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"GodMode is his video game name": situating learning and identity in structures of social practice

Leah A. Bricker · Philip Bell

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Abstract In this paper, we report on the structural nexus of one youth's gaming practices across contexts and over time. We utilize data from an ethnography of youth science and technology learning, as well as expertise development, across settings and developmental time. We use Ole Dreier's theory of persons to understand how this youth is able to develop considerable gaming expertise. Additionally, we explicate the learning practices embedded in the structural nexus of this youth's gaming and we examine associated issues of learning and identity. We problematize the lack of continuity between his formal schooling experiences and the structural nexus of his gaming practices as situated in a variety of other contexts and we reflect on the implications for the design of STEM gaming experiences in formal school environments.

Keywords Learning · Identity · Structures of social practice · Ethnography · Video gaming

A growing number of scholars design video and other types of technologically supported games and simulations to scaffold disciplinary knowledge and practices in formal learning environments (for a brief overview, see Collins and Halverson 2009). Several of these gaming and simulation environments engage youth with science, technology, engineering, and mathematics (STEM) ideas and practices (e.g., Horwitz and Christie 2000). Many claim that in addition to the learning affordances supported by these environments (e.g., immediate feedback on performance), students are more engaged in gaming and simulation activities as compared to more traditional forms of instruction (cf. Gee 2003).

We have argued elsewhere that the STEM education community could glean design principles for the design of formal learning environments by deeply exploring youth informal and elective pursuits (e.g., Bricker and Bell 2009). Thus, this paper is not an

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L. A. Bricker (✉) · P. Bell
University of Washington, Seattle, WA, USA
e-mail: lbricker@u.washington.edu

analysis of an in-school STEM gaming environment. Rather, it showcases an analysis of one youth's out-of-school gaming practices. Utilizing features of youths' out-of-school activity in the design of formal learning environments is one avenue for connecting school curricula to the lives of youth and their communities, a practice scholars have shown increases learning and engagement (cf. González, Moll, and Amanti 2005). In this paper, we present the case of Steve Lee.[1] Steve was a participant in an ethnography we conducted of youth science and technology learning across settings (e.g., schools, museums, homes) and over extended time (a four-year period) (see Bell et al. 2006). At the time of his participation in the study, Steve was a dedicated and fervent video and computer game player.

In this paper, we explicate the details of Steve's gaming practices (as observed by us and as documented and explained by Steve through self-documentation and interview protocols). During the period of our research, Steve was specifically interested in the Halo video game franchise, a video game series that at the time was considered the best of the first-person shooter games (see Games Industry.biz 2006). We examine the associated learning practices, as well as features of identity and expertise development in his game play. The research question associated with this analysis is: What are the key components of the structural nexus of Steve's gaming practices and how do they contribute to Steve's learning and identity development?

Theoretical framework

Ole Dreier's theory of persons (2009) is situated in the field of psychotherapy, but is relevant to our analysis of Steve's gaming practices. Dreier utilizes a sociocultural historical lens (Vygotsky 1978) to argue against the canonical perspective from classical psychology, a perspective that theorizes processes, such as thinking, learning, and reflection, as individualist and mentalist (cf. Thorndike 1910). Richard Jessor (1996) argues that we need to recover people "…from the matrix of relationships that continue to be established among variables of scientific interest…The absence of a person focus…has yielded a body of knowledge in which persons in all of their complexity…are difficult to discern" (p. 4). With his theoretical framing, Dreier recovers people from the often overgeneralized (and at times, over-simplified) theoretical landscape of classic psychology and in doing so, highlights people's "…personal trajectories in relation to structural arrangements of social practice" (Dreier 2009, p. 193).

Dreier conceptualizes people as active participants in their contexts and is thus able to examine relationships between people participating in various social practices both within and across contexts, as well as their positioning with respect to others in those contexts (e.g., Harré et al. 2009). He defines context as "…a place in which persons, activities, and objects are linked with each other, and this place is linked with other such places in a structure of social practice" (Dreier 2008, pp. 23–24). Dreier invokes a weaving metaphor to describe the structural "nexus" of social practice that includes people, activities, and objects. He is especially interested in the sociomaterial arrangements of contexts as affordances for the structural nexus of social practice.

Dreier (2008) notes that people's participation in any given context is impacted by the structures of social practice within the specific context but is also impacted by people's pursuit of their interests and stances across contexts. For Dreier then, learning and

[1] All names—people, schools, etc.—used in this paper are pseudonyms.

reflection are the outcomes of people's comparisons of the differences and contrasts across contexts. Dreier's theory of persons is highly situated (cf. Lave and Wenger 1991) yet also distributed (cf. Hutchins 1995). Contexts are linked through the structures of social practice within and between them and therefore, contexts should not be theorized in isolation.

Because Dreier examines people as part of their social contexts and as part of the activity within those contexts, he contends that people help reproduce the structural arrangements within any given context, re-purpose them, or change them altogether. Using Dreier's theoretical ideas allows us to understand people's participation in activities within social structures as "trans-local" (Dreier 2008, p. 23) and as occurring across multiple timescales. Dreier notes that applying this lens enables us to "… address the circulation of things and persons, meaning and references, resources, power, and capital in and across places (cf. Middleton, 2003)" (2008, p. 23). Dreier is affiliated with the field of critical psychology and thus, pays particular attention to the role of power in his analyses.

Questions related to access to and distribution of power, as well as those related to the relationship between power and contextual arrangements (and who has the right to arrange), are important drivers of his theoretical landscape. Dreier conceptualizes power within his theory of persons as follows:

> Power over practices in contexts and over links between contexts may be exercised by arranging the contexts and links in particular ways. Such arrangements restrict influence over contextual practices to particular parties and ends while closing them off to other potential participants or constraining their access to them and the ends they are able to pursue in them. Participation in contexts and the optional uses thereof in the pursuit of one's interests are thus unevenly distributed and controlled. On the other hand, influence over contexts may be democratized by expanding the links between them, the common access to them, the common scopes in them, and the joint command over them…(Dreier 2008, p. 27)

Looking at the power dynamics at play in our analysis of Steve's gaming practices becomes especially important when we examine the trajectory of his gaming practices across home and school contexts.

