Game-Based Learning for Identity Change

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Abstract: This study examined the extent to which a game, Land Science (LS), afforded identity change opportunities as defined by Projective Reflection (PR). PR served as a theoretical lens to analyze the design of LS and existing logged and intact data for 16 high school participants. Preliminary analyses indicated that LS met the intended design goals of supporting students' knowledge gain for urban science and scientific modeling. Identity change was partially met as impacting students' content knowledge. LS did not afford opportunities for learners to explore multiple science identities, set personal goals within the learning environment, or establish personal relevance to game experiences. Hence, it was unclear whether participants valued the experience and content as personally significant to their future goals. Implications are discussed for advancing knowledge in the field about educational gaming for changing students' science identities.

Learning in the 21st Century and Identity Change

The context of learning in the 21st century heightens the need for educators and designers to develop curricula and learning environments that facilitate students' foundational knowledge, meta knowledge, and humanistic knowledge (Kereluik, Mishra, Fahnoe, & Terry, 2013). It also requires that learners develop trans-disciplinary skills such as abstracting, patterning, and synthesizing (Mishra, Koehler, & Henriksen, 2011). Additionally, discussions of 21st century knowledge and skills emphasize the importance of reflexive self-reconstruction strategies to meet the needs of an increasingly globalized and technological society. As such, a focus on facilitating students' abilities to explore and form identities (e.g. exploring who they are or who they want to become) has gained prevalence in the 21st century (Kaplan & Flum, 2012). Guiding students in trying out different identities as they engage in learning, and simultaneously promoting student agency, may be a crucial educational goal for facilitating student engagement with academic material and the development of aforementioned knowledge and skills. Furthermore, curricula designed to enable identity exploration in students may prove useful, especially in light of the new and developing careers of the 21st century for which student preparation and mentorship may be limited or unavailable.

Game-based learning and Identity Change

As immersive digital environments, games have the potential to further the development of students' long-term interests in educational content. Games can influence players' identity exploration and change processes by illuminating the personal relevance and utility of information beyond school settings (Foster, 2008). For instance, a study of engineering virtual internships *Nephrotex* and *Rescushell* by Chesler and colleagues (2015), demonstrates how games can offer authentic virtual environments that emulate professional settings, thereby facilitating player acquisition of situated content knowledge and exploration of domain-related identities. Such affordances might serve as motivators for students to consider career domains with limited acquisition rates, or those lacking positive social status among youth (i.e. careers in science, technology, engineering, and mathematics domains). Nonetheless, research examining identity exploration and change in a game-based learning context is still in its infancy.

Game-based learning research has explored the process of identity change as (a) the process by which individual learning develops within and across games ("the what of learning"), and (b) the ways in which learning is influenced by learner characteristics along biological, cognitive, experiential, and affective lines ("the who of learning") (Foster, 2014). For example, Statecraft X is a game-based curriculum designed to develop the connection between citizenship and governance by encouraging players to act as citizens with a sense of national identity (via agency and social cohesion) (San Chee, 2013). Though research exists to illuminate some elements of identity change in game contexts, few studies have explored (c) the ecological context of learning ("the where of learning"), or (d) the inevitable shift in the frame of learning as a player changes (however inconspicuously) over time ("the when of learning") (Alexander, Schallert, & Reynolds, 2009). Given the clear affordances of games as contexts for identity exploration, some research exists to explore the effects of games on player identity change, though examples of this line of research are less prevalent. Notably, Chesler

and colleagues' (2013) study of epistemic games offers insight into players' developing epistemic frames as ways of thinking, valuing, and knowing about professional engineering praxis.

Existing research on identity exploration focuses primarily on projective identities, defined as identities that stem from the comingling of real self and virtual self in a game space. Theoretical discussions of projective identities depict identity as both a singular and temporary development (Gee, 2007). Other identity researchers expand on this concept, positing that identity and context are continually in flux, subject to construction or reconstruction as the situational context (i.e. game play) evolves and develops (Sinai, Kaplan, & Flum, 2012). As a learner engages in identity exploration over a significant period of time, the temporary nature of projective identities fades as learners experience what Markus and Nurius (1986) call possible selves. Possible selves comprise of the desired selves we would like to become and/or the feared selves we wish to avoid. The development of possible selves in a game context is influenced by (a) students' prior knowledge and perceived competence, (b) students' social networks, which can influence interest development as a given domain gains acceptance among peers (Oyserman & James, 2011), and (c) opportunities to identify with available domain examples to see themselves in a given role and develop knowledge in the domain (Foster, 2008). The facilitation of long-term identity change also necessitates intentional student reflection on a starting self, through possible selves, and on the new self that emerges at the end of a game experience, which must be measured across long periods of time (Foster, 2014).

