

# DESIGNING PHILADELPHIA LAND SCIENCE AS A GAME TO PROMOTE IDENTITY EXPLORATION

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## ABSTRACT

Few digital tools are designed to support identity exploration around careers in science, technology, engineering, and mathematics (STEM) that may help close existing representation gaps in STEM fields. The aim of this project is to inform the design of games that facilitate learning as identity change as defined by the Projective Reflection theoretical framework. Projective Reflection is the process by which a person who is engaging in digital gameplay or a virtual environment constructs and/or enacts an identity that has the potential to modify the person's possible/future self and lead to a new sense of identity in a domain (Foster, 2014). This paper reports on *Philadelphia Land Science*, an educational web-based game that allows players to explore roles related to urban planning and environmental science careers as they connect to a Philadelphia context. We describe game design and iterative changes as backed by theory and existing research. The game iteration is detailed in terms of the embedded content, the pedagogical approaches used, and the technological features that support the learning goals.

## KEYWORDS

Projective Reflection, STEM, Game-Based Learning, Game Design, Identity Exploration, Identity Change

## 1. INTRODUCTION

Identity exploration, or “the deliberate internal or external action of seeking and processing information in relation to the self,” (Flum & Kaplan, 2006, pp 100), has been identified as an essential tool for learners adapting to the needs of a 21<sup>st</sup> century workforce (Kaplan et al., 2014). Supporting students in this intentional process of identity self-construction could prove particularly useful for increasing representation in science, technology, engineering, and mathematics (STEM) careers, given workforce statistics that illustrate limited gender and racial diversity in these fields (US Congress Joint Economic Committee, 2012). Student identity exploration can lead to targeted identity change when a curriculum supports intentional reflection on their starting/current selves (who they are), through exploration of possible selves (who they might want or expect to be), and on their new selves that emerge at the end of a learning experience (Foster et al., 2017). Tracking student identity exploration over a period of time (long or short) can also illustrate when and how students synthesize developing experiences with a given STEM domain into understandings of self.

Games can also influence players' identity exploration and change processes by illuminating the personal relevance and utility of STEM content beyond school settings (Foster, 2008). For example, an examination of engineering virtual internships Nephrotex and Rescushell by Chesler and colleagues (2015) demonstrates how games can offer authentic virtual environments that emulate professional settings, support situated understandings of content, and allow players to explore domain-related identities. Such affordances might encourage students to consider career domains with limited acquisition rates, or those lacking positive social status among youth (i.e. careers in STEM domains).

We argue that game design and implementation supported by identity exploration theory could encourage student identity change toward STEM careers, particularly among students who may not be prompted to explore STEM identities in other ways (i.e. minority students with few existing professional examples to identify with) (Foster & Shah, 2016). However, research on facilitating identity exploration through game-based learning is still an emerging area.

This work details the design of *Philadelphia Land Science (PLS)*, which was informed by what was learned from existing exemplary games to optimally support students' identity exploration as they take on roles as urban planning interns at a virtual city design firm. The Projective Reflection theoretical framework, used to operationalize identity exploration in game-based learning contexts, was used to structure design changes made to the original game to enhance its capacity for supporting identity exploration and change around urban planning and environmental science careers.

## 2. PROJECTIVE REFLECTION

The Projective Reflection (PR) framework frames identity change in an individual as a process of identity exploration over time. Adapted from Kaplan and Garner's (2016) Dynamic Systems Model of Role Identity (DSMRI), Projective Reflection frames identity exploration in a game-based learning context as changes in: a) content knowledge and game or technical literacy (Kereluik et al., 2013), b) regulated actions (i.e. self-organization and control) (Hadwin & Oshige, 2011), c) interests and valuing of domain (Foster, 2008), and d) self-perceptions and self-definitions (Kaplan et al., 2014). The framework comprehensively informs the process of identity exploration as it is measured at repeated points over the course of students' learning experiences, thereby tracking learning as identity change over time in a targeted academic domain (Foster et al., 2017; Foster & Shah, 2016). Projective Reflection can be used to inform both assessment and design of games and supportive curricula for identity exploration.