We highlight later in the paper how those with power in Steve's home contexts (i.e., his parents) sanctioned his game play and arranged (both materially and socially) the associated contexts so that Steve had ample opportunity and support to play games of interest and develop his expertise with respect to gaming and the use of various technologies writ large. By arranging contexts associated with Steve's game play so that Steve was able to spend large amounts of time gaming, his parents transferred much of the power associated with Steve's game play to Steve himself. They ensured that he had autonomy within the structural nexus of his gaming practices. We contrast this with the school context where game play was not sanctioned and contexts were not arranged to support Steve's practices or the learning strategies that Steve utilized as part of those practices (e.g., extended time on task).

Another important concept with respect to our analysis of Steve's gaming practices is the conception of personal ability. In classic psychology, ability has been theorized as innate (cf. Fodor 1983), but in sociocultural historical landscapes, and Dreier's work is no exception, personal ability is learned and developed through participation in activity; it is not solely a product of our genetics. Additionally, abilities are relational because they are only called abilities in relation to any given context's affordances. "Indeed, contextual arrangements and forms of practice presuppose that participants possess particular,

necessary personal abilities…[arrangements and forms of practice] define abilities as well as disabilities…[which] are [both] matters of social practice" (Dreier 2008, p. 33). In our analysis of Steve's gaming, we examine how he comes to be labeled by others as a highly capable gamer.

Identity

The concept of ability is closely related to the concept of identity. We construct our identities within the context of social practice; identities constitute how we see ourselves within those practices, how others see us within those practices, and how we are part of the communities in which we are situated (see Halverson 2009). Identities are therefore individually, socially, and historically situated. April Luehmann (2009) defines identity as the recognition of oneself as "…a certain kind of person" within a given social practice (p. 52). Based in part on a framework developed by Na'Ilah Nasir and Victoria Hand (2008), Luehmann posits that identity and learning are linked through identity resources and that learning potential is high in social practices that afford the greatest number of identity resources. The following are the identity resources that she explicates: "…level of activity, level of agency, level of support, distribution of expertise, amount and timing of feedback, importance of feedback, level of learner accountability, positioning, and opportunities for meaningful recognition…" (p. 57). In our analysis of Steve's gaming, we look for these identity resources and gauge their import within the structural nexus of Steve's practices.

In Dreier's theory of persons, self-understanding is embedded within everyday life and the social practices therein. For Dreier, identity is located in the "continuity of personal experience," which he defines as "…the embodied located-ness of participation" (Dreier 2009, pp. 199 and 200). As readers will see, Steve formulated his identity as a talented gamer in relation to those people with whom he games as well as others with whom Steve had contact (e.g., teachers, peers). We contend that these relationships should be examined along with the various contexts in which these people are situated and in relation to the structural specifics of his gaming practices.

Empirical techniques for documenting learning pathways across settings and over time

The data we collected and utilized for this analysis were part of a long-term team ethnography (cf. Erickson and Stull 1998) that we conducted to examine youths' learning and expertise development, related in large part to STEM disciplinary knowledge and practices, across settings and over time (Bell et al. 2006). We formed a partnership with a local elementary school (Granite Elementary), which serves a diverse student body with respect to ethnicity, nationality, languages spoken, and socioeconomic status. We recruited families from Granite into the ethnography with the understanding that families would participate for at least a year (unless families wanted to discontinue their participation beforehand). Participation included two to three visits per month for 2–4 hours per visit. Thirteen families agreed to participate in the ethnography.

We balanced the sample of focal youth for age (six youth were in fourth grade and seven were in fifth grade at the beginning of the study) and gender (seven boys and six girls participated as focal participants). The focal participants and their families were representative of the racial and ethnic diversity found in the Granite community. The majority of

parents and other family members in the study immigrated to the United States and several of the focal participants themselves also immigrated to the United States with their families. Other than the focal participants and their immediate family members, extended family members (e.g., grandmothers, cousins), teachers, and peers also consented into the study. As of December 2007, 128 people were consented into the ethnography.

Our guiding methodological principle was to follow *the same people across the settings of their lives* in order to document their situated activities. The majority of our observations of the focal participants took place in their homes and at school. However, we also observed focal participants engaging in activities and interacting with others in a multitude of additional settings, such as religious institutions, afterschool clubs, museums, sporting events, camping excursions/vacations, neighborhoods, and parks.

Regardless of setting, our data collection methods included: (a) systematic observation and participant observation; (b) interviews (both ethnographic and clinical); (c) self-documentation techniques (e.g., Clark-Ibañez 2004) during which we gave focal participants digital cameras and asked them to document various objects and activities in their lives and then answer questions about their photographs; and (d) document collection. In addition, we administered two surveys that we designed to gather information about socioeconomic status and ethnic identity, and participation in science. We also conducted analyses of public census tract data relative to the participating families' neighborhoods. Our data sources included: (a) *field notes* of all observations, interviews, participant self-documentation assignments, and documents collected; (b) *video- and audio-tape* of all observations and interviews (when we were in settings that allowed video and/or audio taping); (c) *digital photographs* taken during observations and interviews; (d) *video and/or digital photographs* taken by participants as part of their self documentation tasks; (e) *documents* collected during family visits (e.g., magazines, school work, writing samples from clinical interviews, written survey responses); and *survey results*.

