Feeling Fast: The Role of Intuitive Thinking in Video Games

Video games constitute an important part of the lives of children and youth in today's world. The PEW Internet and American Life Project claims that as many as 97% of American youth play video games and 50% play games daily for an hour or more (Lenhart et al., 2008). A growing body of research suggests that video games contribute to epistemic literacy (Gee, 2003), mimic proven and effective learning environments (Stevens, Satwicz, & McCarthy, 2008), positively impact learning motivation (Orvis, Horn, & Belanich, 2008), alter quantitative reasoning (Satwicz & Stevens, 2008), and can be effective at leveraging expertise in formal learning environments (Shaffer, 2006).

Although much has been written about the ability of video games to act as powerful learning environments in science (Gee, 2003; Green & Bavelier, 2003; Kafai, 1996; Satwicz & Stevens, 2008; Shaffer, 2006; Squire, 2006) , studies that investigate learners' intuitive knowledge structures involved in playing video games are lacking in the field. To address this issue, the goal of this pilot study is to investigate the intuitive thinking involved in the learners' minds based on their interactions with a popular racing video game. Specifically I investigate how young physics novices interpret situations within the games that involve canonical concepts such as velocity and acceleration in terms of their intuitive knowledge structures identified by other researchers (diSessa, 1993; Roschelle, 1991).

Theoretical Framework

The analytical framework used in this study is based on the following constructs: *registrations* (Roschelle, 1991) and *sense-of-mechanism* (diSessa, 1993). Roschelle (1991) states, "by registrations, I refer to the way students carve up their sensory experience, give labels to

parts, and assign those labelled parts significance" (p. 9). While playing a video game the player notices patterns on the screen related to the way they interact with the controller. The combination of action on screen and controller use, identified as "significant" to the player, is a *registration. Registrations* are interpretive acts, and can be best understood as ways in which the player labels salient game features.

To analyze how players label *registrations*, I utilize diSessa's (1993) notion of *sense-of-mechanism*. Core components of this sense-of-mechanism are hypothetical knowledge elements called *phenomenological primitives*, or *p-prims*. *P-prims* are very basic schematizations that help us explain phenomenon we experience in the real world and make predictions about situations we cannot see or are unfamiliar with.

Method

This study is based on ethnographic observations of three participants (Jason 12, Allen 10, and Justin 12) playing *Burnout Paradise* on the XBox 360, and *Mario Kart Wii* on the Nintendo Wii. Since the goal of this study was to identify learner's unschooled, intuitive thinking, this age group was selected as the participants had not yet been exposed to formal physics education.

During the observations I conduced informal semi-clinical interviews, during which I would typically ask them to explain their actions in situations that involved changing velocity or acceleration of the cars in the video games. In some cases, I would ask them further questions in order to clarify their initial responses. These interactions were videotaped. The data was then transcribed and coded inductively in an iterative process over multiple passes. Codes were

verified and discussed with colleagues in an effort to minimize variability and maximize interpretation validity.

Results

During the observations velocity was the most discussed topic. While observing Allen and Justin playing *Mario Kart Wii,* 58% of all conversations focused on velocity. In addition, 62% of all velocity discussions directly concerned the spatial relationships between the player's vehicle and the competition (see Figure 1). For example, early in the interview Allen began talking about how fast he was going. When asked how he knew he was going fast he quickly responded, "I'm in first! That pretty much tells me I'm going fast!" (5/7/09, Transcript). While playing with his brother Justin, the two continually referenced their ordinal position and their spatial separation as they argued about who was the better player. Statements such as "Oh man I'm in 4th! […] this car isn't going that fast!" (5/7/09, Transcript) were common. When asked how he knew he was going fast, Jason claimed, "You can tell like oh they're going the speed limit and I'm going like 80 times faster than they are… See that guy all the way up there? And I just pass him like really quickly which proves that he was going really slow" (1/31/09, Transcript).

Players also suggested that the visual movement of the surroundings past their vehicle gave them an indication of their speed. Justin claimed he determines speed "from like stuff on the sidewalks and stuff on the streets like stoplights" (1/31/09, Transcript). This feature that was so salient to the players is likely an intentional game design choice--consistently spaced objects near the edge of the track were present in nearly all races. Justin references these objects when

asked again about how he knew he was moving fast stating, “by comparing to other people, and by how fast the landscape is moving by” (5/7/09, Transcript).

