ability to use in words or actions understanding how cities impact environmental issues like water quality, air quality, and habitat quality
   b. Cities impact social issues: Ability to use in words or actions understanding the relationships between land use and social issues like jobs, housing, and the character of a neighborhood
   c. Land use impacts are interconnected: Ability to use in words or actions understanding how changing land uses impact multiple issues

11. Terms of art
   a. Knowing specific planning terms of art like land use codes, preference survey, stakeholders, etc.

Hey team. Let’s talk about your iPlan practice map and get onto the “same page”. I’d like to hear from everyone.

<table>
<thead>
<tr>
<th>Ask each individual these questions:</th>
<th>Take home</th>
<th>Listen for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>[NAME], would you mind telling us what you just finished doing?</td>
<td>Hypothesis testing</td>
<td>Made land use changes that stakeholders might approve</td>
</tr>
</tbody>
</table>

Follow up questions

<table>
<thead>
<tr>
<th>How did you start? What worked/what didn’t and why?</th>
<th>Sharing data</th>
<th>Tried to decrease nitrates</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>What did you find out from creating your practice plan in iPlan?</th>
<th>Land use impacts are interconnected</th>
<th>Changing land uses and getting unintended consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental and social impact of land uses</td>
<td>Environmental issues impacted by land use changes</td>
<td></td>
</tr>
<tr>
<td>Identify consequences</td>
<td>Social issues impacted by land use changes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Noticing that multiple land uses affect the same issue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Noticing that multiple issues are affected by changing the land use of one parcel</td>
<td></td>
</tr>
</tbody>
</table>
Follow-up questions

| In what way(s) was it easy or difficult to meet your stakeholders’ concerns? | Hypothesis testing | Specific strategies or hypotheses |
| What strategies did you use? | | |
| By making the changes your stakeholder group wanted, how were the other issues (social and environmental) impacted? | | |
| Were there any unintended consequences? | | |

OK, so we see that because iPlan measures the projected social and environmental impacts of zoning changes, it allows you to test ways of making the site work for the stakeholders without bringing in actual bulldozers. You discovered that one characteristic of the site is that it is a complex system, which means that changing one parcel impacts more than one indicator. There may be trade-offs with every change.

Ask each team these questions:

<table>
<thead>
<tr>
<th>With the information we have, what should we do next?</th>
<th>Take home</th>
<th>Listen for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social impact of land uses</td>
<td>Creating a plan to please stakeholders</td>
<td></td>
</tr>
<tr>
<td>Draw conclusions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Follow up question

<table>
<thead>
<tr>
<th>How can we use iPlan to help our stakeholders?</th>
<th>Hypothesis testing</th>
<th>Specific strategies or hypotheses</th>
</tr>
</thead>
</table>

What else do we need in order to get that done?

| Stakeholders have nonspecific concerns | Need to learn more specifically what the stakeholders want. |

Since we can measure the complex social and environmental impacts of zoning changes, we can work as a team to hypothesize how much change will please the stakeholders. Given that everything on the site is interconnected we also need to find out how hard it is to give them what they want.
We test our hypotheses by sending stakeholders draft plans to find out whether they like our how we changed the site. We call these draft plans preference surveys.

We have a specific process for creating preference surveys here at UDA, and I’m sure that by now Maggie has sent you an email describing it.

**UNLOCK PRE-TIM LOCK**

**11:30: Target identification matrix**

**Players receive TIM email from Maggie.**

→Mentor calls a team meeting.

*Please read your new email from Maggie.*

How do we know if stakeholders will approve of our plans? We create preference surveys.

A *preference survey* is a plan we send to the stakeholders to find out how much they want things changed.

Each of you is going to send the stakeholders a plan. This isn’t the final plan. That comes later.

*First, let's make sure we agree on what the stakeholders want. Please open your Target Identification Matrix. We’re going to fill that out now.*

→Check to see that everyone has opened their TIM.

**TIM example:**
What were your stakeholders’ opinions about each issue? [go through each issue]

[encourage players to look back at their site assessment and notebook]

*We agree on what they want, but we want to find out how much or little of each thing they want.*

*To do that, you each need to send them a slightly different plan. That way, when they tell us whether they like the plans, we know more specifically how much change will make them happy (or unhappy). We’re trying to uncover their thresholds or limits.*

*The TIM shows us what the initial value is for each issue in the Northside. Now each of you needs to put in what you are going to try and get for each issue when you go back to iPlan on your preference survey.*

*The numbers you put here are targets (or goals). They are the numbers you will try to get when you are making the land-use choices. Make sure your targets are doable. Make sure everybody’s targets are different.*

*I saved the TIM, so please close your TIM window.*

→When team is done, mentor presses freeze/done button.
Pre-Game
Mentors respond as NPCs to emails as necessary

UNLOCK TIM LOCK

9:00: Preference survey

Players log-on.
Welcome back! Please check your inbox for emails from Curt and Maggie. Their emails tell you just about everything you need to know and do. If you are still confused, let me know and I can help.

Players receive Preference Survey email from Maggie.
You are ready to start your preference survey. To do that go to iPlan: Preference Survey (on the right).

[If you haven't done the TIM you need to do it. Mentor needs to unlock the group’s TIM and relock it when player is done. Use instructions from last week for these players.]

There is a legend that tells you what the land-use codes stand for that pops up when you click the land use codes button on the top right.

Are you finding any relationships between land use codes and the indicator graphs? What are you finding? iPlan shows how land use choices might impact the things that people care about.

Remember to aim for the targets we set as a team in the Target Identification Matrix.

Try changing different size parcels.

Has anyone found a way to increase/decrease [indicator]?

Use your teammates as resources. If you are having trouble, ask your colleagues.

Get as close to your target as you can and then move on.

Preference survey example email
Hi Maggie,

Here is the explanation of my Preference Survey.

Recommendations:
Based on all of the information I collected and my work with iPlan, I recommend the following changes:

- Changing a few OS open space lots to C2 and keeping most of the rest at C1-R4 but otherwise not changing anything. This increases housing units and jobs.
- Changing some R1 to M1 or C2 to increase the traffic and sales.
- Changing a few OS to R1, R2, and R3 to allow more people to move into the neighborhood.
Justifications:
I think that the changes I am recommending will please my stakeholder group because:

- Paul told me that he wanted more sales, and I added 4,000 new sales per year. That also increased the number of jobs, which will please Lisa.
- By relaxing the allowable levels of nitrates and carbon tetrachloride, I made it easier for Raoul to build more and better houses.
- With more traffic in the neighborhood, Jon will support my plan. It will make it easier for him to sell houses.

Thanks,
George

9:45: submit preference survey

Mentors encourage players to finish iPlan:PS. Remind them to submit.

Players submit PS and are sent to Maggie email.

*Use the Preference Survey model in the professional resources. You need to reply to Maggie’s email.*

Players told to open email reply to Maggie.

*Describe what you did for Maggie.*

Players send preference survey email.

Subject line must be: Re: Preference Survey

Players receive acknowledgment email from Maggie

UNLOCK PREFERENCE SURVEY LOCK

10:00: Preference survey feedback

SEND STAKEHOLDER FEEDBACK

Players receive stakeholder feedback from Maggie.

Players receive stakeholder assessments email from Curt.

10:15: Same page meeting

Same page meeting 3: Preference Survey

Take homes

1. Using Data
   c. Analyze data: Ability to analyze multiple sources of data using a variety of methods including through using a simulation and by reading text
2. Using simulation (iPlan) to explore a complex system
   a. **Hypothesize**: Ability to hypothesize projected impacts and tradeoffs of multiple scenarios using a simulation
   b. **Hypothesis testing**: Ability to test hypotheses in a closed simulation environment
   c. **Propose plan without social impacts**: Ability to use a simulation to propose plans without negative social impacts
   d. **Propose plan without environmental impacts**: Ability to use a simulation to propose plans without negative environmental impacts

3. Identifying goals
   a. **Stakeholders have concerns**: Ability to identify that stakeholders have concerns

4. Collaborating
   a. **Sharing data**: Ability to share data with others
   b. **Draw conclusions**: Ability to draw conclusions with team members during a team meeting
   c. **Ask questions**: Ability to ask questions of team members to obtain specific information that will benefit the entire team

5. Justifying recommendations
   a. **Justify recommendations**: Ability to recognize that recommendations need to be justified so that others can understand the process that went into making certain choices
   b. **Use data to justify**: Ability to use data to justify specific recommendations to others
   c. **Explain recommendations**: Ability to clearly explain recommendations to others

6. Social impact of planning decisions on communities
   a. **Social impact of land uses**: Ability to use in words or actions understanding how changing any of the ways land is used has social impacts (for better or worse)
   b. **Measuring social impacts**: Identifying and measuring social impacts such as housing units, number of jobs, sales revenue, and the character of the neighborhood

8. Environmental impact of planning decisions on communities
   a. **Environmental impact of land uses**: Ability to use in words or actions understanding how changing any of the ways the land is used impacts the environmental balance (for better or worse)
   b. **Measuring social impacts**: Identifying and measuring environmental impacts such as water quality, air quality, and habitat quality for specific species

9. Interconnectedness of cities
   a. **Cities impact environmental issues**: Ability to use in words or actions understanding how cities impact environmental issues like water quality, air quality, and habitat quality
   b. **Cities impact social issues**: Ability to use in words or actions understanding the relationships between land use and social issues like jobs, housing, and the character of a neighborhood
   c. **Land use impacts are interconnected**: Ability to use in words or actions understanding how changing land uses impact multiple issues

11. Terms of art
   a. Knowing specific planning terms of art like land use codes, preference survey, stakeholders, etc

16. Justification considers and describes all of the relevant facets
   a. **People’s concerns**: Refers explicitly to people’s concerns
   b. **Environmental concerns**: Refers explicitly to animals, plants, habitat, water or air quality

---

**Hey team. Let’s talk about the preference survey process and get onto the “same page”. I’d like to hear from everyone.**

<table>
<thead>
<tr>
<th>Ask each <em>individual</em> these questions:</th>
<th>Take home</th>
<th>Listen for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>[NAME], would you mind telling us what you just finished doing?</td>
<td>Hypothesize&lt;br&gt;Hypothesis testing&lt;br&gt;Propose plan without social or environmental impacts</td>
<td>Learn specifically what the stakeholders want&lt;br&gt;Sent the stakeholders “sample plans” to get feedback</td>
</tr>
</tbody>
</table>

**Follow up questions**

<table>
<thead>
<tr>
<th>What did you do first?</th>
<th>Listen to others in the planning process</th>
<th>Collected data as a team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why did you do that?</td>
<td>Stakeholders have concerns&lt;br&gt;Use data to justify and explain</td>
<td>Recommended changes based on stakeholders’ interests</td>
</tr>
</tbody>
</table>
What did you find out when you conducted your preference survey?

- Propose plan without social or environmental impacts
- Learned if the stakeholders were happy with specific indicator levels
- Environmental impact of land uses
- Measuring environmental impacts
- The stakeholders’ desires sometimes caused environmental problems.
- Cities impact social issues
- Land use impacts are interconnected
- Other issues are affected when trying to focus on meeting one target

Follow up questions

- Which targets were hard to meet?
  - Cities impact social issues
  - Land use impacts are interconnected
  - It was hard to increase xxx, while also keeping yyy stable, because they are both affected by changes in zzz differently
- How did you justify the changes you made on your preference survey?
  - Use data to justify and explain recommendations
  - People’s concerns
  - Environmental concerns
  - Made changes that the stakeholders said they wanted during the virtual site visit

OK. So it sounds like you were able to create some hypotheses about what changes in the site would meet the needs of your stakeholder, and then test it by giving them preference surveys—and that gave you more specific information about the social and environmental issues your stakeholder cares about. Is that right?

Ask each team these questions:

<table>
<thead>
<tr>
<th>Take home</th>
<th>Listen for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK. Is that all we need to do, then, or is there something more that we need to do with that information we have?</td>
<td>Hypothesize Hypothesis testing</td>
</tr>
<tr>
<td>What else do we need in order to get that done?</td>
<td>Sharing data Draw conclusions Analyze data</td>
</tr>
</tbody>
</table>
OK. So to be able to rezone the Northside well, you need to get a good estimate of the amount of change that your stakeholder wants for each issues, and then we need to record that in a way that will be clear to other people in the firm.

At UDA we do that with something called a “stakeholder assessment form”. I just checked my inbox and I see that Maggie sent an email about how to do that.

Why don’t you check your email and then let me know if you have any questions about the stakeholder assessment before we start?

UNLOCK PREFERENCE SURVEY LOCK: WORKING WITH STAKEHOLDER FEEDBACK EMAIL

10:30: Stakeholder assessment

Players receive working with stakeholder feedback email from Maggie.

→ Mentor calls a team meeting.

Has everyone opened their stakeholder assessment? Our goal as a team is to figure out what we learned from the stakeholders’ responses to our preference surveys.

The stakeholder assessment has a tab for each issue that your stakeholders care about. It shows what the initial value was and the value that you submitted in your preference survey.

First thing you each need to do is mark whether your stakeholders thought your plan was ‘acceptable’ or ‘unacceptable.’ And press the ‘update’ button. Do this for each issue (each issue has its own tab).

As you do that, you will see a table form below. The table pulls all of your team’s results together. Red means the stakeholders weren’t happy with the number, and green means they were.

Before we only knew that the stakeholders wanted more or less of certain things. Now, using this table we have more information about what they want. We might know numbers that definitely won’t make them happy. We might know numbers that definitely will make them happy.

Mentor goes through the acceptable and unacceptable rows first and writes in the values. Maybe shows how the first one works.

For the unacceptable row, can put in the initial value if they didn’t learn any more information about what the stakeholders won’t accept.

For the recommended row, need to put in the least amount of change that the stakeholders accepted. This is usually the value that is in the acceptable row. If there is no value there, then have to guess that it is a little bit more or less than the value in the ‘unacceptable’ row.

In some cases, the recommended value is not the accepted value. For example, if the accepted value seems like an outlier. The important thing is that you will need to justify your choices to the stakeholders at the end. Imagine they will be standing in front of you asking why you made the choice you did.