We began data analysis while our fieldwork was still in progress in an effort to guide future data collection. We content logged all video- and audio-taped segments and we coded both logs and field notes using a set of conceptual tags (e.g., [tech] for technology-related activities in the data corpus). We created transcripts of any video- or audio-taped segments that were of analytical interest. We then coded these transcripts with codes we created based on meanings generated by participants and patterns we found in the data, as well as important constructs from the literature. We identified and generated patterns and assertions from coding exercises and triangulated using other data sources, when applicable. As part of searching for disconfirming evidence (cf. Erickson 1986), we member-checked assertions and representations with research participants in order to solicit their thoughts about our ideas (cf. Heyl 2001). We also cross-checked our assertions and representations with colleagues who were present during any given data collection moment.

Steve's case study

As discussed, this analysis is a case study (Yin 2009) of the ecology of one youth's game play. Jerome Bruner (1987) used a William James dictum to justify his focus on narrative, "…to study religion one should study the most religious man at his most religious moment" (p. 15). Out of all study participants, we contend that at the time of data collection Steve was the most dedicated video game player and therefore, we decided to use his case as the basis for this analysis. The bulk of the data collection with respect to Steve's case took place between 2006 and 2008. Within that time period, we visited Steve and his family a total of 38 times representing 95 total hours of data collected in their

home. We recorded 86 hours of video and 79 hours of audio. We took 1,311 digital photographs and field-noted all of our observations, interviews, and email. In addition, we spent 85 hours in Steve's 4th grade classroom and 157 hours in Steve's 5th grade classroom (we did not observe in Steve's middle school classrooms).

We recorded Steve's gaming practices using two cameras; one camera focused on Steve and one camera focused on the gaming action on the Television or computer screen. We then synchronized these recordings so that we could examine both actors (Steve and game) simultaneously. As discussed earlier, this analysis represents an examination of Steve's gaming ecology with respect to its sociocultural, historical, and material characteristics and affordances.

The structural nexus of Steve's gaming practices

We begin our analysis of the structural nexus of Steve's gaming practices by situating this nexus in the broader historical context of Steve's relationship with technology. Steve was in fourth grade when he and his family enrolled in our study. Our first visit with the Lees–Steve, his mother, his father, and his sister Sydney (in first grade when the Lees enrolled in our study)—occurred at their home in January of 2006. We immediately noticed the plethora of technology in the home, including cell phones, digital cameras, personal digital assistants (PDAs), digital video recorders (DVRs), computers in each room, several large screen television sets, Xbox and other gaming consoles, and electronic photograph frames. There was so much technology in the home that the charging equipment completely covered a large table. We left the house that evening and jokingly nicknamed the family "the Technos," only to be told later by the family that all of their friends use that nickname for them. We learned over the course of subsequent visits that the Lees had a technology inheritance system (i.e., Mr. Lee would purchase a piece of technology and when he was through using it, he would pass it down to Steve, who would in turn pass it down to Sydney). This practice created apprenticeship-like interactions that occurred on an as-needed basis (cf. Rogoff 1990).

In a past professional life, Mr. Lee worked in the Information Technology (IT) sector. During the Lees' participation in our research, Mr. Lee rebuilt computers and maintained a computer network for the family to use. Mr. Lee was an active gamer himself and in fact, the entire family participated in gaming of one sort or another (e.g., computer games, such as Pandora's Box and RuneScape, Sudoku, chess, and various video games such as Halo, Halo2, and Halo3). Although a game player (e.g., Sudoku), Mrs. Lee was the only family member who did not participate in computer and video-supported gaming.

We learned that Steve had been around a computer since he was very young. In a recent email communication, Mrs. Lee communicated that from the moment the Lees brought Steve home from the hospital, he was colicky and would not sleep through the night. To keep herself awake, Mrs. Lee would work on the computer with Steve in her lap. By the time Steve was 1 year old, he figured out that if he woke up in the middle of the night, he would get to play on the computer. At 18 months, Steve started to move the mouse by himself. Mr. and Mrs. Lee reported that at the age of two, Steve started to play Pandora's Box (a puzzle-solving computer game). When Steve was six, Mr. Lee introduced him to Halo, the first game in the Halo series. As a reminder, Halo is a science fiction, first-person shooter video game. It can be played as a single-player game, a cooperative multi-player game, or a competitive online multi-player game.

Steve reported that when he first attempted to play Halo at 6 years of age, he was quite frustrated but a co-worker of Mr. Lee's helped him learn how to play. In the coming years (after Steve learned how to play Halo but before Steve and his family consented into the research when Steve was 9 years of age), this same co-worker hosted Halo parties at his home, which Mr. Lee and Steve attended. Steve was the only young child playing; the rest of the players were adults but Steve quickly earned a reputation of being better than any of the adults attending the parties. Mr. Lee then started to host Halo parties at their home. Steve's Halo play was consistent during the course of his participation in our study in terms of the time he spent playing, his level of game play, and the Halo games that he played (Halo2 at the beginning of the study and Halo3 once it was introduced onto the market). He played other computer and video games as well but he reported that the Halo series was a favorite. Each time we visited the family home, we saw Steve gaming, usually playing a version of Halo, but at times playing other games as well (video games, computer games, and occasionally card games like Yu-Gi-Oh). Many times, he would game by himself. Every so often, a friend was visiting when we arrived for our research visit and we would observe Steve and the friend gaming together.

Components of Steve's gaming network

Now that readers have a sense of some aspects of the historical context undergirding Steve's gameplay during the time he participated in our study, we turn to an explication of the structural nexus in which Steve's gaming practices were situated. We use the following categories to describe various features of the structural nexus of Steve's gaming practice: (a) the *social networks* of people who endorsed and participated in his game play (e.g., Steve's parents, other gamers with whom he played), (b) the *artifacts* involved in Steve's game play (e.g., Halo and other computer and video games, game controllers, game guides, YouTube artifacts), (c) the *cultural practices* embedded in Steve's game play (e.g., the free time that Steve received once his homework was completed, the family's technology inheritance system and technology apprenticeship practices), and (d) the *contexts* involved in Steve's game play (e.g., home, other gamers' homes, the video and computer games themselves, an after school technology club, and school, although only tentatively with respect to this last conext). In what follows, we explicate the details of these categories. We want to emphasize, however, that none of the components operated in isolation and all components were in dialogue with one another to continuously shape Steve's gaming practices. In turn, his gaming practices reshaped and arranged these various components.