Given the emergent landscape of identity research in a game-based learning context, we argue for the need for a unified approach for examining how games facilitate identity change. We propose the use of Projective Reflection as a theoretical framework for analysis (Foster, 2014; Foster & Shah, 2016).

Theoretical Framework

Projective Reflection is a theory and a process of identity change in immersive virtual environments (Foster, 2012; 2014). Projective Reflection is defined as "the process by which a person engaging in digital gameplay or in a virtual environment constructs and/or enacts an identity in the game/virtual environment that has the potential to modify the person's possible/future self and lead to a new sense of identity in a domain" (Foster, 2012; 2014). We are examining Projective Reflection as a process to facilitate identity exploration in an intentional way. To do this, we built on the modified the Dynamic Systems Model of Role Identity (DSMRI) developed by Kaplan, Sinai and Flum (2014) that focuses on identity exploration using four constructs: a) ontological and epistemological beliefs, b) action possibilities, c) purpose goals, and d) self-perception and definition of self. The Projective Reflection model operationalizes the DSMRI constructs in a game-based learning experience as a) content knowledge and game and technical literacy, b) regulated action, c) interest and valuing, and d) self-perception and definition of self, respectively, thus serving as a comprehensive lens to frame identity exploration, the precursor to identity change.

To develop a more fine-grained understanding of identity change along these four constructs, we consider changes over time in a) what the learner knows – current knowledge, b) what the learner cares about – self and interest/valuing, c) what/who the learner expects to be throughout the virtual experience and long term- future self, d) what the learners wants to be - possible self, e) how the learner thinks – self and interest, and f) how the learner sees him/herself - self-perception and self definition. We map these questions to the four modified DSMRI constructs described above, resulting in detailed descriptive player cases that can track how an individual changes in relation to content knowledge, game and technical literacy, regulated action, self-perception and definition of self, and interests and valuing, as a result of engagement in the learning environment. It is this tracking of identity exploration as incremental changes in these constructs over time, culminating at a particular end point typically defined by teacher or learning goals, that we refer to as identity change. Thus, Projective Reflection helps us describe learning as identity change in terms of opportunities for identity exploration, and changes in learners' knowledge, attitudes, regulation of actions, self-perceptions, interests, and valuing in relation to specific/targeted domains and in an intentional manner. Projective Reflection is facilitated by an instructor through the play-based pedagogical model Play Curricular activity Reflection Discussion (PCaRD) (See Foster & Shah (2015) for more information). In this paper, we examined the following research question: "To what extent does the design of a virtual learning environment/game, namely Land Science, facilitate identity change?"

Methods

This investigation is part of a larger 5-year NSF project that aims to develop and test a process of supporting intentional identity exploration and change for students using immersive learning environments to learn science, and provide implications for designing and teaching in technological environments for learning as identity change (Foster, 2014). This paper reports initial findings from years 1 and 2 of the project. Years 1-2 involved investigating and characterizing the processes of identity change in known exemplary science games/virtual learning environments (EcoMUVE, Land Science, and River City) that aims to facilitate a science identity for users. We used intact complete existing data from these environments in our studies. The process involved (1) analyzing the design of Land Science for identity change affordances, and (2) examining existing data from completed studies of participants using the game to learn science and explore science identities. A known limitation of using existing data is that we did not have access to the all elements of the play context or the conditions under which players were playing, thus some information relating to identity change maybe missing. The existing raw data we analyzed was obtained through partnerships with the host institutions for each environment. This paper reports preliminary findings for data shared by the Epistemic Games Group for the game Land Science.