From professional resource:
The Stakeholder Assessment is a tool to help your team use your Preference Survey feedback to determine as specifically as possible what land use changes will please and/or displease your stakeholders. For each issue, your team needs to recommend values the firm should aim for in its final plans.

1. For each issue that your stakeholders care about, there is a tab. Each issue tab will show the initial value and also the value from your submitted plan.
2. For each tab, you need to select “Acceptable” or “Unacceptable” from the drop-down menu based on the feedback you got on your preference survey and press the update button. As your team marks whether the stakeholders accepted or rejected your plan, a color-coded table of the values you submitted to your stakeholders will be created. Red means your stakeholders rejected the value, green means your stakeholders were happy with the value.
3. Once all of the issues have been updated and the green and red table has all of your teammates’ preference survey results, your team should discuss the results with your planning consultant. Decide what your team’s preference surveys tell you about the values that will please your stakeholders. For each issue, look for the minimum or maximum values a final plan will need to please your stakeholder group. Finally, your team needs to decide what value the entire firm should aim for when preparing final plans.

SAVE STAKEHOLDER ASSESSMENT

UNLOCK STAKEHOLDER ASSESSMENT LOCK

Players receive stakeholder assessment received email.

FILL IN STAKEHOLDER ASSESSMENT RECOMMENDED VALUES FOR EQUAL OPPORTUNITIES FOR ALL (USING TARGETS) IF WE DON’T HAVE THAT TEAM.

11:45: Same page meeting

Same page meeting 4: Stakeholder Assessment

Take homes

1. Using Data
   a. Collect data: Ability to collect data using various methods including individually reading background material and collaborating with teammates
   b. Use data to inform recommendations: Ability to collect data to inform recommendations and justifications
   c. Analyze data: Ability to analyze multiple sources of data using a variety of methods including through using a simulation and by reading text
   d. Synthesize data: Ability to synthesize information from multiple sources to draw conclusions and make recommendations.

3. Identifying goals
   a. Stakeholders have concerns: Ability to identify that stakeholders have concerns
   b. Stakeholders have nonspecific concerns: Ability to identify that stakeholder concerns are not always specific
   c. Identifying goals: Identifying goals involves collecting data in multiple ways

4. Collaborating
   a. Sharing data: Ability to share data with others
   b. Draw conclusions: Ability to draw conclusions with team members during a team meeting
   c. Ask questions: Ability to ask questions of team members to obtain specific information that will benefit the entire team

6. Envisioning alternatives/identifying tradeoffs
   a. Multiple solutions: Ability to see multiple ways to address a problem

7. Social impact of planning decisions on communities
   a. Social impact of planning on communities: Ability to use in words or actions understanding how the current land use configuration has specific social effects on the community

8. Environmental impact of planning decisions on communities
   a. Environmental impact of planning on communities: Ability to use in words or actions understanding how the current land use configuration has specific effects on the environment

11. Terms of art
   a. Knowing specific planning terms of art like land use codes, preference survey, stakeholders, etc
12. Serving public interest
   a. Represent others: Seeing one’s job as representing the concerns of others while proposing changes to a landscape instead of advancing personal interests

13. Compromise
   a. Diverse interests: Realizing that when many people are involved in a process, interests do not always align
   c. Professional judgment: Working with others to decide which interests to pursue based on professional judgment rather than personal or individual interests

14. Respecting all points of view
   a. Respecting all points of view: Considers all concerns of others even when those concerns don’t align with personal interests

16. Justification considers and describes all of the relevant facets
   a. People’s concerns: Refers explicitly to people’s concerns
   c. Environmental concerns: Refers explicitly to animals, plants, habitat, water or air quality

**Hey team. Let’s talk about your stakeholder assessment and get onto the “same page”. I’d like to hear from everyone.**

<table>
<thead>
<tr>
<th>Ask each individual these questions:</th>
<th>Take home</th>
<th>Listen for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>[NAME], would you mind telling us what you just finished doing?</td>
<td>Collect data</td>
<td>Compare the stakeholder feedback to team’s preference surveys</td>
</tr>
<tr>
<td></td>
<td>Use data to inform recommendations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analyze data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Synthesize data</td>
<td></td>
</tr>
<tr>
<td>Follow-up questions</td>
<td>Use data to inform recommendations</td>
<td>Made recommendations to planning firm</td>
</tr>
<tr>
<td>What did you find out when you did your stakeholder assessment?</td>
<td>Stakeholders have concerns</td>
<td>Specific stakeholder concerns, with numerical data</td>
</tr>
<tr>
<td></td>
<td>Stakeholders have nonspecific concerns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identifying goals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>People’s concerns</td>
<td></td>
</tr>
</tbody>
</table>

So we were able to use the stakeholder assessment to make sense of the stakeholder feedback to the preference surveys. By analyzing this data we were able to estimate more accurately what the stakeholders will support or not support. Based on our estimates, we recommended targets for pleasing the stakeholders. Does that sound right?

<table>
<thead>
<tr>
<th>Ask each team these questions:</th>
<th>Take home</th>
<th>Listen for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>With the information we have, what should we do</td>
<td>Represent others</td>
<td>Make new plans that will please all of the</td>
</tr>
<tr>
<td>next?</td>
<td>Compromise</td>
<td>stakeholders</td>
</tr>
<tr>
<td>-------</td>
<td>------------</td>
<td>--------------</td>
</tr>
</tbody>
</table>
| What else do we need in order to get that done? | Stakeholders have concerns  
Sharing data  
Draw conclusions  
Ask questions  
Collect data  
Use data to inform recommendations  
Analyze data  
Synthesize data | Learn about other stakeholders’ interests.  
Collaborate with other teams and analyze their data |

So now we have more specific data about what [stakeholder group] wants. To create a final plan, you’ll need to find out the same information about what all of the other stakeholders want, because their preferences for the site are just as important.

When you start making your final plan, UDA has arranged it so you’ll see your colleagues’ recommended targets for the stakeholder groups they researched.

Once finished, mentor tells players the teams will change. Pretty soon you will join a new team. Each of you will represent your stakeholders that you have learned about. Soon you will be working on a final plan, where you will have to please all of the stakeholders, not just the ones you have learned about. I will only be working with some of you so I just wanted to say thank you for being so professional and working so hard. Your stakeholders will be thankful for it!

**Urban Science Playbook: Session 3**

**Pre-Game**

Mentors respond as NPCs to emails as necessary

UNLOCK NEW TEAMS LOCK

9:00: Meet new teams

Players log on.

Players receive New Teams for Final Proposal email.
Players receive Working Together email.

Mentors welcome new chat group: *I’m looking forward to working with you. We need to help each other because each of you is an expert on one stakeholder group, and when you do your final plan and proposal, you will need to please all the stakeholder groups. You may have to make compromises, because the stakeholder groups sometimes disagree about what should be done with the Northside.*

**TEAM MEETING**

1. Share what you learned from the stakeholder assessment.
2. Tell your new group about any land use strategies you learned for making the changes.
3. Explain why your stakeholders wanted these particular changes. You will need to justify the land use changes you make in your final plan when you write your final proposal, and your colleagues will have to help you, and you them.

**9:15: Final plan**

Players start final plans.

*Use the recommendations of your colleagues. If you have trouble meeting the targets that your colleagues recommend, ask the team via chat. Someone may have figured out how to increase or decrease something that you are having trouble with.*

**9:45: Same page meeting**

**Same page meeting: Final plan**

**Take homes**

1. Using Data
   a. **Use data to inform recommendations:** Ability to collect data to inform recommendations and justifications
   b. **Analyze data:** Ability to analyze multiple source of data using a variety of methods including through using a simulation and by reading text
   c. **Synthesize data:** Ability to synthesize information from multiple sources to draw conclusions and make recommendations
2. Using a simulation (iPlan) to explore a complex system
   a. **Hypothesize:** Ability to hypothesize projected impacts and tradeoffs of multiple scenarios using a simulation using a simulation
   b. **Hypothesis testing:** Ability to test hypotheses in closed simulation environment
   c. **Propose plan without social impacts:** Ability to use a simulation to propose plans without negative social impacts
   d. **Propose plan without environmental impacts:** Ability to use a simulation to propose plans without negative environmental impacts
3. Identifying goals
   a. **Stakeholders have concerns:** Ability to identify that stakeholders have concerns
4. Collaborating
   a. **Sharing data:** Ability to share data with others
   b. **Draw conclusions:** Ability to draw conclusions with team members during a team meeting
   c. **Ask questions:** Ability to ask questions of team members to obtain specific information that will benefit the entire team
6. Envisioning alternatives/identifying tradeoffs
   a. **Multiple solutions:** Ability to see multiple ways to address a problem
7. Social impact of planning decisions on communities
   a. **Social impact of planning on communities:** Ability to use in words or actions understanding how the current land use configuration has specific social effects on the community
   b. **Social impact of land uses:** Ability to use in words or actions understanding how changing any of the ways land is used has social impacts (for better or for worse)
   c. **Measuring social impacts:** Identifying and measuring social impacts such as housing units, number of jobs, sales revenue, and the character of the neighborhood
8. Environmental impact of planning decisions on communities
   a. **Environmental impact of planning on communities**: Ability to use in words or actions understanding how the current land use configuration has specific effects on the environment
   b. **Environmental impact of land uses**: Ability to use in words or actions understanding how changing any of the ways the land is used impacts the environmental balance (for better or for worse)
   c. **Measuring environmental impacts**: Identifying and measuring environmental impacts such as water quality, air quality, and habitat quality for specific species

9. Interconnectedness of cities
   b. **Cities impact social issues**: Ability to use in words or actions understanding the relationships between land use and social issues like jobs, housing, and the character of a neighborhood
   c. **Land use impacts are interconnected**: Ability to use in words or actions understanding how changing land uses impact multiple issues

10. Following an existing process/strategy
    a. **Strategy**: Knowing and following specific steps of the planning process including the site visit, preference survey, stakeholder assessment, and plan

11. Terms of art
    a. Knowing specific planning terms of art like land use codes, preference survey, stakeholders, etc

12. Serving public interest
    a. **Represent others**: Seeing one’s job as representing the concerns of others while proposing changes to a landscape instead of advancing personal interests
    b. **Respecting conflict**: Respecting the public interest by listening to the conflicting, sometimes non-specific concerns of stakeholders

13. Compromise
    a. **Diverse interests**: Realizing that when many people are involved in a process, interests do not always align
    b. **Solutions for the public**: Devising solutions that please the public rather than you or an individual
    c. **Professional judgment**: Working with others to decide which interests to pursue based on professional judgment rather than personal or individual interests

14. Respecting all points of view
    a. **Respecting all points of view**: Considers all concerns of others even when those concerns don’t align with personal interests

15. Justification based on satisficing
    a. **Can’t please everyone**: Refers explicitly to people’s conflicting concerns and describes why specific choices were made in light of those conflicts/tradeoffs (you can’t please everyone)

16. Justification considers and describes all of the relevant facets
    a. **People’s concerns**: Refers explicitly to people’s concerns
    b. **Environmental concerns**: Refers explicitly to animals, plants, habitat, water or air quality

---

**Hey team. Let’s talk about your final plan and get onto the “same page”. I’d like to hear from everyone.**

<table>
<thead>
<tr>
<th>Ask each individual these questions:</th>
<th>Take home</th>
<th>Listen for…</th>
</tr>
</thead>
</table>
| [NAME], would you mind telling us what you just finished doing? | Represent others  
People’s concerns  
Can’t please everyone  
Strategy | Tried to meet all of the stakeholders’ needs in a final plan  
Used the recommended targets for each stakeholder group  
Noticed that some of the stakeholders’ recommended targets for the same issue don’t overlap  
Process and justification for determining which targets to meet |
| What did you find out when you conducted your final plan? | Respect all points of view  
Respect conflict  
Can’t please everyone | Stakeholders’ concerns are not all compatible |
| Follow up questions | | |
| **Were you able to meet all of the targets? Why not?** | Social and environmental | Discussing interconnections |
Which targets were difficult to meet? Why do you think they were difficult to meet?

<table>
<thead>
<tr>
<th>Impacts of land uses</th>
<th>Land use impacts are interconnected</th>
</tr>
</thead>
</table>

What do you think the environmental impact of your final plan will be? Why?

<table>
<thead>
<tr>
<th>Environmental impacts of land uses</th>
<th>Measuring environmental impacts</th>
</tr>
</thead>
</table>

What do you think the social impacts of your final plan will be? Why?

<table>
<thead>
<tr>
<th>Social impacts of land uses</th>
<th>Measuring social impacts</th>
</tr>
</thead>
</table>

Not all stakeholder concerns are compatible, as you know. How did you decide which changes to make in your final plan?

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Diverse interests</th>
<th>Solutions for the public</th>
<th>Professional judgment</th>
</tr>
</thead>
</table>

It seems like you had to make some decisions in your final plans that will have social and environmental consequences that may not please all of the stakeholders. You had to make some compromises.

Ask each team these questions:

<table>
<thead>
<tr>
<th>Take home</th>
<th>Listen for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Justify and explain recommendations using data</td>
<td>Justifying recommendations in the final plans</td>
</tr>
<tr>
<td>Represent others</td>
<td>Importance of justifying so that stakeholders support plans</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What else do we need in order to get that done?</th>
<th>Diverse interests</th>
<th>Need the stakeholders’ feedback on final plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diverse interests</td>
<td>Solutions for the public</td>
<td>Need the stakeholders’ feedback on final plans</td>
</tr>
</tbody>
</table>

It sounds to me like you know your final plans are not going to please everyone. To get the stakeholders’ support, even if you didn’t give them exactly what they wanted, you’ll
need to justify how your land use choices are good for the site using the data you have collected throughout this entire process.

Along with the final plans, we send the stakeholders final proposals. Final proposals use the data from the site assessments and stakeholder assessments to justify the choices and compromises you made and the trade-offs you considered.

10:00: Final proposal

Mentors tell players to submit their maps, and to start on their final proposals.

In your final proposal, you will need to describe what you did in the recommendations section. You will need to justify what you did (why you did it). And you will need to describe the limitations of your plan (what were you not able to do).

Use the model in the professional resources menu. Before you mark it complete, paste what you wrote in the chat so I can see it. If you want to be thorough, and make sure that you do a good job, you can cut and paste a section into an email to me and I will look it over before you mark it complete.