Social network

As readers learned from Steve's technology history, other people played an important role in his gaming practices. Steve's gaming social network usually included some combination of the following people: Mr. Lee, Mrs. Lee, Sydney Lee, Mr. Lee's co-workers and friends, Steve's cousins, Steve's game-playing peers, and other gamers who were strangers to Steve (more about this in a moment). It is important to note that these actors played various specialty roles in the larger gaming network depending on the game Steve played. For example, with respect to the Halo gaming series, Mr. Lee and his co-workers were instrumental in helping Steve learn how to play and in helping to bring him more fully into the gaming practices. However, with respect to the computer game Pandora's Box, Mr. and Mrs. Lee were instrumental in helping Steve learn to play and then Steve helped mentor Sydney into this game's practices.

Mapping Steve's overall gaming social network and then analyzing who in the overall network was tied to the specific games Steve played, enabled us to envision smaller specialty networks within the larger network. We analyzed these smaller specialty networks in relation to the positions each actor in the network played relative to Steve's gaming practices (e.g., who was instrumental in helping him learn important features of the game, who was instrumental in creating space and time for him to practice). This approach enabled us to analyze the context of Steve's game play using Dreier's weaving metaphor (i.e., the people involved and their various roles in Steve's game play are part of the tapestry of his game play) (2008). We contend that this is one illustration of Dreier's (2008) trans-local concept outlined earlier because through this illustration, we begin to see how Steve's participation with others occurred across contexts, many of which were virtual (e.g., in-game chat features, virtual collaborative game play).

In some cases, specific actors operated across specialty networks, which made them critical nodes in Steve's overall gaming social network. Mr. and Mrs. Lee are two examples of this. Mr. Lee functioned as technology gatekeeper (he usually introduced Steve to games) and gaming partner (Steve often played new games with Mr. Lee and they learned how to play them together). Both Mr. and Mrs. Lee sanctioned Steve's game play and thus, created space and time for him to play. Such sanctioning is important relative to Dreier's (2008) conception of power discussed earlier. Mr. and Mrs. Lee were the people within Steve's gaming network who ultimately arranged and controlled the contextual features of Steve's game play during the time of this analysis (e.g., to what games Steve had access, how much time Steve was able to spend playing games, with whom Steve could game). However, none of Mr. and Mrs. Lee's decisions relative to these contextual features served to restrict Steve's game play. The opposite was true; because Mr. and Mrs. Lee sanctioned Steve's game play and encouraged it, Steve had a great deal of autonomy when it came to his game play and thus, was able to vastly increase his gaming expertise and pursue his gaming interests. This autonomy is in contrast to the school node of Steve's game play nexus, which we will discuss later, where a very different picture unfolded.

The details of how interactions unfolded during gaming in the various specialty networks depended on the structures of the specific games in question. Consider the following example that captures some of the interaction when Steve and a friend played Halo2 (the second video game in the Halo series):

1	Friend: Okay. They don't trust us. Look at this
2	Steve: Huh?
3	Friend: Look at the force field
4	Steve: Actually, there is a way to de-activate the force field
[00:00:11.17]	
5	Friend: Oh
6	Steve: It's like a (inaudible) secret code. You have to do like uh, you like um, put a ghost on it
7	Friend: [whispers] (inaudible-sounds like 'of course')
[00:00:20.27]	
8	Friend: Oh crud. Oh crud. Oh crud
9	Friend: I hate this control (inaudible)
[00:00:32.15]	
10	Steve: Dang it. (inaudible)
11	Friend: (inaudible)
12	Steve: (inaudible) Yeah. It does. It's all yours

[00:01:00.25]

13 Friend: I hate this control. That's why
14 Steve: There. I got one
15 Friend: I (inaudible) couldn't get them cuz I HATE THIS CONTROL! (inaudible) control

We kept the time stamps visible in this transcript segment to show that the gaming sessions we captured during the research never included a lot of verbal dialogue. As readers can see, in this particular transcript there were fifteen lines of talk in just over an hour. Turns of talk 4–7 exemplify one prominent type of interaction when Steve gamed with friends or with Sydney; peer-to-peer learning and teaching. Jean Lave (1996) argued that any question about teaching has to be co-located with questions about learning. She also stated that her argument was analogous to Dreier's arguments relative to therapists and patients. Both scholars contend that an examination of people within their contexts and participating in activity is critical to an understanding of any phenomenon of interest. In other words, it is not possible to truly understand a phenomenon of interest without situating it.

In the peer-to-peer learning and teaching interactions within Steve's game play, we are able to examine specific teaching strategies that appear helpful to learning in game play because we examine the activity within context. For example, Steve and his game play partners' interaction would often focus on one gamer helping the other notice important aspects of the game narrative and/or helping the other learn how to employ certain moves (e.g., how to use the game controller to move objects in the game in certain ways). Just because there was very little verbal dialogue that took place during this segment of game play does not indicate that there was a lack of communication. The micro-interactional analysis that we are beginning will explicate the detail of nonverbal communication in Steve's game play. Physical and virtual artifacts played a role in the communication during game play, whether the artifacts were objects of communication, a communicative source, or communicative partners.