## 3. METHODS

The design, development, and implementation of a digital tool to support learning as intentional student identity exploration is part of a 5-year NSF CAREER project (Foster, 2014). Early phases of the project involved the examination of existing games with exemplary design characteristics for promoting science learning and identity exploration: *EcoMUVE*, *Land Science (LS)*, and *River City* (Foster et al., 2017). From 2014-, we analyzed the design features of each game using the four PR constructs to understand how these environments excelled at encouraging some aspects of identity exploration, and to identify opportunities to design for closer alignment with PR in future design. The playing research method (Aarseth, 2003) guided this process through analysis of both firsthand gameplay experiences and secondary game information (e.g. research papers).

From 2016-2017, authors partnered with Epistemic Games Group in the development of a new design iteration of *Land Science* that implemented what was learned from game analysis using the Virtual Internship Authoring (VIA) tool. This paper introduces the design characteristics of this iteration, named *Philadelphia Land Science (PLS)*, illustrating how it capitalizes on the game's existing characteristics to support comprehensive identity exploration through PR.

### 3.1 *Land Science* and Existing Context

*Land Science* was designed to serve as a virtual internship for students studying urban planning, or other related environmental, economic, and engineering concepts. Students play as interns at Regional Design Associates, a fictitious urban planning firm that models how real-world professional settings are structured. Groups of students are synchronously guided through the process of creating zoning plans for the city of Lowell, Massachusetts by online mentors.

First, students read about the city's unique history and structure, researching the needs of key stakeholder groups introduced through community brochures. Then, student groups engage in a virtual professional meeting, in which knowledge is exchanged between players. Players then individually use an interactive digital map of the city to rezone areas as commercial, industrial, open space, wetlands, or single-family, two-family (duplexes), or multi-family housing. As players experiment with different zoning combinations, they develop contextualized understandings of how different city designs influence environmental and economic issues such as housing density, job growth, pollution control, wildlife protection, and waste disposal. Finally, groups receive feedback on their collection of city designs from virtual non-player characters representing key community members, and the iterative process of meeting, redesign, and feedback begins again, until individual final proposals are developed and submitted electronically.

### 3.2 Philadelphia Land Science

To pilot the *Philadelphia Land Science* implementation, researchers collaborated with a science museum in downtown Philadelphia that partners with a local public magnet high school to offer STEM-focused, entrepreneurial, and practice-centered learning experiences. Forty ninth-grade students met at the museum for one of two eight-week 'Virtual City Planning' courses in fall 2016 and winter 2017. This describes key design differences between *Land Science* and *Philadelphia Land Science* with consideration for this classroom context. Table 1 offers an overview of *Philadelphia Land Science* modifications to enhance *Land Science's* alignment with PR constructs.