Acceleration, a difficult topic for novices to identify, was rarely discussed explicitly. Typically participants identified it as either a static property of the chosen vehicle, or something that is intentionally enacted by the player through the use of games items, specific buttons, or by driving over a specific section of the track.

When playing *Mario Kart Wii*, Justin had a difficult time identifying acceleration as a dynamic quantity--talk typically involved speed as either fast or slow, but not a quantity that changes. However, when pushed to give an explanation of acceleration he put down his controller and acted out acceleration by referencing a static object (a stuffed fish) in the room. Justin states, “Well say...I’m running...that stuff is passing faster. Like I’m walking, see the fish is still there...but when I run, the fish passes by really fast. It’s kinda the same like that” (5/7/09, Transcript). When explicitly asked to define acceleration Justin simply stated, “acceleration is like how fast you speed up” (5/7/09, Transcript).

Players also referenced the game’s use of car attributes when discussing acceleration. Both games allow the player to select their vehicle. Each vehicle has a distinct list of “properties” complete with a bar representation of the property’s value (see Figure 2). Included in this list of properties are speed and acceleration. When selecting cars, Allen claims he chooses his car because, “this one has the best speed and acceleration” (5/7/09, Transcript). Later Justin suggests the importance of these static properties, “with bowser and his worse car you’ll probably be 12, where with baby mario and your fast car you’re in 1st” (5/7/09, Transcript).

Discussion

The purpose of this study was to identify video games features players *registered* as velocity and acceleration and to then connect these *registrations* to an intuitive interpretation. Players typically create *registrations* of velocity based on both spatial relationships between vehicles and the movement of the landscapes around the vehicle. Acceleration *registrations* were more vague, but seemed to involve intentional player actions (such as pressing a "boost" button) and the notion of acceleration as a static vehicle attribute (see Table 1).

In his work on *phenomenological primatives*, diSessa (1993) identifies a number of *children's p-prims* which may account for some of the intuitive interpretations of velocity and acceleration enacted by players in this study. As seen in Table 2, the primitives "being ahead means going fasters," and "getting to a goal first means having gone faster" (diSessa, 1993, p. 224) account for the importance of spatial relationships and ordinal position. Justin and Allen's tendency to continually reference their race position and make statements such as "I'm in 4th […] so slow, what's going on?" (5/7/09, Transcript) directly indicate these *children's p-prims.* In addition, the importance of the moving surroundings in determining velocity is likely related to the "Passing means going faster" (diSessa, 1993, p. 224) *p-prim*. This primitive could also be relevant to the importance of the spatial relationship between players.

While players seem to be able to give a "text book" definition when asked explicitly about acceleration, their interpretation of acceleration in the game focuses on static vehicle attributes and the player's use of the controller. While there are analog buttons for both "gas" and "brake" that read varying pressures applied, players typically "mash" button. When I asked Justin if the game had a "brake" button he stated, "Yeah but I never use it […] mostly I hold the gas down. Maybe once or twice I'll let go but I never brake" (5/7/09, Transcript). It's possible

this could be an enactment of *Ohm's p-prim*, that "an agent or casual impetus acts through a resistance or interference to produce a result" (diSessa, 1993, p. 217). Wanting to make the car accelerate faster they intuit that they must press the button as hard as they can.

Conclusions

This study highlights the complex nature of intuitive thinking involved while participants play these games. Due to the exploratory nature of this study and the limited diversity in participants, findings may not necessarily be generalizable. An expanded version of this study currently underway will utilize a larger and more diverse participant pool and alternate analogous activities to identify unique differences in intuitive ideas of velocity and acceleration in the game environment.

It's clear that player's intuitive ideas about velocity, acceleration, and momentum are involved during their interactions with these video game environments. Player's ideas of velocity and acceleration in the game world are shaped by their conception of the spatial relationship between their car and competition cars. In addition, players typically identify the "movement" of structures surrounding their car as another indicator of velocity and acceleration. Unfortunately, player descriptions seemed to indicate that they think of velocity and acceleration in the game as static quantities. While descriptions of velocity and acceleration were difficult to distinguish, the idea of velocity and acceleration as static attributes of a car seemed to be at least somewhat related to typical controller use and the video game's design of cars quickly reaching their top speed.