Artifacts

Much of the interaction during Steve's gaming involved artifacts. For example, in turns of talk 1–7 in the above transcript, the interaction centered on an object in the game—a force field that was hindering Steve and his friend's progress. Similarly, in turns of talk 8–15 the game controller was hindering the play of Steve's friend. Dreier states that objects within contexts are part of the structural nexus of social practice and are integral to his theory of persons. Objects are not stable but rather are "…themselves transformed, even coming into being, within ongoing human practices…which in turn, transform those practices" (Costall and Dreier 2006, p. 11). In any game Steve played, components of the game such as the characters in the game and the game's storylines served as actors in Steve's game playing network (cf. Latour 1987). Granted, humans created the various games Steve played (and therefore, could technically be considered part of Steve's gaming social network, even though they were strangers to Steve). However, Steve was in interaction with the various artifacts the game designers created; both Steve and the artifacts had agency and it was their interaction that constituted the structures of Steve's gaming practices.

Unlike the force field and the game controller that we highlighted earlier, some key artifacts that were physically attached to or embedded in specific games Steve played were peripheral to Steve's actual game play but still essential. For example, Steve would make use of Halo's official strategy guide, a book that Halo gamers can purchase to supplement

their game play. Steve preferred playing a game first in order to learn as much as he could by playing and without consulting the accompanying guide. He noted that by playing first, he found the strategy guides more helpful when he chose to consult them because he already understood aspects of the game such as the various storylines and the weaponry used (in the case of the Halo videogames).

Steve also made use of the Internet. During one research visit, he told us that he found "things" on the Internet that conferred special abilities for him during his Halo game play. Steve showed Leah an example of this, which is captured in the following transcript segment:

1 Steve: [showing Leah Halo screenshots on YouTube that other Halo gamers had posted] It (inaudible) be there
2 Leah: It's the what?
3 Steve: I'm (inaudible) skull
4 Leah: Oh, that you didn't know where it was before [in the Halo game]?
5 Steve: Yeah
6 Leah: Cool. Oh yeah! So, can you do stuff with those skulls, in the, in the game?
7 Steve: Yeah. They unlock some other stuff
…
8 Steve: Some skulls help you and some skulls make it harder
9 Leah: Which, what that, what's that new one do? That you just found?
10 Steve: Uh. Let's see. The enemies are more aware um, how, um more where you are, where you are
…
11 Leah: So that makes it harder, huh?
12 Steve: Yeah

This example demonstrated how Steve made use of Halo screen shots that other Halo gamers had posted on YouTube—showing where various artifacts were located in the Halo games that conferred special abilities. For any artifact he felt was useful to him (for example, the skull he mentioned in the above transcript segment), Steve would study the surroundings captured in the screen shots, return to the video game, find those particular surroundings, and then find the desired artifact. Steve's game play was very much a distributed system (cf. Hutchins 1995); distributed between human actors and non-human artifacts. This entire system was a community of networked expertise (Hakkarainen et al. 2004). In addition to Steve's gaming social network, including non-human artifacts, his game play was also aided by various cultural practices adopted by the Lees and by various contexts in which he gamed. We turn now to that discussion.

Cultural practices

Na'Ilah Nasir, Ann Rosebery, Beth Warren, and Carol Lee (2006) describe an image of culture as practice. They define culture as:

> …the constellations of practices historically developed and dynamically shaped by communities in order to accomplish the purposes they value. Such practices are constituted by the tools they use, the social networks with which they are connected, the ways they organize joint activity, the discourses they use and value (i.e., specific ways of conceptualizing, representing, evaluating and engaging with the world). (p. 489)

The culture of technology was pervasive in the Lee household and consisted of various cultural practices. Steve was able to further his gaming practices and his developing technology expertise because of his participation in these practices. It was clear from our first visits to the Lee household that every member of the family valued technology.

We have already described the technology inheritance and "just in time" apprenticeship systems that the Lees designed. Steve and Sydney spent a large amount of their out-of-school time interacting with technology in one form or another. Mrs. and Mr. Lee implemented a rule that as long as Steve and Sydney finished their school homework and completed it accurately, they could spend the rest of their waking hours as they saw fit. For Steve, this meant gaming.

Another practice that Mrs. Lee actively employed was one of searching for out-of-school activities involving technology in which Steve and Sydney could participate. For example, both Steve and Sydney participated in an after school and summer technology club and their participation spanned the entire course of our research. Steve learned how to design video games during his participation in this program. Just recently, Sydney was awarded a cash scholarship for her design of a community block that included a museum, an art center, a green house, and a church (Sydney used SketchUp, Google's 3D modeling program). When asked during the award ceremony what Sydney envisioned doing for a career, she stated that she wants a career in technology, focused specifically on video game design. The cultural practices associated with Steve and Sydney's various technology-related activity systems clearly shaped Steve and Sydney's forms of participation in those activity systems. As Dreier (2008) made clear, however, the contexts in which those activity systems are situated are also critical to analyze with respect to participation.

Contexts

Readers will recall that Dreier (2008) defines context as a place where people, activities, and artifacts are linked to other places and it is this linkage that creates the structural nexus of social practice. Using this definition, it follows that the Lee home was a context for Steve's gaming practices, as were the homes of others (e.g., Mr. Lee's co-workers who threw Halo parties). Other physical sites such as the technology after school club that provided opportunities for Steve and Sydney to hone their technologically enabled practices also served as a context in the structural nexus of Steve's gaming practices.

Fred Erickson and Jeffrey Schultz (1997) problematize the typical definition of "context" as a physical place. They draw on the work of Ray McDermott (1976) to paint an image of context as interaction, insisting that contexts are constituted "…by what people are doing *and* where they are doing it…people in interaction become environments for each other" (p. 22). In our analysis, we sought to define other contexts within the home context, for example. Using McDermott's definition, we created an image of nested contexts to help us better analyze the details of how Steve, his fellow gamers, their activities, and the artifacts important to those activities were linked to form the structural nexus of Steve's gaming practices. For example, the Halo video games themselves are contexts because of the interaction they created among Steve, Mr. Lee, Mr. Lee's co-workers, Steve's peers, and the non-human actors in the game.