Table 1. Summary of design changes made in *Philadelphia Land Science*

Change	<i>Land Science</i> characteristics	<i>PLS</i> design changes	Enhanced PR constructs
1. Context	<ul style="list-style-type: none"> <li>• <i>LS</i> is set in Lowell, MA</li> <li>• Interactive map design matched Lowell context (i.e. two-family "duplexes")</li> <li>• Stakeholder groups set in Lowell</li> <li>• NPC's representative by gender; limited racial/ethnic diversity in NPC biographies</li> </ul>	<ul style="list-style-type: none"> <li>• <i>PLS</i> is set in Philadelphia, PA, where students live</li> <li>• Interactive map aligned with Philadelphia context (i.e. medium-density "row houses")</li> <li>• Stakeholder groups set in Philadelphia</li> <li>• New NPC's representative based on gender, race, and ethnic background</li> </ul>	<ul style="list-style-type: none"> <li>• Interests and valuing</li> <li>• Content knowledge</li> </ul>
2. Writing deliverables	<ul style="list-style-type: none"> <li>• Players summarize what they learned from meetings, map design, and NPC feedback as professional "notebooks"</li> </ul>	<ul style="list-style-type: none"> <li>• 7 new deliverables prompt students to reflect on developing interests, valuing, self-perceptions and self-definitions</li> </ul>	<ul style="list-style-type: none"> <li>• Interests and valuing</li> <li>• Self-perceptions/definitions</li> </ul>
3. Intake + exit surveys	<ul style="list-style-type: none"> <li>• Intake/exit interviews assess changes in knowledge, self-organization and self-control</li> </ul>	<ul style="list-style-type: none"> <li>• Intake/exit questions added to assess changes in self-perceptions and definitions, interests and valuing</li> </ul>	<ul style="list-style-type: none"> <li>• Interests and valuing</li> <li>• Self-perceptions/definitions</li> </ul>
4. Role-plays	<ul style="list-style-type: none"> <li>• Virtual meetings" facilitated by online urban planning mentors; co-regulated learning</li> </ul>	<ul style="list-style-type: none"> <li>• In-person instructor roleplaying as an urban planner, facilitating socially-shared and self-regulated learning</li> </ul>	<ul style="list-style-type: none"> <li>• Self-organization and self-control</li> </ul>
5. Game scaffolding	<ul style="list-style-type: none"> <li>• Chat log plays key role in peer/mentor interaction</li> <li>• Example final proposals and other texts provided; plagiarism noted in existing play data</li> </ul>	<ul style="list-style-type: none"> <li>• Chat log takes on secondary role to in-person interactions</li> <li>• Examples replaced with 1-2 line prompts specifically describing what players should write about</li> </ul>	<ul style="list-style-type: none"> <li>• Game literacy</li> <li>• Self-organization and self-control</li> </ul>

#### 3.2.1 Change 1: Content and Context

Much of the existing game content was either retained in *Philadelphia Land Science*, or mirrored to reflect a Philadelphia context. Redesigning the game for the city of Philadelphia was intended to develop student engagement and understanding of the relevance of urban planning in their lives. For example, *Philadelphia Land Science* maintained the general design of the interactive map, but shifted

the setting from Lowell to Philadelphia. Some of the zoning codes on the map also shifted; single-family, two-family, and multi-family residential were renamed low, medium, and high-density housing. For students residing in an urban center, researchers recognized that two-family housing in particular might be an unfamiliar concept. Redefining housing density codes allowed for descriptions that aligned more closely with students' urban lived experiences, and illustrated the nuances of housing density in downtown Philadelphia more accurately.

Environmental and economic issues addressed in the game were largely analogous to Philadelphia, though environmental variables related to animal populations in Massachusetts shifted to represent Philadelphia-native species: Eastern Bluebirds and Eastern Mud Turtles. Philadelphia-specific brochures and biographies describing fictitious community stakeholders were also developed for *Philadelphia Land Science*, organized into stakeholder groups with varying combinations of economic and environmental values.

*Philadelphia Land Science* capitalized on opportunities to demonstrate diverse employees and leaders in urban planning. Portraying urban planners with whom players can identify is key to the development of possible selves in the domain, as it encourages players to see themselves in a given role and develop domain-specific knowledge (Foster, 2008). Male and female non-player characters with Latina-American, African-American, and Indian-American heritages were added.

### 3.2.2 Change 2: Writing Deliverables

*Land Science* was designed with a cyclical pedagogical structure that progresses students through one "room" of activities to the next, to guide players through the process of developing urban planning proposals. Activities such as researching stakeholders, participating in professional peer meetings, making zoning changes to the interactive maps, and reviewing NPC feedback on map designs, are each encapsulated in a room. Rooms start with an email from the supervisor that introduces the activity, and outlines how students will summarize their experiences in a concluding "notebook entry."