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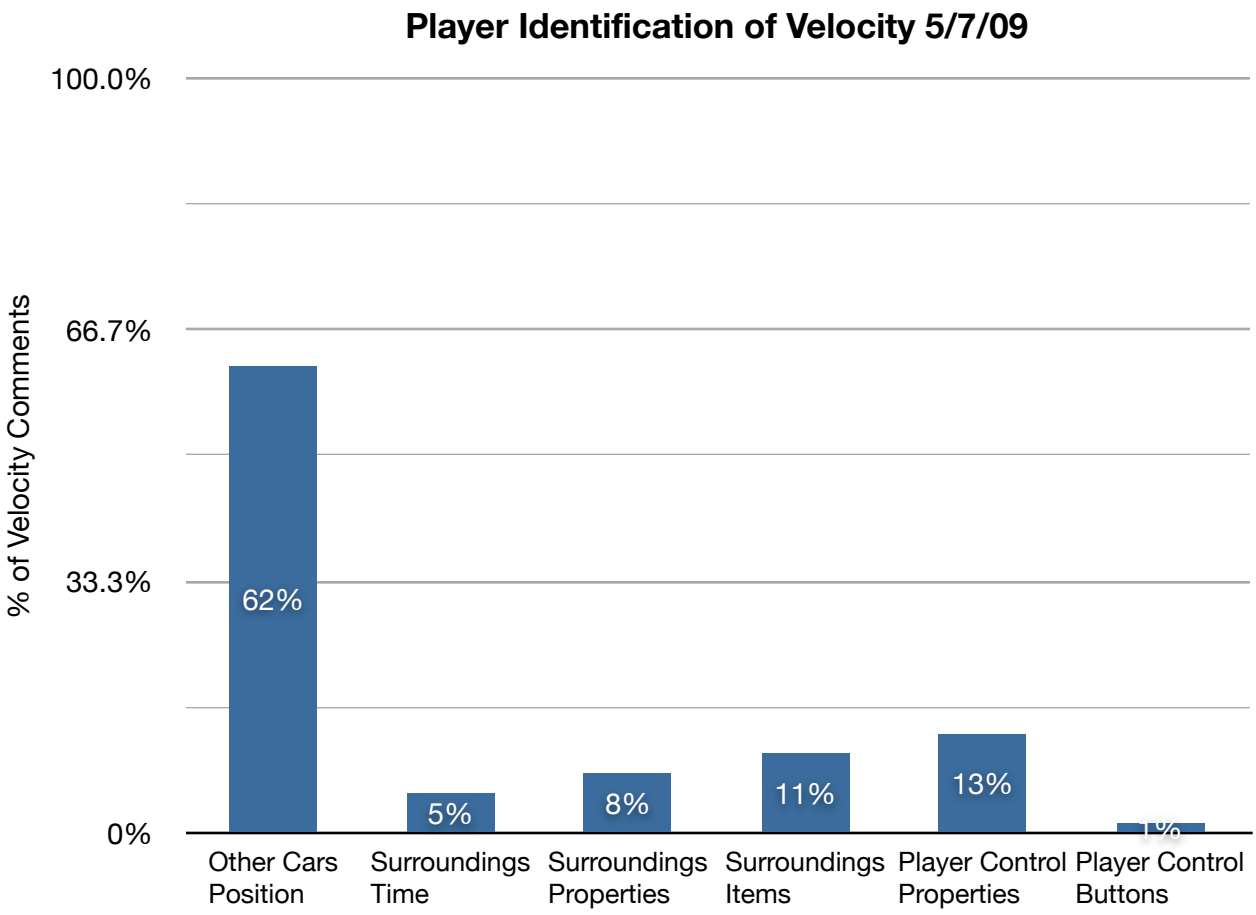
Figure Caption

Figure 1. Percentage of conversation units Allen and Justin identified velocity using these in-game features.

Figure 2. A screenshot of the vehicle select screen in *Mario Kart Wii*. Players often suggested that velocity and acceleration were static attributes that cars had, rather than something that can change.


Player Identification of Velocity 5/7/09
100.0%
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8%
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13%
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Surroundings Time
Surroundings Properties
Surroundings Items
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