Remember, this is for the mayor of Madison, so please write professionally.

You now have a good idea what some of the stakeholders want. Use what you found out about your stakeholders from doing the virtual site visit and writing the site assessment. Also, you can use the preference survey feedback. To know about the other stakeholder groups, you will have to use the expertise of your colleagues who worked with them. You can ask them via chat. Or they can direct you to public notebook entries that they wrote about their stakeholders.

Introduction:

Goals: What you were trying to achieve with your final plan.

For example, “In this proposal, I was trying to create a new plan for the Northside that pleased four distinct stakeholder groups.”

Challenges: Things that were difficult while trying to achieve your goal.

For example, “In the process of working towards my goal, I found that some of the stakeholders’ desires were in direct conflict with one another.”

Recommendations:

Based on all of the information I collected and my work with iPlan, I recommend the following changes:

- Changing a few R1 housing lots to R4 and keeping most of the rest at R1 but otherwise not changing anything. This increases housing units and keeps crime pretty much the same.
- Changing some R1 to C2-R4 to increase the tax revenue and housing units.
Changing a few R1 to OS to create more places for community get-togethers.

Justifications:

I think that the changes I am recommending will please the stakeholders in the neighborhood because:

I increased housing because Kids First and the Construction Associates of Madison wanted more housing, allowing people who work in the Northside neighborhood to live there as well.

I increased the number of jobs because the Business Council and the Construction Associates of Madison wanted more jobs to improve the economy.

I allowed the acceptable levels of nitrate pollution to increase because the Construction Associates of Madison and the Business Council wanted it increased, to draw more industry to the area.

I increased tax because Kids First wanted it higher, so now kids will have enough school supplies for a proper education.

I increased greenspace because Kids First and the People for Greenspace wanted it higher; this also helps keep carbon dioxide lower than 209 ppm. We added greenspace in residential areas with no greenspace nearby.

Limitations:

Some compromises had to be made in our final plan that may not please all of the involved stakeholders. These limitations are listed below.

I increased the allowed levels of pollution, which met the needs of the Construction Associates of Madison but not those of the People for Greenspace.

I did not meet the greenspace needs of the People for Greenspace or the Kids First stakeholders.

I did not meet the Business Council’s needs because we decreased sales.

I did not meet the Kids First’s request to decrease traffic.

WHEN PLAYERS ARE FINISHED WITH FINAL PROPOSAL, UNLOCK FINAL PROPOSAL LOCK.

11:00: Reflection email

Mentors should get players to finish proposals and move on to summary reflection emails.

Please respond to the summary reflection email.

☐ What you think went well during your planning work
☐ What you could improve on
☐ What you learned about being a planner and the planning process
[Right questions to be asking??]

11:15: Same page meeting

Same page meeting: Final Proposal, Overall Game

Take homes

1. Using Data
   c. **Analyze data**: Ability to analyze multiple source of data using a variety of methods including through using a simulation and by reading text
   d. **Synthesize data**: Ability to synthesize information from multiple sources to draw conclusions and make recommendations

3. Identifying goals
   a. **Stakeholders have concerns**: Ability to identify that stakeholders have concerns

4. Collaborating
   b. **Draw conclusions**: Ability to draw conclusions with team members during a team meeting
   c. **Ask questions**: Ability to ask questions of team members to obtain specific information that will benefit the entire team

5. Justifying recommendations
   a. **Justify recommendations**: Ability to recognize that recommendations need to be justified so that others can understand the process that went into making certain choices
   b. **Use data to justify**: Ability to use data to justify specific recommendations to others
   c. **Explain recommendations**: Ability to clearly explain recommendations to others

6. Envisoning alternatives/identifying tradeoffs
   a. **Multiple solutions**: Ability to see multiple ways to address a problem
   b. **Identify consequences**: Ability to identify the possible consequences

7. Social impact of planning decisions on communities
   a. **Social impact of planning on communities**: Ability to use in words or actions understanding how the current land use configuration has specific social effects on the community
   b. **Social impact of land uses**: Ability to use in words or actions understanding how changing any of the ways land is used has social impacts (for better or for worse)

8. Environmental impact of planning decisions on communities
   a. **Environmental impact of planning on communities**: Ability to use in words or actions understanding how the current land use configuration has specific effects on the environment
   b. **Environmental impact of land uses**: Ability to use in words or actions understanding how changing any of the ways the land is used impacts the environmental balance (for better or for worse)

9. Interconnectedness of cities
   a. **Cities impact environmental issues**: Ability to use in words or actions understanding how cities impact environmental issues like water quality, air quality, and habitat quality
   b. **Cities impact social issues**: Ability to use in words or actions understanding the relationships between land use and social issues like jobs, housing, and the character of a neighborhood
   c. **Land use impacts are interconnected**: Ability to use in words or actions understanding how changing land uses impact multiple issues

10. Following an existing process/strategy
    a. **Strategy**: Knowing and following specific steps of the planning process including the site visit, preference survey, stakeholder assessment, and plan

11. Terms of art
    a. Knowing specific planning terms of art like land use codes, preference survey, stakeholders, etc

12. Serving public interest
    a. **Represent others**: Seeing one’s job as representing the concerns of others while proposing changes to a landscape instead of advancing personal interests
    b. **Respecting conflict**: Respecting the public interest by listening to the conflicting, sometimes non-specific concerns of stakeholders

13. Compromise
    a. **Diverse interests**: Realizing that when many people are involved in a process, interests do not always align
    b. **Solutions for the public**: Devising solutions that please the public rather than you or an individual
    c. **Professional judgment**: Working with others to decide which interests to pursue based on professional judgment rather than personal or individual interests

14. Respecting all points of view
    a. **Respecting all points of view**: Considers all concerns of others even when those concerns don’t align with personal interests

15. Justification based on satisfying
    a. **Can’t please everyone**: Refers explicitly to people’s conflicting concerns and describes why specific choices were made in light of those conflicts/tradeoffs (you can’t please everyone)

16. Justification considers and describes all of the relevant facets
    a. **People’s concerns**: Refers explicitly to people’s concerns
    b. **Future generations**: Refers explicitly to future generations
    c. **Environmental concerns**: Refers explicitly to animals, plants, habitat, water or air quality
    d. **Good urban form**: Refers explicitly to principles of good planning/urban form
So you just spent some time reflecting on your experience at UDA. I’d like to hear some of your thoughts about what you have been doing.

<table>
<thead>
<tr>
<th>Ask each <em>individual</em> these questions:</th>
<th>Take home</th>
<th>Listen for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>[NAME], would you mind telling us what you just finished writing?</td>
<td>Analyze data</td>
<td>Using iPlan to find out about how changing land use codes affects certain indicators</td>
</tr>
<tr>
<td></td>
<td>Synthesize data</td>
<td>Specific recommendations to make and work towards in a final plan, using data to justify and explain recommendations</td>
</tr>
<tr>
<td></td>
<td>Justify recommendations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use data to justify</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Explain recommendations</td>
<td></td>
</tr>
<tr>
<td>Stakeholders have concerns</td>
<td></td>
<td>Specific stakeholder needs and conflicts Putting the stakeholders’ needs above personal opinions</td>
</tr>
<tr>
<td>Respect conflict</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respect all points of view</td>
<td></td>
<td></td>
</tr>
<tr>
<td>People’s concerns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Represent others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solutions for the public</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional judgment</td>
<td></td>
<td>Rationale behind justifications in final proposal</td>
</tr>
<tr>
<td>Environmental concerns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good urban form</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What did you find out while you were working on your final proposal?</td>
<td>Multiple solutions</td>
<td>Rationale behind planning decisions</td>
</tr>
<tr>
<td>Identify consequences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social and environmental impact of planning on communities</td>
<td></td>
<td>Connections between land use changes and social and environmental effects on the city—justifying their recommendations</td>
</tr>
<tr>
<td>Social and environmental impact of land uses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cities impact social</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
and environmental issues
Land use impacts are interconnected

Diverse interests The needs of the different groups overlapped.

Can’t please everyone Realized that we can’t make everyone happy and had to justify the decisions we made.

So being a planner involves: collecting different types of data about the site and its stakeholders in order to meet their social and environmental concerns. We hypothesize solutions that will please the stakeholders and test those hypotheses with preference surveys. We offer final plans and proposals that attempt to find the best solution for the entire community.

<table>
<thead>
<tr>
<th>Ask each team these questions:</th>
<th>Take home</th>
<th>Listen for…</th>
</tr>
</thead>
<tbody>
<tr>
<td>With the information we have, what should we do next?</td>
<td></td>
<td>Applying knowledge to other cities</td>
</tr>
<tr>
<td>Follow-up question</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If you were doing this again, based on what you learned, what would you do differently/the same?</td>
<td>Strategy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What else do we need in order to get that done?</td>
<td>Stakeholder concerns Strategy</td>
<td>Stakeholder feedback, aspects of the planning process</td>
</tr>
<tr>
<td>Follow up question</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What other resources of information would you like in order to do this again?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[No transition needed here. Just revoicing of what the players say. Especially if they talk about how they would do things differently the next time, and if those things concern strategy, research, collaboration etc (any frame elements).]

**UNLOCK SUMMARY REFLECTION LOCK**

**11:30: Exit interview**

Players receive Thank You email from Maggie and Final Proposal Complete email from Curt
Players take exit interview

Players receive Best Wishes email from Curt
Appendix 3: Conservation Leadership Program—Final Agenda—August 16-20, 2010

CLP DRAFT AGENDA:

Group A

Block 1: Monday AM→Intro to program; habitats; field walk, goals/expectations

Block 2: Monday PM→Land Science (1)

Block 3: Tuesday AM→Intro to Ecological Management Plan: What is a REA; How we will conduct a similar assessment at DF; Build Field Skills; Field Tools- mobile mapper, camera, field sheets; set up study site; Kestrel; Discussion of farm/nature connection; human input into conservation decisions….etc.

Block 4: Tuesday PM→Land Science (2)

Block 5: Wednesday AM→Continue REA; Scenarios discussion: using flip charts, etc. Connection, etc. How do humans fit in? Begin project planning…invasive management, wetland assessments?

Block 6: Wednesday PM→Wrap up Land Science

Block 7: Thursday AM→Bryan Windmiller: Conservation Research Projects; hands-on and discussion about how humans intervene in a “natural system”. Wetland Exploration, etc.

Block 8: Thursday PM→Finalized and begin stewardship projects

Block 9: Friday AM→Bob Wilbur; Connections to field work and Land Science; feedback on programs; begin projects.

Block 10: Friday PM→Complete projects; end of week party

Group B

Block 1: Monday AM→Intro to program; habitats; field walk, goals/expectations

Block 2: Monday PM→Intro to Ecological Management Plan: What is a REA; How we will conduct a similar assessment at DF; Build Field Skills; Field Tools- mobile mapper, camera, field sheets; set up study site; Kestrel; Discussion of farm/nature connection; human input into conservation decisions….etc.

Block 3: Tuesday AM→Land Science (1)

Block 4: Tuesday PM→Continue REA; Scenarios discussion: using flip charts, etc. Connection, etc. How do humans fit in? Begin project planning…invasive management, wetland assessments?

Block 5: Wednesday AM→Land Science (2)

Block 6: Wednesday PM→Finalized and begin stewardship projects

Block 7: Thursday AM→Wrap up Land Science
Block 8: Thursday PM ➔ Bryan Windmiller: Conservation Research Projects; hands-on and discussion about how humans intervene in a “natural system”. Wetland Exploration, etc.

Block 9: Friday AM ➔ Bob Wilbur; Connections to field work and Land Science; feedback on programs; begin projects.

Block 10: Friday PM ➔ Complete projects; end of week party

**Monday, 8/16**

- **Block 1 (Kris, Sally, Brian) – 9:00-12:00**
  - 8:00’ish – CLP staff arrive (all)
  - Get the water out!
  - 8:30 – CLP youth begin to arrive (all) @ Education Building
  - 9:15/9:30 – Begin with name game as Kris finishes greeting parents (Brian)
  - 10:00 – Name Games, Ice Breakers, Educational New Games @ Nature Center (Brian, Kris, Sally)
    - **Materials**- Brian, please bring any supplies we will need for the games, etc.
    - 10:45 – Field Walk up and over Drumlin, end at Overlook Site
      - **Materials**- Sally, please bring field tools, such as two-way viewers, magiscopes, insect nets, field guides, binoculars, etc.

- **12:00-12:30 – Lunch! @ Overlook (all)**

- **Block 2 – 12:30-3:45**
  - **Team A @ Hatheway** (Robin, Elizabeth, and “some third person” to be identified later)
    - Land Science
  - **Team B @ Overlook** (Brian, Sally, Kris, maybe Renata)
    - Introduce Ecological Management Plan
    - What is REA
    - How we will conduct a similar assessment at DF
  - **12:45-1:05 – Kestrel ARK (delivered by WLC to the Overlook and possibly led by WLC as staff are available; one of the CLP staff can return the kestrel)**
    - **Notes for Wildlife Care**- *We are using the American Kestrel as an example of a wild animal that would be attracted to the immediate habitat surrounding the Overlook Site where we will be our ARK program. These surrounding habitats are places like the Bobolink Field and nearby open fields and crops fields at DF. The youth will be documenting populations of invasive plant species, which compete with other organisms in the said habitats and

---

11 In the Conservation Leadership Program, Urban Science was referred to as “Land Science.”
otherwise throw off the ecological balance. An ARK program with the kestrel will provide us with the opportunity to connect native wildlife with the habitat we will be working to improve, by removing the invasive plant “purple loosestrife” throughout the remainder of the week. Thank you for all of your coordination and of course for your direct care for the kestrel.

- **Build Field Skills and Set-up Study Site.**
  - This will include proper plant ID of purple loosestrife and anything else that appears in the Bobolink Field and the WHIP area. We will stake out a small area (orange stakes and yellow string) to do the ID manually. Then we will move into the following documentation using technology-based field tools, especially the mobile mappers.