Description of Land Science and Participants

The game Land Science was designed to offer players the opportunity to explore an urban science epistemic frame: the skills, knowledge, values, identity, and epistemology that an urban planner takes on as a part of the community of practice (Bagley & Shaffer, 2009). Players role-play as urban planning interns within a fictional firm, Regional Design Associates (RDA). Land Science is played in two phases, with each phase engaging learners in individual and group activities. Players obtain information and get familiarized with cognitive (e.g. proposal writing) and technical (e.g. iPlan) tools that will help them create a zoning map for the city of Lowell. In phase one, players learn about the city's need for a new zoning plan. Four groups of players meet with a unique stakeholder group to learn about their concerns. They also perform virtual site visits and preference surveys, and create practice zoning maps in order to understand the extent to which the needs of the stakeholders they satisfied with could be reasonably addressed in proposing a new plan. In phase two, players are assigned new groups in which members come with knowledge of different stakeholders needs. In this phase, members of a team work together to meet the needs of all possible groups. They work together in team meetings to discuss how the stakeholders' interests can be integrated to propose a well-rounded re-zoning proposal.

Participants consisted of 16 high-school students (8 female and 8 male) in northeastern United States. They completed Land Science over three days in April 2014 in an out-of-school setting. Prior to the start of the study, participants reported engaging in online activities such as watching videos, playing video games, and chatting on social networking platforms for about 4 hours a day.

Data Sources

The design of Land Science was analyzed to identify features that afforded identity change. Existing logged data from 16 students was collected from the game experience, consisting of intake and exit interviews, chat archives, notebook entries, and iPlan map images. Intake and exit interviews consisted of written responses to in-game survey questions pertaining to players' technical and gaming literacy (i.e. online and game activities), knowledge of urban science, and the tools and skills required to act as an urban scientist. The chat feature archived all communication between participants, as well as conversations between participants and mentors during in-game team meetings. Notebook entry documents contained student responses to assigned tasks as part of the apprenticeship experience. Finally, iPlan map images were captured from the iPlan tool in Land Science, which allowed players to manipulate city zoning in the process of developing a re-zoning plan. Figure 2 depicts a screenshot of the Land Science interface.

Figure 2. Resources are given to the players so they can refer back to this information when they need to (Screen shot from Land Science game by Shaffer and colleagues).

Data analysis

Overall, game design features and participant data were coded using combined deductive (i.e., theory-guided) and inductive (i.e., data-guided) analyses for examining features the game that impact identity exploration in the content area. Deductive coding followed the theoretical definitions of the constructs of current selves, possible selves, regulated action, interest/valuing, and science knowledge. Inductive analysis involved the use of discourse analysis (Gee, 2011), and quantitative content analysis (Riffe, Lacy, & Fico, 2014) for characterizing design principles. A computer algorithm was created that made it possible to streamline the large datasets of participant responses from the pre-post data and worksheets into a single table to simplify the discourse analysis process.

Existing data was examined for all 16 participants in terms of the changes in what they know, what they care about, what they expect to be, how they think, how they see themselves and what they want or would like to be in terms of science related identities, before, during, and after playing the game. The changes were triangulated along the aforementioned parameters with the designed characteristics of the game. For instance, in order to understand the extent to which the game supported a participant's knowledge (what they know), existing data from all sources were examined chronologically and as they occurred in the game (in-take interview, notebook entries, iPlan maps, chat archives, and exit interview). The changes in participants' knowledge of urban science and scientific modeling (a complex process that allows urban scientists to assess how multiple factors within a system impact one another) before and after the game intervention was examined in relation to changes in a) procedural, declarative, and contextual knowledge, b) game and technical literacy, c) interest in science, d) valuing of science, and e) regulated action. This was repeated for understanding changes in a) how participants' think, b) how participants' see themselves, c) what participants' expected to be, d) what participants' care about, and e) what participants' would like or want to be in terms of science related identities before and after playing the game. Statistical analysis was not possible due to the nature of data obtained from Land Science. Therefore, in-depth interpretive analysis was performed for all the participants. Together, this analysis allowed us to track the extent to which LS afforded opportunities for identity change as defined by Projective Reflection (Foster, 2014).

Results

We report results for the extent to which the design of Land Science facilitated identity change. First, we report changes in participants' learning for the whole group followed by a case that illustrates identity change based on the current game design.