Power is also an important dimension in our discussion of context because power is manifested through the details of interaction. In the structural nexus of Steve's gaming practices, Mrs. and Mr. Lee conferred power on Steve, Sydney, and their friends to hone their gaming practices over extended periods of time. They conferred power by infusing the various contexts discussed above with values related to the benefits of technology and

the power people, who are facile with technology, hold in society. They also conferred power by providing opportunities for Steve and Sydney to interact with a variety of technology over extended periods of time and in ways that Steve and Sydney saw fit.

We made the point earlier that the school context was only tentatively linked to Steve's gaming practices. Michael Bonnett (2009) argues that for many students, schools are places oppositional to "self." Many students do not see themselves and/or lose themselves because all too often school practices and at times, people, reject students' home and community-based practices, identities, and discourses. In his place-based critique of schools, he describes how alien an institution of formal learning can be for some youth.

Steve was (and continues to be) a good student. With respect to his technology expertise, however, it was rare that we saw any semblance of "self" in school that we were used to seeing at home. Although technology (e.g., computers) was present in Steve's schooling experiences and was utilized as part of his schooling activities (i.e., to create reports and PowerPoint presentations), Steve's interactions with technology in school were markedly different from his interactions with technology at home. Unlike at home, the locus of power at school did not reside with Steve and his peers. The students were told when to use technology, how to use technology, and what technology to use for each specific task; no choice was conferred. Additionally, the extended periods of time for practice, trial and error, and reflection that were hallmarks of Steve's gaming practices at home were completely absent from his technology practices at school.

Steve's teachers were aware that he loved to play video games. Whenever possible, Steve would work his gaming into assignments (e.g., highlighting his gaming practices when asked to create a PowerPoint about who he was as a person). Every so often Steve was granted permission to do a book report using an official Halo strategy guide. Overall, however, we argue that Steve's schooling experiences during the time he participated in our research represented a missed opportunity to deeply leverage his developing technological expertise. One example of this manifested itself in a well-intentioned but misguided role that teachers asked Steve to play. They told him that they knew how much he loved technology and because of that, they granted him permission to be the student who was responsible for turning on all of the computers each morning in both his classroom and the school's computer lab. Steve saw the task as a burden rather than a privilege.

The school could likely have built on his expertise in more direct and interesting ways. Steve has prodigious expertise in leveraging multiple sources of information—digital and material—to research and solve specific problems in complex domains—as this is something he routinely does in his game play. Perhaps he could have been tasked with helping other students learn this research skill and also identify online learning resources related to classroom topics. Steve was also learning to develop a game in an afterschool program during this time period. He could have been asked to develop an educational game related to a curricular topic.

In the first 2 years of the study (Steve's 4th and 5th grade experiences), we saw only one instance of Steve bringing his gaming practices to bear during school. Steve and his classmates were in the computer lab and were supposed to be engaging with an online mathematics tutorial game in preparation for upcoming state testing. At one point in the activity, we observed several of Steve's classmates looking at Steve's computer screen. Upon observing Steve's activity, we learned that instead of participating with the goal of getting the right mathematical answer (the original intent of the game), he had somehow configured the game-like tutorial so that it now included an element of time. Because of this, Steve's new goal was to reach the end of the game in as little time as possible,

while still maintaining accuracy (note that the original configuration of the game did not include an element of time; students could take as long as they wanted to obtain correct answers).

The teacher present sensed a disturbance (i.e., peers sitting next to Steve looking at his computer screen) but did not investigate. Instead, she asked the peers to Steve's left and right to turn off their computers and sit in the middle of the computer lab on the floor in a "time out." Steve was not subjected to a time out but after this incident, he returned to playing the game as it was intended to be played for the rest of the time he and his classmates were in the computer lab.

We coded this incident as an attempt by Steve to introduce elements of his gaming practice into his schooling activities and ironically, in this instance, with the benefit of increasing his mathematical fluency against a time constraint, an activity valued in school and as part of standardized testing. However, Steve's activity was not sanctioned by the institution. Because of these types of decisions about which activities were sanctioned and which were not, those wielding the power in the institution ensured that the school context was only tentatively linked, if linked at all, to Steve's developing technological expertise (as situated in his family's use of technology, including extensive video gaming, as well as his after school program experiences focused on learning various technological practices like programming and game design). Steve was developing this technological expertise in almost every other context in his technology nexus and as we have previously argued, this was an example of a missed opportunity with respect to learning.

Learning

Readers will recall that Dreier (2008) argues *learning is the outcome* of people's comparisons of the differences and contrasts related to the structures of social practice across contexts. With respect to Steve's case, learning takes place within the structural nexus of his gaming practice but it is not solely a component of the nexus in the way that the contexts, the artifacts, and people are components. Learning is accomplished through a refinement of how one discovers to interact productively with the various components of the nexus. Dreier notes that the concept of learning in his theory of persons "…is in accordance with Lave's (e.g., 1988) conception of learning as changing participation in a changing social practice" (2008, p. 110). Ray McDermott (1996) adds to this image of learning by highlighting the importance of actors in interaction with one another. He defines the term "learning" as follows:

> …[the] term learning simply glosses that some persons have achieved a particular relationship with each other, and it is in terms of these relations that information necessary to everyone's participation gets made available in ways that give people enough time on task to get good at what they do. (p. 277)

Steve talked frequently about the importance of his social network to his learning. The following transcript segment exemplifies his perspective. At one point during our research, Steve played a lot of Yu-Gi-Oh, a card game that is based on a Japanese manga. Leah told Steve that she wanted to learn how to play and she wanted him to teach her. Leah asked Steve for his advice in terms of how she should go about learning to play Yu-Gi-Oh; what strategies she should use. Leah and Steve had the following conversation:

1 Steve:…play an expert first
2 Leah: Oh

3 Steve: And just see how he plays. And then a try um, a beginner, and then see how he plays. What's the difference and then uh, play each one on a different player. See which one wins
4 Leah: So your advice is to play somebody really…well, who, what's an expert to you? I mean, what's that mean? Like an expert at Yu-Gi-Oh is what?
5 Steve: Like a person um, who has a great deck [of cards], has good experience, knows um, how to, knows about (inaudible) cards without even reading them
6 Leah: Okay
7 Steve: And…knows when to activate them [the cards] at the known time
8 Leah: Okay. So you say, play that kind of a person first
…
9 Leah: And then go down to beginner?
10 Steve: Yeah
11 Leah: So you can compare. Is that what you said?
12 Steve: Yeah. But then try it on another player. See which one is better. Cause sometimes even a master player doesn't uh, always have a winning strategy

Regardless of the game Steve was learning, he adopted the practice he discussed in this conversation; learning from more experienced others in his network. Readers will recall that Steve noted how frustrated he was the first few times he tried to play Halo and that it was his father and his father's co-worker, both more experienced Halo players, who helped Steve learn how to play the game. In addition, Steve embodied Dreier's ideas, in turns of talk 9–12, about the importance of examining the contrasts among practices across contexts. Turn of talk 12 is particularly significant because Steve highlights the importance of learning strategy in game play and notes that even experts do not "…always have a winning strategy" so it is important to observe less-expert gamers in action too.

By observing more experienced others and by contrasting the game play of gamers at all levels, Steve developed professional vision (Goodwin 1994), "…socially organized ways of seeing and understanding" (p. 606). When we asked Steve what he thought made someone an expert gamer, he said the following, "Uh, see, a person that's really good. Uh, gets the game. Knows how to operate the thing quickly. Uh. Knows the concept of the game…" For Steve, someone who "gets the game" and "knows the concept of the game" has professional gaming vision.

Learning how to "see" involves a certain amount of risk taking and the willingness to make mistakes. Steve identified these practices as critical to his learning how to game. During the course of our research, we asked Steve why he loved playing video and other games so much. He said the following:

1 Steve: Um. Let's see…it's not really a big risk in there
2 Leah: There is big risk in there?
3 Steve: Not really a big risk
4 Leah: Oh. Okay
…
5 Steve:…You can just find out uh, how things happen
6 Leah: So, you mean within the game, like one of the things you like is trying to figure out what happens. Is that what you mean?
…
7 Steve: I always wondered uh, how much damage uh, on this one, like how much damage can you cause just crashing into a freeway [Steve was playing a car videogame called Burnout Revenge]

8 Leah: Yeah. So you're saying here you can just do it…and check it out
9 Steve: Yeah
10 Leah: And like you said before, it's not real life
11 Steve: Yes. Yeah

For Steve, it was the very fact that he coded his game play as different from "real life" that allowed him to take risks within the game (see turns of talk 1 and 7). The risks that he took in the game were so different from real life that he did not code them as risks (see turns of talk 1 and 3). James Gee (2005) describes the importance of risk-taking to learning. He notes that within games, players are encouraged to take risks and explore. He notes that the risk-taking and exploration often lead to failure but that learning occurs, in part, through failure. Gee contrasts gaming contexts with school contexts and notes that risk-taking, exploration, and failure are not often acceptable strategies and sanctioned activities in schools and the implication is that many schools are therefore not rich learning environments. Gee explicates other gaming features that support learning and that we have highlighted in Steve's gaming practices. Examples include (a) a *high level of interaction* (as seen in Steve's gaming network with all actors, human and non-human alike), (b) *customization in order to tackle problems* (exemplified by Steve's customization of the math computer tutorial he was asked to engage with in school), (c) *challenge and frustration* (exemplified by Steve's initial attempts to play Halo), and (d) *extended time on task* (Steve gamed for hours at a time and throughout the duration of our four-year research study).

This discussion of learning is directly related to Dreier's theory of persons (2009). Readers will remember that Dreier argues that people's ideas and actions cannot be analyzed separately from the structural nexus of social practice within which people are situated. As we noted at the beginning of this section, Lave (1996) makes a similar point about learning. Learning is an outcome of participation in socially-situated practice and not something that takes place in an individual's head, separated from the sociocultural, historical milieu in which individuals are situated. Thus, throughout this case study we have explicated various aspects of Steve's structural nexus of gaming practice that we observed and that he reported as being critical to his learning within this nexus. We contend that if STEM educators wish to design games for use in K-12 STEM education, an understanding of the various features of the structural nexus of gaming practice and their relationship to learning is critical given that learning within complex domains is arguably the most important goal of K-12 education.

Identity

In the last section of our analysis, we turn to the concept of identity. We contend that identity, like learning, is another outcome of the structural nexus of Steve's gaming practice rather than a component of it. However, people's identities readily influence the structural nexus of practice because people utilize these identities in contexts to materially and socially continuously rearrange activity. Coming to view one's self as wanting to learn from and contribute knowledge to specific social domains, while coming to be socially recognized as "the kind of person" who belongs as an expert member of that social domain, highlights how identity development should be viewed as a central goal of education (cf. Bell, Lewenstein, Shouse and Feder 1999). Readers will recall that Luehmann (2009) claims learning potential is high in social practices that afford the greatest number of identity resources, including level of agency, level of support, distribution of expertise,

and meaningful positioning. At the time of his participation in our study, Steve's level of gaming activity was extremely high given that he spent the majority of his out-of-school participating in gaming experiences. Within those experiences, he had a tremendous amount of agency with the support of everyone in his network (his parents being the most important power gatekeepers in this network and they allowed Steve to use his time as he saw fit). In this structural nexus of gaming practice, we saw a complex distribution of expertise (between Steve, other people within his network, and artifacts such as YouTube videos and gaming strategy guides), which enabled the entire network to receive important feedback on performance quickly. The level of learner accountability in this structural nexus of gaming practice was high and was accompanied by a plethora of opportunities to be positioned in this nexus as accomplished and expert. In short, we have attempted to show in this paper that the structural nexus of Steve's gaming practices out-of-school affords all possible identity resources and therefore, the nexus is a rich learning environment.