- **Materials** - Sally, let’s hold on to those same field tools, and Brian, let’s please, add in the mobile mappers, digital cameras from Beck. Flip Cams from Kris, and field sheets with clip boards and pencils from Brian.
  - Ecological Management Plan
  - Ecological Management MAPS
  - Maps of DFWS
  - Confirm Study Site w/Tia
  - Confirm possible stewardship projects
  - Field Guides
  - REA protocols
  - Cameras
  - FLIP camera
  - Mobile Mappers
  - Stakes/String/Hammer
  - Magnifiers/Magiscopes
  - Clipboards
  - Pencils/Pens
  - Nets
  - Insect Traps
  - White Boards
  - Chart Paper
  - Waders??
  - Boots

- Discussion of farm/nature connection; human input into conservation decisions…etc

- 3:45 – Debrief the Day and Closing (all) @ the Education Building

**Tuesday, 8/17** (Sally and Susannah out all day.)

- Get the water out!
- 8:30 – CLP youth begin to arrive (all) @ Education Building
• 9:00 – Begin by giving agenda for the day, etc. and then head to separate sites for the morning. (all)

• Block 3 – 9:15-12:00
  o Team B @ Hatheway (Robin, Elizabeth)
    ▪ Land Science (1)
  
  o Team A @ Overlook (Brian, Kris, shadowed by Priscilla Guiney from Concord-Carlisle H.S.)
    ▪ Introduce Ecological Management Plan
    ▪ What is REA
    ▪ How we will conduct a similar assessment at DF
    ▪ 11:30-11:50 – Kestrel ARK (delivered by WLC to the Overlook and possibly led by WLC as staff are available; one of the CLP staff can return the kestrel)
      • Notes for Wildlife Care- *We are using the American Kestrel as an example of a wild animal that would be attracted to the immediate habitat surrounding the Overlook Site where we will be our ARK program. These surrounding habitats are places like the Bobolink Field and nearby open fields and crops fields at DF. The youth will be documenting populations of invasive plant species, which compete with other organisms in the said habitats and otherwise throw off the ecological balance. An ARK program with the kestrel will provide us with the opportunity to connect native wildlife with the habitat we will be working to improve, by removing the invasive plant “purple loosestrife” throughout the remainder of the week. Thank you for all of your coordination and of course for your direct care for the kestrel.
    ▪ Build Field Skills and Set-up Study Site.
      • This will include proper plant ID of purple loosestrife and anything else that appears in the Bobolink Field and the WHIP area. We will stake out a small area (orange stakes and yellow string) to do the ID manually. Then we will move into the following documentation using technology-based field tools, especially the mobile mappers.

• Materials-
  • Ecological Management Plan
  • Ecological Management MAPS
  • Maps of DFWS
  • Confirm Study Site w/Tia
  • Confirm possible stewardship projects
  • Field Guides
  • REA protocols
  • Cameras
  • FLIP camera
• Mobile Mappers
• Stakes/String/Hammer
• Magnifiers/Magiscopes
• Clipboards
• Pencils/Pens
• Nets
• Insect Traps
• White Boards
• Chart Paper
• Waders??
• Boots

• 12:00-12:30 – Lunch! @ Overlook (all)

• Block 4 – 12:30-3:45
  o Team A @ Hatheway (Robin, Elizabeth, Sandy)
    ▪ Land Science (2)

  o Team B @ Overlook (Brian, Kris)
    ▪ Continue REA
    ▪ Scenarios discussion: using flip charts, etc.
    ▪ Connection, etc. How do humans fit in?
    ▪ Begin project planning… invasives management plans and wetland assessments?
    ▪ Materials-
      • Get flip charts from Karen.

• 3:45 – Debrief the Day and Closing (all) @ the Education Building

Wednesday, 8/18

• Get the water out!
• 8:30 – CLP youth begin to arrive (all) @ Education Building
• 9:00 – Begin by giving agenda for the day, etc. and then head to separate sites for the morning. (all)

• Block 5 – 9:15-12:00
  o Team B @ Hatheway (who?)
    ▪ Land Science (2)

  o Team A @ Overlook (Brian)
    ▪ Continue REA
    ▪ Scenarios discussion: using flip charts, etc.
    ▪ Connection, etc. How do humans fit in?
    ▪ Begin project planning… invasives management plans and wetland assessments?
- Materials-
  - Get flip charts from Karen.

- 12:00-12:30 – Lunch! @ Overlook (all)

- Block 6 – 12:30-3:45
  - Team A @ Hatheway (Kris)
    - Wrap Up Land Science (3)
  - Team B @ Project Site (either Bobolink Field or Poultry Pond) – (Brian)
    - Finalize stewardship project planning and begin implementing action plans.

- 3:45 – Debrief the Day and Closing (all) @ the Education Building

Thursday, 8/19 (Brian will be out during the afternoon portion of this day. Susannah will be graciously filling in.)

- Get the water out!
- 8:30 – CLP youth begin to arrive (all) @ Education Building
- 9:00 – Begin by giving agenda for the day, etc. and then head to separate sites for the morning. (all)

- Block 7 – 9:15-12:00
  - Team B @ Hatheway (who?)
    - Wrap Up Land Science (3)
  - Team A @ ????????? (Bryan Windmiller, Brian)
    - Bryan Windmiller: Conservation Research Projects; hands-on and discussion about how humans intervene in a “natural system”. Wetland Exploration, etc.?
    - Materials- We will need DF ponding equipment for this program. Some of it is in Kris’ office (per Kris).

- 12:00-12:30 – Lunch! @ Overlook (all)

- Block 8 – 12:30-3:45
  - Team A @ Project Site (either Bobolink Field or Poultry Pond) – (Susannah)
    - Finalize stewardship project planning and begin implementing action plans.
  - Team B @ ????????? (Bryan Windmiller, can Sandy assist here?)
    - Bryan Windmiller: Conservation Research Projects; hands-on and discussion about how humans intervene in a “natural system”. Wetland Exploration, etc.?
    - Materials-
• We will need DF ponding equipment for this program. Some of it is in Kris’ office (per Kris).

• 3:45 – Debrief the Day and Closing (all) @ the Education Building

---

**Friday, 8/20**

• Get the water out!
• 8:30 – CLP youth begin to arrive (all) @ Education Building
• 9:00 – Begin by giving agenda for the day, etc. and then head to separate sites for the morning. (all)

• **Block 9 – 9:15-12:00**  
  o Teams A & B @ location?????????????? (who?)  
    ▪ Bob Wilbur; Connections to field work and Land Science; feedback on program; begin projects.

• **12:00-12:30 – Lunch! @ Overlook (all)**  
  o Pass out post-pilot-program review form to youth (at this time perhaps???)

• **Block 10 Block Party! – 12:30-3:45**  
  o Teams A & B @ Project Site (either Bobolink Field or Poultry Pond) – (Susannah)  
    ▪ Complete both projects. If one team is finished with their project, they can come to the rescue of the other team (aka total teamwork!).  
    ▪ Pass out post-pilot-program review form to youth (at this time perhaps???)  
    ▪ Party down with pizza, popsicles and some ARK animals.
      • ARK led by Sally = Spotted Turtle.
      • ARK led by Brian = RTH.

• 3:45 – Debrief the Day and Closing (all) @ the Education Building
• 4:00 – Go back to bed.

**Program Needs:**

Ecological Management Plan

Ecological Management MAPS

Maps of DFWS

Confirm Study Site w/Tia
Confirm possible stewardship projects

**Supplies:**
Field Guides
REA protocols
Cameras
FLIP camera
Mobile Mappers
Stakes/String
Magnifiers/Magiscopes
Clipboards
Pencils/Pens
Nets
Insect Traps
White Boards
Chart Paper
Waders??
Boots

**Logistics**
Snacks
Water
# Appendix 4: Intake and Exit Interview Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Intake</th>
<th>Exit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  How would you rate your typing ability?</td>
<td>1</td>
<td>0</td>
<td>Lenhart et al. (2008)</td>
</tr>
<tr>
<td>(Likert scale: Excellent, Good, Average, Below Average, Poor)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  How often do you use computers for: E-mail and basic searches</td>
<td>1</td>
<td>0</td>
<td>Lenhart et al. (2008)</td>
</tr>
<tr>
<td>(Likert scale: Every day, weekly, once in awhile, never)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  How often do you use computers for: Information gathering</td>
<td>1</td>
<td>0</td>
<td>Lenhart et al. (2008)</td>
</tr>
<tr>
<td>(on products, news, health)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Likert scale: Every day, weekly, once in awhile, never)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4  How often do you use computers for: Online shopping</td>
<td>1</td>
<td>0</td>
<td>Lenhart et al. (2008)</td>
</tr>
<tr>
<td>(Likert scale: Every day, weekly, once in awhile, never)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5  How often do you use computers for: Watching online video, playing</td>
<td>1</td>
<td>0</td>
<td>Lenhart et al. (2008)</td>
</tr>
<tr>
<td>games</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Likert scale: Every day, weekly, once in awhile, never)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6  How often do you use computers for: Instant messaging, reading blogs</td>
<td>1</td>
<td>0</td>
<td>Lenhart et al. (2008)</td>
</tr>
<tr>
<td>etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Likert scale: Every day, weekly, once in awhile, never)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7  How often do you use computers for: Downloads: videos, music, podcasts</td>
<td>1</td>
<td>0</td>
<td>Lenhart et al. (2008)</td>
</tr>
<tr>
<td>(Likert scale: Every day, weekly, once in awhile, never)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8  How often do you use computers for: Creating blogs, social</td>
<td>1</td>
<td>0</td>
<td>Lenhart et al. (2008)</td>
</tr>
<tr>
<td>network profiles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Likert scale: Every day, weekly, once in awhile, never)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9  In 1999 nearly 500,000 acres of coniferous forest was blown down by</td>
<td>1</td>
<td>1</td>
<td>Miller (1999, p. 123)</td>
</tr>
<tr>
<td>a windstorm in the Boundary Waters Canoe Area in the United States and</td>
<td></td>
<td></td>
<td>Matched-pair with 11</td>
</tr>
<tr>
<td>Quetico Provincial Park in Canada. The area is now a fire hazard to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nearby property as well as being a visual mess. Some people argue that</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>salvage loggers should clean out the area and replant pine trees. Others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>argue that it was a natural forest and should be left to natural forces.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What do you think?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11. An amusement park in Florida wants to expand onto a wetland. This new development will impact the habitat for a variety of plants and animals. The amusement park has offered to create a new wetland to make up for the one it is destroying. Some people argue that the new wetland will not support the same species or be of the same quality. Others argue that the amusement park should be able to expand onto a wetland as long as they create a new wetland even if the new wetland supports different species of plants and animals. **What do you think?**

12. **Why do you think that?**

13. Your town is located on a river between Lafayette and Carencro. Your town dumps its sewage and industrial wastes into the river, and the waste travels downstream to Carencro. Lafayette, which is upstream from your town, also dumps its waste into the river, and the effects are seen in your town and towns further downstream like Carencro. **What are the rights and responsibilities of upstream communities to downstream communities?**

14. **Why do you think that?**

15. Your town is located between Spring Valley and Baldwin. Your town’s coal fired power plant releases its emissions into the air, and because of the direction of the prevailing winds, the air emissions affect Baldwin. Spring Valley, which is up wind from your town, also has a coal fired power plant that releases its emissions into the air, and the effects are seen in your town and towns further downwind like Baldwin. **What are the rights and responsibilities of up wind communities to downwind communities?**

16. **Why do you think that?**

17. What are three important issues that need to be taken into account when making decisions about the environment and cities? **[3 text boxes]**

---

12 The questions developed by Bagley & Shaffer (without a citation) were validated through an expert/novice study with professional urban planners and true novices.
<table>
<thead>
<tr>
<th></th>
<th>In what ways do cities and people affect their surrounding environment? [1 text box]</th>
<th>1</th>
<th>1</th>
<th>Developed by Shaffer &amp; Bagley</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>What are three important things that affect water quality? (It is okay to say that you don’t know’). [3 text boxes]</td>
<td>1</td>
<td>1</td>
<td>Developed by Shaffer &amp; Bagley</td>
</tr>
<tr>
<td>19</td>
<td>What are three important things that affect the quality of habitat for Blanding’s turtles? (It is okay to say that you don’t know’). [3 text boxes]</td>
<td>1</td>
<td>1</td>
<td>Developed by Shaffer &amp; Bagley</td>
</tr>
<tr>
<td>20</td>
<td>The town of Maple Ridge, MI is concerned about high levels of nitrates and carbon tetrachloride in their lakes. <strong>What could they do to clean up their lakes if they care most about reducing the level of nitrates (NO$_3^-$)?</strong> [1 text box]</td>
<td>1</td>
<td>1</td>
<td>Developed by Shaffer &amp; Bagley</td>
</tr>
<tr>
<td>21</td>
<td>The town of Forest Hill, CO is concerned about high levels of nitrates and carbon tetrachloride in their rivers. <strong>What could they do to clean up their rivers if they care most about reducing the level of carbon tetrachloride (CCl$_4$)?</strong></td>
<td>1</td>
<td>1</td>
<td>Developed by Shaffer &amp; Bagley</td>
</tr>
<tr>
<td>22</td>
<td>You decide to inventory the nearby Great Blue Heron nesting sites as a Massachusetts Audubon project. During this inventory, you locate a total of 34 nesting sites, only 14 of which are being used by Great Blue Herons. The others are currently unoccupied. You decide that you would like to know why some of the nesting sites are occupied and others are not. <strong>What information would you need to answer this question and how could you get that information?</strong> [1 text box]</td>
<td>1</td>
<td>1</td>
<td>Adapted from Bell et al. (2003)</td>
</tr>
<tr>
<td>23</td>
<td>You decide to inventory the nearby prairie dog burrows as a Sierra Club project. During this inventory, you locate a total of 25 burrows, only 5 of which are being used by prairie dogs. The others are currently unoccupied. You decide that you would like to know why some of the burrows are occupied and others are not. <strong>What information would you need to answer this question and how could you get that information?</strong></td>
<td>1</td>
<td>1</td>
<td>Adapted from Bell et al. (2003)</td>
</tr>
<tr>
<td>24</td>
<td>Why do people plan cities?</td>
<td>1</td>
<td>1</td>
<td>Bagley &amp; Shaffer (2009)</td>
</tr>
</tbody>
</table>
| 25 | How do you decide when a city is well planned or not? | 1 | 1 | Bagley &
<p>| 27 | What information do urban planners use? | 1 | 1 | Bagley &amp; Shaffer (2009) |
| 28 | What are the parts of a good urban plan? | 1 | 1 | Bagley &amp; Shaffer (2009) |
| 29 | How do you decide whether an urban plan is good? | 1 | 1 | Bagley &amp; Shaffer (2009) |
| 30 | Was the internship fun overall? | 0 | 1 | Developed by Shaffer &amp; Bagley |
| 31 | What was the most fun thing about the internship? | 0 | 1 | Developed by Shaffer &amp; Bagley |
| 32 | If you could change one thing to make the internship better, what would it be? | 0 | 1 | Developed by Shaffer &amp; Bagley |
| E1 | While I was in the internship, I could easily picture the events in it taking place. (4 point scale: 1=strongly disagree, 4=strongly agree) | 0 | 1 | Adapted from Green &amp; Brock (2000)* |
| E2 | I could picture myself in the internship. (4 point scale: 1=strongly disagree, 4=strongly agree) | 0 | 1 | Adapted from Green &amp; Brock (2000) |
| E3 | I was mentally involved in the internship while it was going on. (4 point scale: 1=strongly disagree, 4=strongly agree) | 0 | 1 | Adapted from Green &amp; Brock (2000) |
| E4 | After finishing the internship, I found it easy to put it out of my mind. (4 point scale: 1=strongly disagree, 4=strongly agree) | 0 | 1 | Adapted from Green &amp; Brock (2000) |
| E5 | I wanted to learn how the internship would turn out. (4 point scale: 1=strongly disagree, 4=strongly agree) | 0 | 1 | Adapted from Green &amp; Brock |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>0</th>
<th>1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>E6</td>
<td>I found my mind wandering while doing the internship.</td>
<td></td>
<td></td>
<td></td>
<td>(4 point scale: 1=strongly disagree, 4=strongly agree)</td>
</tr>
</tbody>
</table>