Whole group findings

Overall, participants began the LS experience with some knowledge of urban science, often manifesting with a limited degree of specificity and with little awareness of declarative terms. For instance, student responses to intake questions revealed varying degrees of baseline interest in science and urban planning, with some students reporting no interest (i.e. "None"), and some reporting general interests (i.e. "I am interested in making cities as environmentally friendly as possible"). Though not explicitly prompted to do so, some students acknowledged the real-world importance of urban science topics in their in-game writing: "..All of these indicators are important to take into consideration because they are common impacts/aspects that come with a city." Furthermore, all participants demonstrated implicit valuing of game content as they worked to

empathize with stakeholders and address their needs. Throughout the LS experience, students demonstrated increasing knowledge and confidence in their communications using the discourse of urban science, particularly with regards to meeting stakeholder needs. Students were able to articulate and demonstrate nuanced understandings of stakeholders' perspectives, discuss stakeholder conflicts and possible solutions with peers, and use game tools appropriately to assess and address those needs. Interpretive analysis also revealed that participants became increasingly confident in using their emerging knowledge to support peers and justify their own decisions, thus reinforcing our finding that LS offered a safe environment for learners. Nonetheless, despite the changes in participants' knowledge of urban science, it was not clear if participants who completed Land Science experienced changes in their personal interest in science, what they wanted to be in terms of science related careers in the future, or if they valued the experience and the content as personally significant to their future goals.

Descriptive case: Anna (pseudonym)

Changes in what the participant knew and thought. Examples of changes in what Anna knew and thought manifested in terms of her science and content knowledge and game literacy, which are discussed below.

Science and content knowledge. Anna began the Land Science experience by demonstrating a general understanding of urban planning as a science career: "Urban planners use information such as data involving environment, housing, and population." Anna's responses demonstrated initial confidence in her understanding of the relationships between the variables in the scenario, and her ability to identify key information based on these relationships. For example, Anna recognized that toxic algae would influence the farms, and that information that can further detail the cause and effect of that relationship would further the development of a solution. However, Anna's response at the outset involved the use of non-specific terms to conceptualize a solution, such as damage, information, data, amounts, etc., indicating a lack of detailed knowledge on the subject. Anna's understanding of science and urban planning concepts expanded in detail to include more elements of declarative knowledge as the play experience progressed. Summarizing her developing understanding of algae blooms after a virtual site visit, Anna wrote, "these algae blooms can cause a decline in different types of fish, and create invasive species," showing increased understanding of the relationships between algae blooms and other specific environmental variables.

Anna's written final plan in LS demonstrated a synthesis of her increasingly detailed knowledge of the relationships between specific urban science variables and her increasingly detailed declarative knowledge of science terms. Anna identified specific units of measurement (i.e. nesting sites) when discussing urban science variables, and recognized specific local species when discussing environmental interactions. After completing LS, Anna expressed enjoyment for the heightened understanding "about cities and how they're constructed" that the game facilitated.

Game/technical literacy. As part of her intake survey, Anna indicated experience with social media platforms and online chat programs (i.e. Google chat), as well as music and video streaming sites. However, Anna stated that she did not engage in either video gaming or programming activities at the outset of the experience, suggesting a potentially limited level of technical and game literacy. Anna's potential for limited technical literacy did not manifest in artifacts of her gameplay data, as she was able to leverage game tools with little exhibited difficulty to build detail into her existing understanding of urban science processes as gameplay progressed. Anna's reflection on her use of the mapping tool (iPlan) further highlighted her ability to manipulate in-game elements to meet game goals:

> I came up with 9,200 for housing, which was near the target-goal for one of the stakeholder groups, as well as 52,000 jobs, which was also near another target number… I also needed to make sure that for my stakeholder group, the "unacceptable" values were not displayed, so I managed to stay below 36,000 for runoff, above 2,000 for birds, under 0.3 for CO, and under 0.4 for phosphorus.

Anna completed the Land Science activity with confident opinions about enjoyable elements of gameplay and ways to improve game design. She affirmed a desire for the game experience to facilitate "more interaction with other stakeholder groups instead of mainly focusing on one" as a way to improve her experience.