Steve was positioned as an expert game player by all members of his family, by Mr. Lee's co-workers, and by Steve's friends. He wore his expert gamer identity on his clothing (e.g., T-Shirt slogans such as "Video Game Fanatic"). He displayed his gaming identity in some of his school assignments (e.g., noting on a PowerPoint that he was "obsessed about videogames"). When asked if he was an expert gamer, Steve responded with no hesitation that he was an expert. When we asked him to take photographs that represented a favorite activity, he photographed screen shots of Halo2. One of the photographs he took was of his video game name. We had the following conversation about the photograph:

1 Steve: My name is GodMode. Whenever I go to Halo party, uh, I'm always in first place and I rarely get killed
2 Leah: Uh-huh. So what's the "Mode" mean?
3 Steve: Mode?
4 Leah: God*MODE*
5 Steve: GodMode. You know like in, uh, there's like a setting called GodMode that you have infinite ammo. You have infinite health and like you're invincible. It's that

Even Steve's video game name touted his expertise.

As Stanton Wortham (2004) notes, "Individual identities exist only in social contexts…" (p. 164). This idea is well-illustrated through the specifics from Steve's case discussed earlier in this section. His identity as an expert video game player is only apt within the structural nexus of his gaming practice. Like learning, identity is critical to a discussion of gaming and K-12 STEM education. Adam Maltese and Robert Tai (2011) argue that it is not high achievement in STEM classes that is a predictor of which students choose STEM as a career. Rather, it is interest in STEM, and findings are clear that interest must be cultivated in high school if not long before. The experiences students have in their K-12 science classes and their interest in those experiences matter. One can argue that gaming could be a vehicle to increase student engagement and interest—and a growing number of researchers are starting to systematically explore that hypothesis (see Mayo 2009). If students begin to identify with technology fields (like video game production) and other STEM fields (through the context of STEM educational games), then Maltese and Tai's research predicts that they are much more likely to pursue those interests after high school.

Concluding remarks

By explicating the details of Steve's gaming practices, we have argued that there are important lessons to learn from his gaming practices that could potentially inform STEM education game design. We have detailed the learning practices embedded in Steve's gaming such as extended time on challenging tasks, opportunity to develop professional vision by comparing and contrasting the game play of more and less experienced others, opportunity to take risks within a safe space, and access to a distributed community of networked expertise (including social networks and their affiliated, salient artifacts). We have also illustrated how Steve used technology as an identity project. It is an empirical question whether these various learning practices, readily on display in a gaming nexus, could be utilized in the design of educational games and would have the same impacts and affordances in an educational nexus. Many researchers are currently working in this space to investigate these types of questions.

The incorporation of video and other gaming practices in STEM education is ripe with possibility with respect to STEM learning and as noted, many scholars have already made substantial inroads (see Steinkuehler and Duncan 2008). Researchers are touting the possible benefits of game play to STEM learning and to increased student engagement and interest in STEM (see Mayo 2009). The National Research Council recently published a synthesis of STEM educational simulations and games, again touting the potential for increased engagement and learning of STEM ideas and practices (Honey and Hilton 2011).

By explicating the details of Steve's game play, we are not arguing that commercially available games, such as the Halo series, are suitable for STEM education or even that commercially available games are similar to games being developed for STEM education. What we do argue is analyses like this one can highlight various learning practices, conditions, and interests that educational researchers could then build into the designs of STEM games, as well as other educational experiences. STEM gaming environments have the potential to shift the instructional practices of formal education toward the gaming mechanics associated with successful learning in complex games like Halo, which include increasingly complex challenges, quick feedback on performance and promoting learning through iterative trials. Educational games may also be useful for allowing students to productively explore topics of heightened personal interests.

We do wish to conclude with a caution, however. When we asked Steve if he would like to play video games as part of his formal educational experiences in school, his first response was a resounding, "Yes!" Upon further reflection, however, he wondered if being told to game, having gaming imposed on him as part of his formal schooling, would fundamentally change his gaming experiences and strip him of the passion he felt for gaming. It is an empirical question whether gamers like Steve who spend an enormous amount of time out-of-school playing video and computer games will engage with STEM educational games in ways that mirror their out-of-school practices and in ways that they might not engage with more traditional STEM learning and teaching experiences. This question seems well worth investigating.

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Author Biographies

Leah Bricker is a research scientist in the Institute for Science and Mathematics Education at the University of Washington. She holds a Ph.D. from the University of Washington in the Learning Sciences. Bricker pursues ethnographic and design-based research in three broad areas: (a) science education, (b) learning sciences, and (c) science studies. Bricker is especially interested in learning across settings and over time, social disparities related to learning, and youth participatory action research. She has held positions as a middle school science teacher, State Science Coordinator for the Indiana Department of Education, and Senior Program Associate for the American Association for the Advancement of Science/Project 2061.

Philip Bell is the Director of the Institute for Science and Mathematics Education at the University of Washington. He pursues a cognitive and cultural program of research across diverse environments focused on how people learn in ways that are personally consequential to them. He is an associate professor of the Learning Sciences at the University of Washington Seattle and holds the Geda and Phil Condit Distinguished Professorship of Science and Mathematics Education. Bell serves on the Board on Science Education [http://www7.nationalacademies.org/bose/index.html] at the National Academy of Sciences. His research focuses on everyday expertise in science and health, culturally responsive science instruction, the use of emerging learning technologies in science classrooms, children's argumentation and conceptual change in science, and new approaches to inquiry instruction in science. Bell directs the Institute

[http://sciencemathpartnerships.org], co-Directs the LIFE research center [http://life-slc.org/], directs the Learning Sciences Graduate program at UW [http://education.washington.edu/areas/ep/deg_programs/learning_sci/], and directs the Everyday Science & Technology Research Group [http://everydaycognition.org/]. Bell has a background in human cognition and development, science education, computer science, and electrical engineering.