*The engagement questions were adapted to fit the virtual internship environment rather than the literary environment from which they originate.*
Appendix 5: Sample final proposal

Introduction:

Goals: What you were trying to achieve with your final plan.

For example, “In this proposal, I was trying to create a new plan for the Northside that pleased four distinct stakeholder groups.”

Challenges: Things that were difficult while trying to achieve your goal.

For example, “In the process of working towards my goal, I found that some of the stakeholders’ desires were in direct conflict with one another.”

Recommendations:

Based on all of the information I collected and my work with iPlan, I recommend the following changes:

Changing a few R1 housing lots to R4 and keeping most of the rest at R1 but otherwise not changing anything. This increases housing units and keeps crime pretty much the same.

Changing some R1 to C2-N-R4 or C2-N-R4 to increase the tax revenue and housing units.

Changing a few R1 to OS to create more places for community get-togethers.

Justifications:

I think that the changes I am recommending will please the stakeholders in the neighborhood because:

I increased housing because Kids First and the Construction Associates of Madison wanted more housing, allowing people who work in the Northside neighborhood to live there as well.
I increased the number of jobs because the Business Council and the Construction Associates of Madison wanted more jobs to improve the economy.

I allowed the acceptable levels of nitrate pollution to increase because the Construction Associates of Madison and the Business Council wanted it increased, to draw more industry to the area.

I increased tax because Kids First wanted it higher, so now kids will have enough school supplies for a proper education.

I increased greenspace because Kids First and the People for Greenspace wanted it higher; this also helps keep carbon dioxide lower than 209 ppm. We added greenspace in residential areas with no greenspace nearby.

Limitations:

Some compromises had to be made in our final plan that may not please all of the involved stakeholders. These limitations are listed below.

I increased the allowed levels of pollution, which met the needs of the Construction Associates of Madison but not those of the People for Greenspace.

I did not meet the greenspace needs of the People for Greenspace or the Kids First stakeholders.

I did not meet the Business Council’s needs because we decreased sales.

I did not meet the Kids First’s request to decrease traffic.
Appendix 6: Worked example of ENA applied to Player 10’s chat condition data for Reflection Meeting 1

**Step 1:** First, the Player 10’s seven excerpts from Reflection Meeting 1 were coded using the 21 codes described above. Player 10 did not respond to the mentor’s first question, responded three times to the second question, two times to the third question and two times to the fourth question.

<table>
<thead>
<tr>
<th>Question</th>
<th>E_1</th>
<th>E_2</th>
<th>E_3</th>
<th>V_1</th>
<th>V_2</th>
<th>V_3</th>
<th>S_1a</th>
<th>S_1b</th>
<th>S_1c</th>
<th>S_1d</th>
<th>S_2</th>
<th>S_3</th>
<th>S_4</th>
<th>S_5</th>
<th>K_1</th>
<th>K_2</th>
<th>K_3</th>
<th>K_4</th>
<th>K_5</th>
<th>L_1</th>
<th>L_2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Step 2:** Player 10’s data was then aggregated by reflection meeting question which resulted in one vector per question.

<table>
<thead>
<tr>
<th>Question</th>
<th>E_1</th>
<th>E_2</th>
<th>E_3</th>
<th>V_1</th>
<th>V_2</th>
<th>V_3</th>
<th>S_1a</th>
<th>S_1b</th>
<th>S_1c</th>
<th>S_1d</th>
<th>S_2</th>
<th>S_3</th>
<th>S_4</th>
<th>S_5</th>
<th>K_1</th>
<th>K_2</th>
<th>K_3</th>
<th>K_4</th>
<th>K_5</th>
<th>L_1</th>
<th>L_2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Step 3:** Player 10’s data was aggregated across all reflection meeting questions.

<table>
<thead>
<tr>
<th>Segment</th>
<th>E_1</th>
<th>E_2</th>
<th>E_3</th>
<th>V_1</th>
<th>V_2</th>
<th>V_3</th>
<th>S_1a</th>
<th>S_1b</th>
<th>S_1c</th>
<th>S_1d</th>
<th>S_2</th>
<th>S_3</th>
<th>S_4</th>
<th>S_5</th>
<th>K_1</th>
<th>K_2</th>
<th>K_3</th>
<th>K_4</th>
<th>K_5</th>
<th>L_1</th>
<th>L_2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Step 4:** Player 10’s aggregated data for Reflection Meeting 1 was turned into a cumulative adjacency matrix.
Step 5: To control for the variation in excerpt length, player 10’s cumulative adjacency matrix was normalized by dividing each value by the square root of the sum of squares.
<table>
<thead>
<tr>
<th>V_1</th>
<th>V_2</th>
<th>V_3</th>
<th>S_1a</th>
<th>S_1b</th>
<th>S_1c</th>
<th>S_1d</th>
<th>S_2</th>
<th>S_3</th>
<th>S_4</th>
<th>S_5</th>
<th>K_1</th>
<th>K_2</th>
<th>K_3</th>
<th>K_4</th>
<th>K_5</th>
<th>I_1</th>
<th>I_2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
</tr>
<tr>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Step 6:** This new normalized cumulative adjacency matrix was used as input for the classical multi-dimensional scaling algorithm used to reduce the multi-dimensional space to the dimensions that account for the most variance in the data.
Appendix 7: Masters’ paper

Promoting civic thinking through epistemic game play

Elizabeth A. S. Bagley and David Williamson Shaffer

University of Wisconsin-Madison

Educational Sciences Building, Room 1078

1025 West Johnson Street

Madison, WI 53706

easowatzke@wisc.edu

dws@education.wisc.edu
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.

Keywords: Education, civic thinking; epistemic gameplay; Urban Science game
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.

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
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
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).
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.

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

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

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).

![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.](image)

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.

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.
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.”

![Figure 2: Changes in knowledge, skills, and values for 12 Urban Science players.](image-url)
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 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.
ACKNOWLEDGEMENTS

The authors would like to thank the colleagues and sponsors who have contributed to this work, particularly Gina Navoa Svarovsky, David Hatfield, Padraig Nash, Aran Nulty, Kelly Beckett, Justin Bagley, and the staffs of the University of Wisconsin-Madison Department of Educational Psychology and the Wisconsin Center for Educational Research. The research reported in this paper was supported in part by a grant from the Macarthur Foundation, a National Science Foundation Faculty Early Career Development Award (REC-0347000), a Spencer Foundation/National Academy of Education Postdoctoral Fellowship, a grant from the Wisconsin Alumni Research Foundation, the Academic Advanced Distributed Learning CoLaboratory, and by the Wisconsin Center for Education Research, School of Education, University of Wisconsin-Madison. Any opinions, findings, or conclusions expressed in this paper are those of the author(s) and do not necessarily reflect the views of the funding agencies or cooperating institutions.

REFERENCES


Bagley, E. (2010). Epistemography of an Urban and Regional Planning Practicum:


Appendix 8: Prelim paper

WCER Working Paper No. 2010-8
May 2010

The Epistemography of an Urban and Regional Planning Practicum: Appropriation in the Face of Resistance

Elizabeth Bagley
Wisconsin Center for Education Research
University of Wisconsin–Madison
easowatzke@wisc.edu
The Epistemography of an Urban and Regional Planning Practicum: Appropriation in the Face of Resistance

Elizabeth Bagley

The reconstruction of society must begin with man’s re-education. Its starting place is in “the extension of knowledge . . . the investigation of things,” in insight, study, and learning.

—John Friedmann, 1973, p. 27

We live on an urban planet. For the first time in history, a majority of us live in cities. How we grow those cities, how we build neighborhoods, how we provide housing, how we choose to get around, how well we incorporate nature into the places we live—these are the challenges that will largely determine our future. As John Friedmann (1973) noted, our changing society requires a new kind of education where knowledge is extended and people are trained to think about and address the complex problems inherent in city planning and growth.

One group of professionals tasked with addressing several of these challenges is urban planners. Because no planning solution works for every place, the training of urban planners must reflect the diversity of challenges, tools, and solutions that planners encounter in their practice. One way that professionals, including urban planners, are trained is through a practicum (Schön, 1983, 1987), a process by which newcomers are initiated into a professional community of practice. A practicum environment is explicitly designed to forge the links between knowing and doing that are central to the reflective practice of a profession. In a practicum, novices extend their knowledge and tackle complex problems. Measuring learning in a practicum environment can be challenging, however, and a growing body of research suggests that a new method called epistemic network analysis (Shaffer et al., 2009) can inform our understanding of how professionals-in-training learn in a practicum environment.

In this paper, I describe an ethnographic study of a graduate-level practicum at a large Midwestern university in order to examine one of the ways urban planners develop expertise. The graduate students in the practicum were guided in the production of a site plan for a developing area by a planner with 34 years of planning experience. In the study, I used epistemic network analysis to examine the presentation feedback sessions in order to explore emergent relationships between the teacher’s planning expertise and the students’ expertise. These results have the potential to influence the future design of professional practicum environments as well as the broader landscape of education.

This study informed the design of Urban Science, an urban planning–based summer program for middle school students. The development, implementation, and assessment of Urban Science was funded by a Faculty Early Career Development (CAREER) grant awarded to David Williamson Shaffer by the National Science Foundation.
Theoretical Background

A major goal of educators is the creation of instructional contexts in which students master skills and appropriate them as their own (Herrenkohl & Wertsch, 1999). Mastery and appropriation, according to Wertsch and Polman (2001), are part of mediated action—human action that is fundamentally characterized by a tension between active agents and the cultural tools they use to carry out action. Wertsch and Polman defined mediated action as a form of action such as speaking, reasoning, or calculating, which inherently involves agents actively using cultural tools. Herrenkohl and Wertsch stressed that mastery of a cultural tool involves having the skill to use a cultural tool effectively, “knowing how” as opposed to “knowing that” or, in other words, procedural versus declarative knowledge. In contrast, appropriation focuses on an agent’s tendency to use a cultural tool, which can be distinct from the level of mastery involved. Using Bakhtin (1981) as a base, Herrenkohl and Wertsch claimed that appropriation means to adopt, imitate, or pick up someone else’s accent. Thus, appropriation is a process of making something—such as a historical narrative, an accent, a way of thinking, or an approach to a problem—one’s own.

High levels of mastery are frequently associated with appropriation; however, some forms of mediated action are characterized by mastery, but not appropriation, of a cultural tool. Bakhtin argued that cultural tools are often not easily and smoothly appropriated and that although an agent might use a cultural tool, the agent might use it with a feeling of resistance or even outright rejection. Wertsch (1998) argued that when such resistance grows sufficiently strong, the agent may refuse to use the cultural tool altogether, but also noted that “it has become increasingly clear that interactional contexts involving resistance and rhetorical opposition may provide some of the most productive settings for developing mastery and appropriation of cultural tools” (p. 182).

Herrenkohl and Wertsch (1999) believed that one of the most effective ways to foster the appropriation, and not just the mastery, of cultural tools is to coordinate these cultural tools with sociocognitive roles. They claimed that sociocognitive roles can be understood in terms of rights and responsibilities, through which people have opportunities to exercise their rights as a way of being responsible to their community. Herrenkohl and Wertsch offered the example wherein a building inspector exercises her right to stop construction on a building because the contractor is suspected of using subpar materials. In this example, the inspector is exercising a right in the context of her responsibility to protect public safety. Or, put simply, she is performing her job.

Herrenkohl and Wertsch (1999) proposed that by promoting the idea of “doing one’s job” and emphasizing the responsibilities to one’s community and the set of rights that accompany those responsibilities, educators could induce students to practice skills important to the sociocognitive role and begin to master and appropriate them. Unfortunately for educators hoping to introduce sociocognitive roles into their classrooms, Herrenkohl and Wertsch did not outline a specific process for creating the sociocognitive roles or offer suggestions about the types of skills that could be mastered or appropriated through students’ assuming roles.
Schön (1983, 1987) argued that, in most professions, people begin to master and appropriate skills in professional practicum experiences. In a professional practicum, novices engage in simulations of professional work. Their work is guided by repeated and explicit reflection, with peers and mentors, on the actions they take in these simulations—what Schön referred to as reflection-on-action. The process of explicit reflection-on-action allows one to look back on a completed task or process to consider the implications and consequences of actions. Schön argued that the goal of the professional practicum is to bind action and reflection together to produce professional expertise particular to each profession.