Analysis of *Land Science* illustrated how writing deliverables encouraged students to recount in detail what they had learned, but could be further leveraged to support reflections on students' changing interests and valuing of urban planning, and of changing perceptions and definitions of self in relation to the experience. *Philadelphia Land Science* maintained room structures and existing writing prompts, but included seven new deliverables prompting consideration of developing interests and values (e.g. submit "a formal summary of the changes you would make to meet your own needs as a citizen of Philadelphia"), as well as their self-perceptions and self-definitions as related to urban planning (e.g. "reflect on your role in this internship and your expectations about this role going forward").

### 3.2.3 Change 3: Intake and Exit Surveys

Questions on the intake and exit surveys in *Philadelphia Land Science* were also designed to assess aspects of student identity, including player knowledge, interest and valuing, patterns of regulation, and self-perceptions and definitions. Items consisted of short answer, multiple choice, and Likert-style survey questions that take an estimated total of 20 minutes to complete. Intake and exit surveys bookend identity exploration in the game, allowing researchers to track student changes from starting selves, through identity exploration during gameplay, to new selves upon completion.

### 3.2.4 Change 4: Role-plays

The most significant pedagogical changes in *Philadelphia Land Science* related to the enactment of professional peer-to-peer meetings. In *Land Science*, remote mentors communicated with players via chat, answering questions and leading meetings using scripted discussion questions. Analysis of *Land Science* play data revealed that these meetings excelled at providing opportunities for co-regulated learning supported by mentors, and offered some opportunities for socially-shared learning between peers. To better align with Projective Reflection constructs, the redesign of meetings in *Philadelphia Land Science* offered more opportunities for socially-shared and self-regulated learning.

In the Philadelphia museum classroom, players led in-person meetings at round tables, supported by instructors roleplaying as urban planning professionals. The "urban planners" introduced meeting topics and highlighted important points where needed, but also allowed student discussion to develop naturally and for student leaders to emerge in group discussions. During gameplay, urban planners

would move around the room, providing individualized support where needed, then stepping back to allow students to self-regulate or receive assistance from peers. Supplemental opportunities for curricular activities, reflection, and discussion were designed and implemented in the classroom environment as supported by the Play, Curricular activity, Reflection, and Discussion model for game-based learning (Foster & Shah, 2015).

### 3.2.5 Change 5: Game Scaffolding

Most technological features of *Land Science* were retained in *Philadelphia Land Science*, as they were found to support student game literacy development over time. Though the majority of peer-to-peer and peer-to-mentor interactions migrated to real-world role-play in *PLS*, the chat feature was kept so that players could communicate with the online moderator as needed; for example, if students submitted a notebook entry before it was completed, the moderator could coach them through the retrieval process before advancing game activities.

*Land Science* also included sample notebook entries that students could reference as they developed skill in professional writing and speaking; review of the *LS* gameplay data showed some copied sections of sample text to construct their notebook responses. Given the emphasis on personal reflection and regulated learning practices in *PLS*, designers shifted support texts from *how* a notebook was written towards *what* players should write in their entries. For example, a prompt in the Entrance Interview room asked students to “please include a short summary of your experience completing the Entrance Interview.” This change further supported student development of game literacy by simplifying the game interface; instead of clicking between an external example and the notebook text box, *PLS* writing prompts were directly embedded in the text boxes for ease of access.

## 4. CONCLUSION

In this paper, Projective Reflection (PR) was introduced as a framework for facilitating learning as identity change through an intentional process of identity exploration in a given domain or career. Projective Reflection informed game redesign to support identity change towards STEM careers. *Philadelphia Land Science* builds upon the strengths of the original virtual internship to facilitate an intentional process of learning as identity change that emphasizes knowledge construction, interest and valuing, regulated action as self-organization and self-control, and self-perceptions and self-definitions. Future design iterations will involve (a) the incorporation of a procedurally generated map of Philadelphia that updates to reflect real-time zoning changes and open-source data, (b) map and game development around different city sections or of the city as a whole, and (c) the inclusion of more land use codes and variables to support value-driven, personalized learning as identity change.

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