Changes in what the participant cared about. Examples of changes in what Anna cared about throughout the Land Science experience manifested in terms of her developing interest, valuing for urban science. As part of the intake interview, Anna responded to questions designed to explore her understanding of urban science topics. However, these questions did not prompt her to comment on her initial interest in the content or her perceived personal relevance of urban science. However, during the Land Science experience, the development of Anna's relationship with the content often manifested through stated empathy with the needs of the fictional stakeholders (or the "clients" whose needs players must address). For example, when asked to describe the needs of her stakeholders in the group chat, Anna aligned her perspective with theirs:

> I was with the Lowell-Concord River Watershed Council: We basically only care about the environment: we want lower runoff, Carbon monoxide, phosphorus, and especially want to increase the number of Baltimore Orioles (birds) in the region.

In some instances, Anna affirmed the real-world utility of her activities. When discussing the competing variables that urban planners must manage in Land Science, Anna explained, "All of these indicators are important to take into consideration because they are common impacts/aspects that come with a city." However, other examples of valuing primarily manifested when Anna emphasized the importance of pleasing stakeholders. Anna regularly used in-game content with potential value connections in her notebook entries and chats, but she did not explicitly affirm the real-world value of urban science content or connect urban science to her own values beyond the above statement. After completing Land Science, Anna stated, "I enjoy learning more about cities and how they're constructed. I have a little interest in the environment." Nonetheless, Anna was not guided in to conduct reflections about the personal relevance of her experience with Land Science.

Changes in how the participant saw herself. The intake interview, gameplay, and exit interview similarly did not prompt reflection on how Anna might have seen herself pursuing a career in science (urban science, environmental science and related fields). Hence, it is difficult to ascertain how Anna shifted in her perception of herself after her experience as an urban planning intern in Land Science. However, Anna made action-oriented and experiential statements that were self-referential as gameplay progressed. Examples include her use of, "I realized…" I felt that it was unrealistic…" "I faced the risk…" and "I found a way…" when describing her struggle to meet complex stakeholder needs. Anna's self-referential statements suggest she viewed herself as active participant whose realizations, opinions, struggles, and successes have a role in shaping the game experience. Data from chat archives and notebook entries also revealed that Anna identified herself as a member of an urban planning team whose goal is to best represent the needs of stakeholders.

Changes in what the participant expected to be and wanted to be. We were unable to ascertain a shift in this aspect because information on participants' career and future aspirations were not solicited before, during or after playing Land Science.

Project Significance

Projective Reflection was used as the analytical lens to examine existing Land Science data. The Projective Reflection model was not used to inform the design of the game, curricular context, or data collection methods. As a science learning game, Land Science supports identity exploration in relation to some aspects of Projective Reflection by providing players with opportunities to model how urban planners work and think (Bagley & Shaffer, 2015). Our research question explored how the game facilitated the development of urban science identities as well as examining the extent to which elements of our theoretical framework for identity change are reflected in the data. This study is exploratory and the first of its kind given the emerging state of research examining identity change in games (Ecenbarger, 2014). Preliminary findings revealed that the current game design supported the development of declarative content knowledge and game/technical literacy. Participants also demonstrated engagement in the Land Science experience as learners invested in science. They developed empathy with stakeholders and an understanding of their needs. This can be attributed to designed features of LS for individual and social learning (peer and mentor support) throughout the experience. Through one participant's responses, it became evident that the players may be able to identify with the role of an urban planning intern. However, the current design of the game did not afford opportunities for intentional role identification. Thus, such reflection appeared only spontaneously or implicitly. The participants also did not have opportunities to set and pursue personal goals given the game's focus on urban science content. While inconsistent examples of

intentional self-reflection exist, the game design may have limited manifestations of player reflections on their self-perceptions and self-definitions about developing science identities both in and beyond the game experience. By using the PR model to inform design, future games could connect with in game content to support systematic role identification beyond the game experience. Though Land Science was effective at triggering interest in game content, the extent to which players could see future selves investing further time in learning about urban science careers was not assessed. This could be attributed to the design of Land Science, which limited the number of possible selves participants could explore in relation to urban science (Markus & Nurius, 1986). The duration of Land Science may have further impacted findings for identity change among participants as suggested by researchers (Beier et al., 2012; Sinai et al., 2012). The findings of this study inform the design of games for supporting identity change in an intentional manner.

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