Extending Schön, Shaffer (2004a, 2004b, 2006) has argued that a professional practicum is a key step to developing the epistemic frame—or 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. In a practicum environment, experienced mentors explicitly reflect-on-action as a way to model the epistemic frame of a profession. For novices, iterative cycles of action and explicit reflection-on-action with peers and mentors bind together the elements of the epistemic frame—the skills, knowledge, values, identity, and epistemology—that an individual takes on as a member of a community of practice. This collection of cultural tools forms the epistemic frame of the community, which, once appropriated, can be used when an individual approaches a situation from the point of view (or in the role) of a member of the community (Shaffer, 2004a, 2004b, 2005, 2006).

Thus, Schön (1983, 1987) and Shaffer (2006) used a model of learning in a professional practicum that involves iterative cycles of action, explicit reflection-on-action, and the construction of a profession-specific epistemic frame. Their model extends Herrenkohl and Wertsch’s (1998) assertion that coordinating cultural tools with sociocognitive roles can lead to both mastery and appropriation. Specifically, Schön and Shaffer move beyond a conversation about rights and responsibilities into a discussion about designing professional practica and building epistemic frames. However, the model of learning Schön and Shaffer used does not address the role resistance plays in the mastery and appropriation of an epistemic frame.

Although it is possible, and often quite important, to analyze how well students and others have mastered a cultural tool, such analyses can be quite limited in that they do not consider all of the complexities in the relationship between agents and the cultural tools they use (Wertsch, 1998). Thus, measuring appropriation in a practicum setting requires analysis of the process over time to see if there are instances of resistance that inhibit the appropriation of the epistemic frame. One way to analyze those components is through an epistemography, an analysis of the structure of a professional practicum through the lens of epistemic frames where one can examine the kinds of action and reflection-on-action that develop the epistemic frame of a profession (Hatfield, 2008; Shaffer, 2005). An epistemography allows one to see learning principles at work and to recognize some features of the practicum as more essential than others in developing the professional epistemic frame. However, as Wertsch noted, the relationships between agents and their use of cultural tools are complex, and traditional statistical methods do not account for the complexities.
The kinds of professional understanding that a practicum develops are complex because they are not merely a collection of disconnected skills and knowledge. Rather, the power of an epistemic frame is in the connections among its parts, a network that consists of relationships among conceptual, practical, moral, personal, and epistemological parts (Shaffer et al., 2009). Thus, analytical methods such as social network analysis provide a robust set of tools for representing networks of relationships, including complex and dynamic relationships of the kind that characterize epistemic frames (Shaffer et al., 2009). In social networks, individuals are considered nodes in the network, and relationships between individuals are represented as arcs or links between nodes (Haythornthwaite, 1996). For example, a social network analysis of an urban planning practicum might examine the relationships among students and the teacher throughout class meetings. Within each class session, different configurations might emerge as old friends connect, new friendships emerge, and different team projects occur. The amount of time individuals spend with each other can be taken as a proxy for the strength of their relationship by analyzing the different connections among and between nodes and links. That type of analysis would provide a quantifiable way of comparing social relationships across time and a means for better understanding the informal information flows that supplement the formal practicum curriculum.

However, as Shaffer et al. (2009) argued, social network analysis was developed to provide insight into relationships among and between individuals and groups, rather than relationships within the conceptual, practical, moral, and epistemological world of an individual. Therefore, building on social network analysis, Shaffer et al. developed epistemic network analysis, a computational modeling technique for the development of epistemic frames.

Epistemic network analysis is based on two key concepts: (a) thinking can be characterized by the application of an epistemic frame composed of the linkages between professional skills, knowledge, identity, values, and epistemology; and (b) the development of professional thinking can be quantified, analyzed, and visualized through use of a dynamic network model of the developing epistemic frame (Shaffer et al., 2009). Epistemic network analysis has been used to trace frame development in elementary and middle school students during epistemic games based on engineering and urban planning (Nash & Shaffer, 2008; Nulty & Shaffer, 2008). A preliminary reanalysis of qualitative data collected on a science journalism practicum suggested that epistemic network analysis would be a useful tool for analyzing epistemic frame development in professional practica (Hatfield, 2008; Shaffer, 2005).

This study extended the ideas of Wertsch, Schön, and Shaffer by examining the relationships between appropriation, resistance, reflection-on-action, and epistemic frames in a professional planning practicum. The aim of this study was to uncover the learning process within a graduate urban planning practicum. In particular, I investigated how one teacher communicated his urban planning epistemic frame in the face of resistance, describing the students’ initial resistance to the teacher’s frame, the teacher’s explicit reflection-on-action, and the students’ ultimate appropriation of the teacher’s frame. I used epistemic network analysis to examine the teacher’s role in the students’ epistemic frame development by tracking how specific features and events in the practicum led to significant changes in frame development. In this paper, I argue that epistemic network analysis can provide a computational model of the
extent to which participants appropriate the ways of knowing, being, talking, and acting that characterize a particular community of practice. In closing, I discuss how the results of this study could contribute to the design of reflective learning environments and experiences that promote the development of the next generation of urban citizens.

The Ethnographic Study of the Practicum Urban and Regional Planning 912

The main goal of this ethnographic study was to explore the learning processes experienced by the 20 graduate students in the 3-credit practicum course, Urban and Regional Planning (URPL) 912. URPL 912, a prerequisite to entering the professional field of planning, met approximately 3 hours each week for 14 weeks. The teacher during the semester under study was a professional planner with 34 years of planning experience across the United States.

According to his syllabus, the course was designed to help prospective professional planners understand what is involved in the design and execution of complex planning projects. . . . [and focus] on the skills needed to succeed in planning practice, including work programming, gathering specific information needed to prepare a plan for a small area, working as part of a team, and making presentations.

In the course, 20 graduate students in the URPL master’s program prepared a site plan for a developing area of approximately 3,000 acres on the northeast edge of Madison, Wisconsin. In the syllabus, the teacher wrote that he expected the students to “read the landscape” and to expand on the city’s draft neighborhood plan for the area. Class sessions included teacher lectures, class discussion, visits by professional planners, teamwork, student presentations, and feedback on presentations (see Table 1).

Table 1

<table>
<thead>
<tr>
<th>Topics and Activities in Urban and Regional Planning 912, by Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
</tr>
<tr>
<td>Overview</td>
</tr>
<tr>
<td>Teacher lecture</td>
</tr>
<tr>
<td>Guest speaker</td>
</tr>
<tr>
<td>Class discussion</td>
</tr>
<tr>
<td>Teamwork</td>
</tr>
<tr>
<td>Student presentations</td>
</tr>
<tr>
<td>Feedback on presentations</td>
</tr>
</tbody>
</table>

Note. Topics: 1 = mental model of planning; 2 = history of planning; 3 = possible research topics; 4 = process; 5 = stakeholders; 6 = purchase and transfer of development rights; 7 = creating a plan; 8 = final product format.

To prepare the site plan, each student participated in two different teams over the 14 weeks. Students worked in their initial teams in Weeks 2–5 and in their final teams in Weeks 6–14. During the initial weeks, teams gathered background information on the site and were
organized around topics such as infrastructure, existing plans, and transportation. During the final weeks, teams worked on the plans for specific areas within the site. For example, one team was responsible for the open space component of the site plan whereas a second team designed the Burke Station node in the northwest corner of the site. During Week 14, the students presented their site plans to city officials and urban planning professionals, including URPL faculty members.

Data Collection

Data were collected in several ways. I observed all 14 class sessions. During the practicum, the students worked on a site plan, and I joined the final team focused on the development of the southwest section of the site. This team included six students (two males, four females). Additionally, I received access to the course website, which included all course readings, a discussion board, a map server, and all assignments turned in by the students. The teacher also shared the comments he gave the students on their midterm examinations and met informally with me to discuss the progress of the class.

I made digital audio recordings and supplemented these data with field notes. Recordings were transcribed to provide a detailed record of interactions, and field notes were used to capture meaningful nonverbal aspects of the context and to supplement the transcripts. No information on specific career plans was collected; however, several students mentioned plans to pursue planning in city departments, nonprofit groups, and state agencies. No other demographic information was collected about the students.

Data Analysis

The data were segmented into interactive units defined as strips of activity with a consistent interactional structure and topical focus. For example, if the class started discussing the capacity of a proposed wastewater treatment plant and then switched to discussing the location of bike and pedestrian paths, the switch in discourse topic would indicate two separate interactive units. If an interactive unit represented more than one category, it was coded for all applicable codes. Within each interactive unit, the students’ comments were coded cumulatively instead of individually in order to compare the students’ cumulative frame to the teacher’s frame.

This study’s goal was to observe students learning to become planners through participation in a practicum. To capture interactions between the expert teacher and the novice students, I focused on the communication between the teacher and the students during presentation feedback sessions. Presentation feedback sessions were occasions for the teacher and the students to offer feedback on information that teams collected and for the teacher to explicitly reflect-on-action. Those sessions occurred in four classes during the semester (Weeks 4, 5, 11, 13). I analyzed data from the presentation feedback in Weeks 4 and 5 because the feedback given during those weeks focused on the information needed to create successful site plans. (Feedback given in Weeks 11 and 13 focused more on the logistics of preparing for the final presentations.) The specific activities in Weeks 4 and 5 are outlined in more detail in the Results section.
I used the teacher’s epistemic frame in Week 4 as the comparative model for the students’ cumulative epistemic frame in both Weeks 4 and 5 for two reasons. I was interested in seeing if the epistemic frame the teacher used during Week 4 influenced the students’ epistemic frame in Week 5. Additionally, after giving the initial lecture in Week 5, the teacher did not contribute as much as in Week 4. To measure the teacher’s contribution in Weeks 4 and 5, I coded interactive units for the presence of the teacher’s comments.

The segmented interactive units were coded for the presence of resistance to determine whether students were resisting the teacher’s epistemic frame. Data were coded for resisting the teacher’s frame when students discussed or explicitly referred to their conception of how the process should progress in a way that was contrary to the teacher’s conception of how the process should move forward. In this excerpt, for example, a student asserted his idea about how he thought the process should proceed:

I sort of got the sense that they [the city staff] want us to deliver to them a set of policy recommendations and other higher level stuff to help them move this process along rather than [delivering] our own design.

The segmented interactive units were coded for the presence of reflection-on-action to determine whether the teacher explicitly reflected-on-action. Data were coded for this action when the teacher looked back on a completed task or process to consider the implications and consequences of actions, as in this example:

I’m just saying that when you look at the land use pattern, based on uses like that quarry, there’s real limitations on residential in a large part of the area. You have to think about, what are you going to do on the north end where squeezing residential in is not so obvious or so easy? . . . Maybe this needs to be a place with a real employment center instead of just [being] a bedroom community. I’m not saying that you don’t have residential, and I’m not even saying you necessarily start in one place or the other, but I’m saying that it’s gotta be in the thought process here.

The segmented interactive units were also coded for different skills, knowledge, values, and epistemologies of a planning epistemic frame. Though segmented interactive units were coded for identity, the identity component of the epistemic frame is beyond the scope of this paper. The skills, knowledge, values, and epistemology frame elements were broken into sub-elements in order to see a more complete picture of which specific sub-elements differed between the students’ and the teacher’s epistemic frames. The coded segments were aggregated into a database of interactive units showing the presence of the teacher comments, student resistance, teacher reflection-on-action, and teacher and student epistemic frame elements. The relationships among these different components were then analyzed using epistemic network analysis to identify salient themes. Definitions for each sub-element and examples of how each category was used in this analysis are found in the subsections following.

**Skills.** Segments were coded S/L (skill of reading a landscape) when participants discussed or explicitly referred to using the landscape to inform the planning process. For
example, in this excerpt, the teacher appealed to the skill of reading a landscape by telling students:

I [think] that it’s very important that we step back and say, “How does this landscape speak to us?” rather than letting someone else give it to us.

Segments were coded S/A (skill of suggesting alternatives) when participants discussed or explicitly referred to a specific strategy or an alternative way to approach creating a plan. In this excerpt, the teacher suggested alternative land use patterns:

Shoehorning residential onto the north end won’t work. Let’s see if we can put some jobs up there so that the people who live further south, where it’s easier to do residential development, have a place to go that’s a mile away, or a mile and a half away, instead of coming down to Madison. With that, make it a more sustainable community. If you go back to your fundamental rules of sustainability, you can pull that off.

Segments were coded S/QA (skill of questioning assumptions) when participants discussed or explicitly referred to the assumptions made in student analyses. For example, in this excerpt, the teacher encouraged the students to question the assumptions under which the city was operating:

You guys all have to make some recommendations, but I don’t want us to go into this without making sure that we are comfortable with the assumptions they [the city staff] are operating under. . . . I’m not comfortable with all of the assumptions they are operating under, and I think that their assumptions are no longer evidence-based.

Knowledge. Segments were coded K/AI (knowledge of additional information) when participants discussed or explicitly referred to specific information that might be useful in creating the site plan. In this excerpt, one student discussed the additional information her team thought would be important to collect about the site:

This is what we think is important to identify: Property values and who owns it [the property] to see if there’s any correlation there. Target areas for potential development areas, etc., that we’ll hopefully be working on today. Looking into changes in zoning with different incentives for developers, transfer of development rights. Existing view shed protection. We went out there, and we didn’t really come across any.

Segments were coded K/P (knowledge of past process) when participants discussed or explicitly referred to the process used by the City of Madison to create a plan for the same redevelopment area. For example, one student referred to the city’s process by saying:

We saw a map of what they [the city staff] have in mind, and they already have land uses plotted out. They are presenting that to the mayor in the next few weeks. In that land use map, they have mixed-use housing and TODs [transit-oriented developments] and lower density housing, and the majority of it is also going to be lower density acreage.
Values. Segments were coded V/PI (value of serving the public interest) when participants discussed or explicitly referred to considering the needs of people affected by the planning process. In this example, the teacher appealed to the value of serving the public interest by telling the students to consider the involvement of multiple stakeholder groups:

The developer has to be involved in this association. It’s not optional. They have to be part of the deal, and you are going to have to figure out what the City of Madison would say to one or more private land owners.

Epistemology. Segments were coded E/SD (epistemic statement about stakeholders’ desires) when participants justified their decisions based on how they thought a particular stakeholder group would respond. In this example, a student justified his team’s decisions by appealing to the desires of businesses:

Businesses that might be developing through the university or incubator or something. They are going to need production and assembly facilities. They are going to need distribution facilities. And that might not be stuff they can get either on campus or in that incubator. This might be an ideal spot for them.

Segments were coded E/UF (epistemic statement about principles of good urban form) when participants justified their decisions based on the principles of good urban form. In this example, a student justified his team’s decision by discussing these principles:

The city is planning the East Wash build-out in terms of employment . . . which means that it would have to put itself on the periphery because of the land loss. They could have an office near their production facilities. We see that as a potential benefit.

Epistemic Network Analysis

After data collection, I used epistemic network analysis to examine the presentation feedback sessions during Weeks 4 and 5 in order to explore emergent relationships between the teacher’s planning expertise and the students’ expertise. Epistemic network analysis adapts the framework of social network analysis for use with cognitive, rather than social, elements (Hatfield, 2008; Shaffer et al., 2009). As discussed in the Theoretical Background section, Shaffer et al. (2009) developed epistemic network analysis, a computational modeling technique for the development of epistemic frames. (For details on the computations involved in epistemic network analysis, see Shaffer et al. [2009]).

Once an epistemic frame is represented as a series of cumulative adjacency matrices showing the strength of association between each pair of frame elements for a given participant in the data set, the characteristics of the network can be quantified using concepts from social network analysis, such as network density and centrality of individual nodes (Shaffer et al., 2009). The overall structure of an epistemic frame can then be quantified by computing the relative centrality of each node: the square root of the sum of squares of its associations with its neighbors, expressed as a percentage of the weight of the heaviest node in the network.
For this study, the relative centrality of each frame element and sub-element at the final time slice of the presentation feedback activity was calculated in order to compare the cumulative students’ frame in Weeks 4 and 5 to the teacher’s modeled frame in Week 4. Because epistemic frames consist of elements linked together with some elements more central than others, calculating the relative centrality exposed which frame elements were farther from or closer to the center of the epistemic network (relative centrality values closer to 100). In addition, because relative centrality is a cumulative measure of the changes in centrality to the epistemic network graph, using only the final time slice of relative centrality offered the most accurate picture of the students’ cumulative frame development during the weeks studied.

The frame similarity index (FSI) was calculated using the relative centrality and allowed comparisons between the students’ frame development in Weeks 4 and 5 and the frame modeled by the teacher in Week 4. The FSI was computed by using the difference between the students’ cumulative final relative centrality calculations for each frame element in Weeks 4 and 5 and the teacher’s final relative centrality calculations for each frame element in Week 4. The absolute value of the difference of the values was then calculated. In order to make claims about skills, knowledge, values, and epistemology as a whole, the average of the frame sub-elements (for epistemology, e.g., E/SD and E/UF) was computed, and the results were graphed as cumulative frame elements. In the radar plots shown in the sections following, the teacher’s frame is represented as the origin, and the closer the students’ cumulative FSI is to zero, the more closely the students’ frame resembles the frame the teacher modeled in Week 4.

Results

Results of data analysis are described in the following four subsections. First, I identify and describe the interactive units in which the students resisted the teacher during Weeks 4 and 5. Next, I identify and describe the interactive units in which the teacher reflected-on-action during Weeks 4 and 5. Third, I describe the students’ appropriation of the teacher’s epistemic frame in Weeks 4 and Weeks 5. Last, I revisit those data using an epistemic network analysis.

Student Resistance

At the beginning of the semester, the graduate students worked in teams to gather information about the redevelopment site. During the first class session, they learned that although the City of Madison had been working on a plan for the site for 3 years, city staff had not yet presented their plan to the mayor. Also, in contrast to previous practicum courses, the students were not going to be working as consultants for the city; rather, they would be expected to “read the landscape” and expand on the city’s draft neighborhood plan for the area. The students continued to learn about the site through the teacher, guest speakers from the City of Madison planning department, out-of-class site visits, meetings with city officials, and targeted Internet research. The teams were expected to present their initial findings during Week 4 and their more specific findings during Week 5.

While presenting and giving feedback during Week 4, the students referred to the approach the City of Madison was using for the redevelopment site. When the teacher suggested
alternative approaches that were contrary to the city’s approach, the students resisted his suggestions. Overall, in Week 4, 3 of the 11 segmented interactive units in the presentation feedback activity were coded for the students’ resisting the teacher’s ideas, accounting for 54% of the time when both the students and the teacher were talking about the same topic. The dark segments within the presentation feedback section of Figure 1 represent interactive units when the students resisted the teacher. Though the entire segment is shaded, the students were not necessarily resisting the teacher during the entire segment. The activities (guest speaker and presentations) shown in lighter shades on the figure occurred during the Week 4 class session but were not segmented into interactive units or coded for resistance.

![Figure 1. Student resistance to teacher, Week 4.](image)

Three main activities occurred during the 2.5-hour class period: guest speaker (83 min), presentations (30 min), and presentation feedback (37 min). The dark segments within the presentation feedback section represent interactive units when the students resisted the teacher’s ideas (19 min). Note. Only feedback activity was coded for resistance.

For example, when the teacher suggested that the students look into community land trusts as potential models of a community governance organization, one student resisted the teacher’s approach by appealing instead to the city’s approach:

> We sort of came out of the meeting with the understanding that they [the city staff] worked hard on this for a number of years and thought long and hard about the physical layout of the area. It seems like they are looking more for us to plug in the gaps in terms of government concerns, issues like policy, how will they implement the ideas they’ve come up with, rather than us coming up with a design saying this is what we think it’s going to look like because, frankly, there’s no way that you could do all of the research that’s needed to do that in a semester. I sort of got the sense that they want us to deliver to them a set of policy recommendations and other higher level stuff to help them move this process along rather than [deliver] our own design.

In other words, the student was resisting the teacher’s approach to the planning problem and advocating for continuing to use the city’s approach—an approach that he felt would produce results that related to the work the city staff had already accomplished and help move the city process along.
In contrast, in Week 5, the students did not resist the teacher’s suggestions in any of the seven segmented interactive units in the presentation feedback activity when both the students and the teacher were talking about the same topic. In Figure 2 as in Figure 1, the activities that occurred during the class session are shown in lighter shades (teacher lecture, presentations, and teamwork) but were not segmented into interactive units or coded for resistance.

**Figure 2. Student resistance to teacher, Week 5.** Four main activities occurred during the 2.55-hour class period: teacher lecture (25 min), presentations (26 min), presentation feedback (22 min), and teamwork (80 min). The dark segments within the presentation feedback section represent interactive units; however, in Week 5, students did not resist the teacher’s ideas during presentation feedback. *Note.* Only feedback activity was coded for resistance.

**Teacher Reflection-on-Action**

During the presentation feedback activities, the teacher often explicitly reflected on the students’ findings, gave suggestions for additional information they could gather, and shared anecdotes about the similarity of the problems they were facing to problems he had faced in previous projects. In Week 4, 11 of the 12 total segmented interactive units were coded for the presence of the teacher’s comments, and 8 of the 11 segments during which the teacher spoke were coded for his reflecting-on-action (shown in yellow in Figure 3). Though the entire segment is shaded, the teacher was not necessarily reflecting-on-action during the entire segment.
Figure 3. Teacher reflection-on-action, Week 4. Three main activities occurred during the 2.5-hour class period: guest speaker (83 min), presentations (30 min), and presentation feedback (37 min). The yellow segments within the presentation feedback activity represent segments when the teacher reflected-on-action (32 min). Note. Only feedback activity was coded for teacher reflection-on-action.

For example, after one of the teams presented the information they had gathered about the city’s population projections for the site, the teacher reflected on their action by considering the implications and consequences that the information had for the recommendations they would make in their final site plans:

What you’re saying is that it seems pretty comfortable. Then . . . we will talk about what that implies for traffic and other things and how those projections might change. If that’s going to be what affects what we’re able to propose and not propose, and if we really think those 30,000 people need to fit in there, then the question is, how do we do that? . . . How many jobs does it take to sustain 30,000 people? . . . I’m thinking as I let this area kind of settle in on me that I sense that the city was thinking about it starting with residential and then adding everything else on, and as I think about the land use pattern out there and so on, I’m not sure that’s necessarily the place to start. It would be interesting to know whether jobs are projected to grow proportionally with population in Dane County and [what] any projections you can find about what job growth, employment growth look like. Because . . . one of the things that would make a big difference about what we have to plan for in this area is whether or not there are jobs there and you can have some jobs/housing balance right in that area. . . . There’s the possibility of having three or four thousand jobs out there. That can make a really big difference in the land use plan out there.

By reflecting-on-action, the teacher specifically pushed the students to question the city’s assumptions and to consider how the population projections would affect traffic, jobs, and the overall development trajectory. By explicitly questioning the city’s assumptions and offering suggestions about how to deal with multiple possibilities, the teacher spoke directly to the students’ resistance in Week 4 and strengthened the case for having the students use his approach rather than the city’s approach.
In contrast to Week 4, in Week 5 the class started with teacher lecture. During his lecture, the teacher explicitly addressed the students’ resistance from Week 4. He reflected on the actions the students took in Week 4 and referred to his experience as a planner in order to address the students’ anxiety about using his approach instead of the city’s more familiar approach:

Every planning process has to go through a period where people say . . . “I don’t know what the answers are, and if I jump to conclusions now, I’m going to . . . come up with a project that doesn’t work.” . . . And at some point, as you gain experience, you will find that this uncertainty is no longer anxiety, it’s just the way that projects go. And the reason we have a planning process, the reason that we teach ourselves this process is that we know that we’re going to have to go through a period of time when we’re gathering information, and you all have been doing, as near as I can tell, a fine job of collecting the information. I was pleased with what I heard in class last Friday, and I expect to, based on what I have seen, be totally pleased with what you are doing today. So, just let me reassure you that we are on course, that we are doing what needs to be done at this point in the game. And that in this experience, that the main thing, or one of the main things, that you should get out of this is some sense of the pace. And the slowest part of the process is to gather the information, get familiar with the site, let it speak to you, and then once you’ve spent that time, you can sit down at your keyboard, or you can pick up your marker, and you’ll know what to do. . . . I know that you’re anxious, you’re trying to imagine what the final product will look like . . . . We’re not here to learn how to produce documents. That’s something that every planner in the end acquires some skill at because it’s how you report your work. But what we’re here to learn about is how to think about a piece of the landscape and what might happen there.

Specifically, the teacher suggested that taking time to gather information early in the process would have positive implications for the final site plan. To address their anxieties, he encouragingly reflected on the work the students completed in Week 4, told them he was expecting to be pleased in Week 5, and assured them that although they were at a slow part in the process, they were on course. To attend to the students’ concern that his approach would not relate to the work the city had already accomplished, the teacher suggested that the students let this piece of land speak to us . . . . If we try to decide what it’s going to look like before then, what you’re going to end up with is exactly what you don’t want to end up with, which is something that doesn’t relate.

Following the teacher’s lecture, the students presented the information they had gathered about the site and gave feedback on the information presented. During feedback, 8 of the 14 total segments were coded for the presence of teacher comments. In one of these eight segments, the teacher was the only person speaking, and two of the segments were coded for teacher reflection-on-action (shown in yellow in Figure 4). Though the entire segment is shaded, the teacher was not necessarily reflecting-on-action during the entire segment.
Figure 4. Teacher reflection-on-action, Week 5. Four main activities occurred in the 2.55-hour class period: teacher lecture (25 min), presentations (26 min), presentation feedback (22 min), and teamwork (80 min). The yellow segments within the lecture and presentation feedback sections represent segments when the teacher reflected-on-action (6 min). Note. Only feedback activity was coded for teacher reflection-on-action.

During the presentation feedback in Week 5, a student asked about the city’s assumptions, and the teacher reflected-on-action by explicitly considering the implications and consequences that this information had for the recommendations they could make in their final site plans:

We’re simply taking the city’s word. That’s what they anticipate. You found that the total growth was 48,000, so 30,000 is a darn big share of that, but on the other hand, where else can Madison grow geographically? There are a bunch of infill areas that presumably a bunch of those people will go to . . . . One of the questions, although it’s not a particularly simple one, is, Are the town planners correct in saying that they think they need to accommodate 30,000 people here? Are there other locations, presumably infill locations that could absorb more of that? . . . If fewer people show up, you just do less development. We’ll be fine if we’ve set a good pattern in place.

These data suggest that by explicitly reflecting-on-action and addressing the students’ resistance before they rejected his process outright, the teacher created a space where the students could begin to appropriate the epistemic frame he had modeled in Week 4.

Students’ Appropriation of the Teacher’s Epistemic Frame, Week 4

In this section, discussion details student appropriation of the teacher’s epistemic frame in Week 4 by looking at dissimilarity of major elements of the students’ cumulative and the teacher’s epistemic frames. Using epistemic network analysis, the frame similarity index (FSI) was calculated to compare the students’ cumulative epistemic frame with the teacher’s epistemic frame. (The FSI moves toward zero for similar frames.) The total FSI in Week 4 was 165.8: The students’ frame differed substantially from the teacher’s frame (see Figure 5). Although the low FSI for value (based on the sole sub-element V/PI) suggests that the students’ and the teacher’s
frames were similar, the FSIs were high for skills and epistemology and very high for knowledge, showing high dissimilarity in these areas.

Figure 5. Frame similarity index (FSI) for students’ cumulative and teacher’s epistemic frames, Week 4. The point of origin of the radar plot (zero) represents the teacher’s epistemic frame. FSI values closer to zero show similarity of frames. The FSI for value, for example, shows strong similarity of frames for this element.

Further separation of the epistemic frame elements into sub-elements creates a more complete picture about which specific sub-elements differed between the students and the teacher (see Table 2). Relative centrality values closer to 100 indicate that the sub-element was more central in the epistemic frame, whereas values closer to zero indicate that the sub-element was less central to the epistemic frame. For example, V/PI, S/QA, S/L, K/AI, and E/UF were the most central sub-elements in the teacher’s epistemic frame. In contrast, the most central sub-elements in the students’ epistemic frame were V/PI, E/SD, and K/P. In the discussion that follows, we examine only those elements in which these frames differed.

Table 2
Relative Centrality Calculations for Sub-Elements of the Teacher’s and Students’ Cumulative Epistemic Frames, Week 4

<table>
<thead>
<tr>
<th>“Owner” of epistemic frame</th>
<th>S/L</th>
<th>S/A</th>
<th>S/QA</th>
<th>K/AI</th>
<th>K/P</th>
<th>V/PI</th>
<th>E/SD</th>
<th>E/UF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students (cumulative)</td>
<td>0</td>
<td>44.72</td>
<td>60</td>
<td>28.28</td>
<td>91.65</td>
<td>91.65</td>
<td>100</td>
<td>44.72</td>
</tr>
<tr>
<td>Teacher</td>
<td>96.30</td>
<td>46.71</td>
<td>100</td>
<td>95.35</td>
<td>0</td>
<td>100</td>
<td>61.79</td>
<td>91.45</td>
</tr>
</tbody>
</table>

Note. Higher values (max = 100) indicate greater centrality to the particular epistemic frame. S/L = skill of reading a landscape; S/A = skill of suggesting alternatives; S/QA = skill of questioning assumptions; K/AI = knowledge of additional information; K/P = knowledge of past process; V/PI = value of serving the public interest; E/SD = epistemic statement about stakeholders’ desires; E/UF = epistemic statement about principles of good urban form.

Skills. In Week 4, S/L and S/QA were central skill sub-elements in the teacher’s epistemic frame (see Table 2 and Figure 6). In contrast, the students did not use S/L, and S/QA
and S/A were not central to their cumulative epistemic frame. These data suggest that in Week 4 the teacher was mobilizing a different set of planning skills than the students were.

**Figure 6.** Relative centralities of three skill sub-elements—S/L (skill of reading a landscape), S/A (skill of suggesting alternatives), and S/QA (skill of questioning assumptions)—for the students’ cumulative and the teacher’s epistemic frames, Week 4.

**Knowledge.** In Week 4, K/AI was a central knowledge sub-element in the teacher’s frame, but not in the students’ frame (see Table 2 and Figure 7). But K/P, a sub-element the teacher did not use, was the most central knowledge sub-element for the students. These data suggest that although the teacher was mobilizing his knowledge about what additional information might be important to gather, the students were relying on their knowledge about the city’s past approach and were resisting alternative approaches.

**Figure 7.** Relative centralities of two knowledge sub-elements, K/AI (knowledge of additional information) and K/P (knowledge of past process), for the students’ cumulative and the teacher’s epistemic frames, Week 4.

**Values.** The one values sub-element—V/PI—was central in both students’ cumulative and teacher’s epistemic frames and is, therefore, not of interest in this discussion.
**Epistemology.** E/UF was a central sub-element for the teacher’s epistemic frame in Week 4 (see Table 2 and Figure 8). In contrast, although E/UF was not a central sub-element for the students’ epistemic frame, E/SD (epistemic statements about stakeholders’ desires) was a central sub-element for their epistemic frame in Week 4.

*Figure 8. Relative centralities of two epistemology sub-elements, E/SD (epistemic statement about stakeholders’ desires) and E/UF (epistemic statement about good urban form), for the teacher’s and students’ cumulative frames, Week 4.*

These data suggest that although the teacher was justifying his suggestions by referring to principles of good urban form, the students were justifying their decisions by appealing to the desires of stakeholders, including those of the city.

**Students’ Appropriation of the Teacher’s Epistemic Frame, Week 5**

In this section, discussion details changes in student appropriation of the teacher’s epistemic frame from Week 4 to Week 5 by looking at major elements of the epistemic frames, using epistemic network analysis. Figure 9 provides a summary representation of the FSI between the students’ cumulative epistemic frames in Weeks 4 and 5 and the teacher’s modeled epistemic frame in Week 4 (represented by the point of origin of the radar plot). As noted earlier, the total FSI was 165.8 in Week 4, but in Week 5 the FSI decreased to 90.3, suggesting that the students’ frame became more similar in Week 5 to the frame the teacher had modeled in Week 4. Although there was no significant change in value development from Week 4 to Week 5 for the students, skills, knowledge, and epistemology elements in their cumulative frame shifted toward the teacher’s modeled epistemic frame.
Figure 9. Frame similarity index (FSI) for teacher’s epistemic frame, Week 4, and students’ cumulative epistemic frame, Weeks 4 and 5. The point of origin of the radar plot represents the teacher’s frame. As the FSI moves closer to zero, the students’ cumulative frame looks more like the frame the teacher modeled in Week 4. For example, in Week 5 the FSI for the frame element value is zero: For this element, the teacher’s and students’ cumulative frames converged.

By separating the epistemic frame elements into sub-elements, a more complete picture emerged about which sub-elements became more or less central to the students’ epistemic frame from Week 4 to Week 5 (see Table 3). As discussed above, V/PI, S/QA, S/L, K/AI, and E/UF were the most central sub-elements in Week 4 in the teacher’s epistemic frame, whereas the most central sub-elements in the students’ epistemic frame were V/PI, E/SD, and K/P. In Week 5, instead of having a strong central core consisting of V/PI, E/SD, and K/P, the students exhibited a new configuration of their epistemic frame that looked more like the teacher’s, with sub-elements such as S/L, S/A, K/AI, and E/UF increasing in centrality. The order of centrality of frame elements also changed from Week 4 to Week 5.

Table 3
Relative Centrality Calculations for Sub-Elements of the Teacher’s Epistemic Frame in Week 4 and the Students’ Cumulative Epistemic Frame in Weeks 4 and 5

<table>
<thead>
<tr>
<th>“Owner” of epistemic frame</th>
<th>S/L</th>
<th>S/A</th>
<th>S/QA</th>
<th>K/AI</th>
<th>K/P</th>
<th>V/PI</th>
<th>E/SD</th>
<th>E/UF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students (cumulative): Week 4</td>
<td>0</td>
<td>44.72</td>
<td>60</td>
<td>28.28</td>
<td>91.65</td>
<td>91.65</td>
<td>100</td>
<td>44.72</td>
</tr>
<tr>
<td>Students (cumulative): Week 5</td>
<td>55.47</td>
<td>73.38</td>
<td>55.47</td>
<td>83.21</td>
<td>48.04</td>
<td>100</td>
<td>55.47</td>
<td>55.47</td>
</tr>
<tr>
<td>Teacher: Week 4</td>
<td>96.30</td>
<td>46.71</td>
<td>100</td>
<td>95.35</td>
<td>0</td>
<td>100</td>
<td>61.79</td>
<td>91.45</td>
</tr>
</tbody>
</table>

Note. Higher values (max = 100) indicate greater centrality to the particular epistemic frame. S/L = skill of reading a landscape; S/A = skill of suggesting alternatives; S/QA = skill of questioning assumptions; K/AI = knowledge of additional information; K/P = knowledge of past process; V/PI = value of serving the public interest; E/SD = epistemic statement about stakeholders’ desires; E/UF = epistemic statement about principles of good urban form.

According to Shaffer et al. (2009), the relative centrality of a node within a network represents the extent to which the node is or is not part of the dense central core of the network. Thus, although some of the sub-elements became more central to the students’ epistemic frame,
the relative centrality values of the sub-elements in the students’ frame in Week 5 were consistently lower than the teacher’s. Presumably, the teacher had higher relative centrality values for frame elements in Week 4 because his 34 years of planning experience necessitated that his epistemic frame start out more richly interconnected than the students’ epistemic frame. Therefore, the “looseness” of the students’ cumulative epistemic frame may be due to the students’ beginning to appropriate the sub-elements. Because the dense core is central to the strength of the epistemic frame, however, their epistemic frame will likely strengthen over time.

**Skills.** In Week 5, the students followed the teacher’s model and appropriated a new skill, S/L, which became more central to their epistemic frame (see Table 3 and Figure 10). The students’ use of S/A surpassed the teacher’s model in Week 5, suggesting that the students moved away from relying on the city’s assumptions and began suggesting multiple alternatives. The students did not show a significant change in the use of S/QA from Week 4 to Week 5.

*Figure 10. Relative centralities of three skill sub-elements—S/A (skill of suggesting alternatives), S/L (skill of reading a landscape), and S/QA (skill of questioning assumptions)—for the students in Weeks 4 and 5 and the teacher in Week 4. Note. Teacher data are taken from Week 4, but are repeated in Week 5 for comparative purposes.*

**Knowledge.** The students followed the teacher’s model as K/AI became more central and K/P less central to their epistemic frame from Week 4 to Week 5 (see Table 3 and Figure 11). These results suggest that the students were no longer resisting the teacher and relying on their own knowledge about the city’s approach (K/P). Instead, they began suggesting alternative approaches to the site redevelopment (K/AI).
Figure 11. Relative centralities of two knowledge sub-elements—K/AI (knowledge of additional information) and K/P (knowledge of past process)—for the students in Weeks 4 and 5 and the teacher in Week 4. Note. Teacher data are taken from Week 4, but are repeated in Week 5 for comparative purposes.

Values. The one values sub-element—V/PI—was central in both students’ cumulative and teacher’s epistemic frames and is, therefore, not of interest in this discussion.

Epistemology. The students followed the teacher’s model as E/UF became more central to their epistemic frame in Week 5 (see Table 3 and, Figure 12). E/SD became less central to their epistemic frame from Week 4 to Week 5. These results suggest that instead of appealing to the stakeholders’ desires (E/SD) as their main justification technique, the students started referring more to the principles of good urban form (E/UF) and thus had a more balanced epistemology that reflected the teacher’s frame.

Figure 12. Relative centralities of two epistemology sub-elements—E/SD (epistemic statement of stakeholders’ desires) and E/UF (epistemic statement of good urban form)—for the students in Weeks 4 and 5 and the teacher in Week 4. Note. Teacher data are taken from Week 4, but are repeated in Week 5 for comparative purposes.

Discussion

The results described in this paper suggest that examining changes in epistemic frame development across time is a useful way of seeing the process of appropriation in the midst of student resistance. Through explicit reflection-on-action, the teacher addressed the students’ resistance, facilitating their appropriation of his epistemic frame.

This study extends Wertsch’s (1998) work on resistance and appropriation. Wertsch wrote about the productive role of resistance in the process of appropriation, which did occur in Week 4 of URPL 912. In looking across Weeks 4 and 5, however, the results show that the students’ resistance subsided and suggest that the bridge between the students’ resisting and not resisting was the teacher’s lecture. The teacher’s lecture was essentially an explicit reflection on the different frames held by the teacher and the students and provided a map of the professional vision of the planning practice. It seems unlikely, however, that his lecture immediately helped the students understand the epistemic frame of planners in a new light and enabled them to put their new knowledge into practice in their presentation feedback. Therefore, the students must
have started appropriating aspects of the teacher’s epistemic frame in Week 4, despite their resistance.

These results also suggest that the kind of reflective mentoring in professional practicum settings that Schön (1983, 1987) and Shaffer (2004b, 2006) have described accomplishes the task of helping students appropriate a new frame in the face of resistance. Specifically, the results of this study indicate that identifying practicum activities that evoke evidence of certain aspects of an epistemic frame will provide valuable information for designing effective practicum environments and learning environments in general. For example, practitioners thinking about ways to enhance their practice might consider including iterative cycles of action and reflection-on-action, which may facilitate appropriation and mastery.

This study demonstrates that epistemic network analysis can be a productive way of tracking how specific interactions within learning environments lead to significant changes in cognitive development. Building on initial work (Hatfield, 2008; Shaffer et al., 2009), this study adds FSI to the set of techniques useful in epistemic network analysis, in this case to compare the students’ cumulative epistemic frame development in Weeks 4 and 5 to the epistemic frame modeled by the teacher in Week 4. Specifically, the differences between the students’ and the teacher’s relative centrality values suggest that FSIs from epistemic network analysis can be useful in group comparisons and experimental studies of interventions. In other words, epistemic network analysis provides a computational model of the process and of the extent to which participants appropriate the ways of knowing, being, talking, and acting that characterize a particular community of practice. Thus, epistemic network analysis offers a powerful set of techniques for analyzing the kinds of situated understanding that result from sociocultural learning.

The study presented is, of course, limited. First, the ethnographic nature of this study necessarily means that any conclusions are limited to what one group of students and their teacher did in the context of one practicum. Second, this evidence does not support claims about mastery in this setting or about mastery or appropriation in other settings, although examining additional data over a longer time period may expose mastery in this setting. Third, in this particular practicum, values (based on the sole sub-element value of serving the public interest) was already a central frame element for both the students and the teacher, so rather than focusing on the development of professional values, the teacher and students focused on justifying their decisions and using domain-specific knowledge and skills to make and support their justifications in Weeks 4 and 5.

Epistemic network analysis also presents its own set of limitations. Shaffer et al. (2009) have asserted that “the evolution of the epistemic network graph depends partly on the specific point in the practicum, the practicum conditions the students experience (some situations may be more likely to evoke statements of values, for example, or identities), and the changing nature of the students’ actual epistemic network as it develops through these experiences.” Thus, by focusing solely on the relative centrality values at the end of Weeks 4 and 5, this study tells only part of the story. Further research can examine the frame development at additional time points and under a range of practicum conditions, look at more specific subcategories of the epistemic
frame elements, and examine the degree to which individual students appropriate the teacher’s frame. Future work can also use epistemic network analysis to examine the causal connections between a teacher’s explicit reflection-on-action and the students’ appropriation of his or her epistemic frame.

Despite these limitations, this study’s findings can expand epistemic network analysis to provide a computational model of the extent to which participants appropriate a professional epistemic frame in the face of resistance with the help of a mentor’s explicit reflection-on-action. Thus, epistemic network analysis points towards a promising new way of observing the translation of pedagogy into practice in various types of learning environments. These findings—and future studies investigating reflective practica and the development of epistemic frames—can shed light on how to better prepare citizens to think about and address the complex problems inherent in city planning and growth. As John Friedmann (1973) noted, “the reconstruction of society must begin with man’s re-education.”
References


