Creeping Systems: *Dota 2* and Learning In an e-Sport

Chris Georgen & Sean C. Duncan
Learning Sciences Program, Indiana University

Introduction

As the field of games and learning has matured in recent years, we have found ourselves spending a great deal of effort detailing how games "work" as instructional tools, and how they may leverage the interests of youth toward simulations that encapsulate extraordinarily complex systems (Squire, 2002). As a field, we have perhaps shifted our gaze away — if just a little bit — from a focus on understanding the forms of play implicated through play in commercial entertainment games. In this paper, we forward the argument that the investigation of "games and learning" necessitates an understanding of both the complex reasoning practices embedded within the play of contemporary videogame genres, while also posing a number of questions that may help to frame future directions in "entertainment games and learning" research. The "well played" format is ideal for this exploration, given its emphasis on understanding play as it arises from the designed elements of games.

In this paper, we outline a productive case study of the "multiplayer online battle arena" (MOBA) game *Dota 2*. A new entrant in the MOBA space, yet with perhaps the oldest of MOBA pedigrees, *Dota 2* presents a complexity that begs further study as a space for learning in the one of the most socially-negotiated and (potentially) economically significant of current game genres. *Dota 2* is a prime example of how commercial and entertainment games demand — and can potentially teach — *systems thinking*, through awareness, positioning, decision-making, and an understanding of how to function within the game's vast mechanical and social ecosystem.

And yet, how might an investigation of *Dota 2*, also notable in its role as an up-and-coming "e-sport," contribute to a rethinking of what we consider relevant in understanding a game's potential for learning? How appropriate is the framing of a "game" for understanding this kind of social and technical space? How does a look at *Dota 2* help to clarify the differences between "games" and "e-sports" and the potential learning implications of both?

From MOBAs to *Dota 2*

To begin, we need to situate ourselves in the relatively recent but eventful history of the MOBA. *Dota 2* is only one of many recent games in this genre, all of which originally spawned from the *Warcraft III* modification ("mod") titled *Defense of the Ancients* (*DOTA*). The mod was developed and released in 2003 using the "World Editor" of *Warcraft III: Reign of Chaos*. As *Warcraft III* is a real-time strategy game in which strategy focused around the development of heroes supported by an army of units, the *DOTA* mod shifted its focus to the development of a single hero, and units became AI-controlled. *DOTA* laid out the basic landscape for the MOBA genre and its unique mix of real-time strategy, roleplaying, and combat characteristics, as well as its signature map (based on the "Aeon of Strife" *StarCraft* map; see Figure 1, below). Several authors maintained the specific scenario that evolved into *DOTA*, but the longest running developer, the pseudonymous "IceFrog," has maintained the project since 2005.

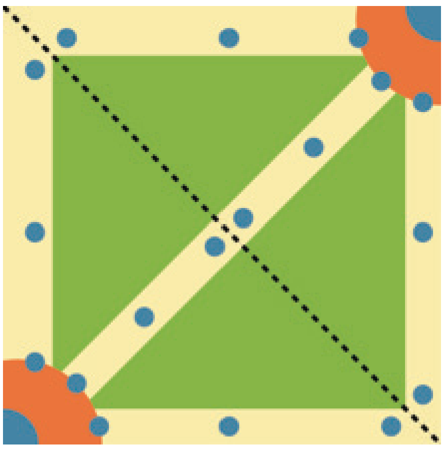

Figure 1: A prototypical MOBA map, action moving between the bottom left and upper right corners.

Dota 2 may not be the most popular *DOTA*-clone — *League of Legends* can boast a staggering *27* million players *daily* (Tassi, 2014) — but it is widely recognized as one of the most nuanced, competitive, and unforgiving games in the genre. Though all MOBAs originally evolved from *DOTA*, Valve Software (the developer of *Dota 2*) is notable for its desire to expand the original *DOTA* into *Dota 2*, and develop the game into one that can be played competitively on many levels. Staying true to the original formula, Valve went so far as to hire *DOTA's* IceFrog as lead designer. This is not a new model for Valve, who has developed mods like *Counter-Strike* and *Team Fortress* into successful videogame franchises in their own right, as well as crafted new franchises by hiring the developers responsible for productive game demos (e.g., the hiring of Kim Swift, based on *Narbacular Drop*, which led to *Portal*). In both instances, Valve purchased the intellectual property and hired the developers of the original modifications to lead the new franchises, while in the case of *DOTA* to *Dota 2*, there has been some degree of legal contention with Activision Blizzard over the appropriation of the name "DOTA" (hence Valve's subtle change of title away from the "DOTA" acronym to "Dota").

Dota 2 plays like the mash-up of a single session, accelerated, massively multiplayer online role-playing game and a focused real-time strategy game in which players control only a single unit. During each session, or match, players command a hero in real-time on a standard map, leveling up, acquiring skills, and buying powerful items. Two teams of five players — the Radiant and the Dire — square off in what Valve calls an "action real-time strategy game" or "ARTS," shifting the framing of *Dota 2*'s genre even further from the "MOBA" acronym, and to a term of their own making.

As with many board games and tactical wargames, every match of *Dota 2* is played on a single, common map. The map is divided into three lanes with a river running through the middle (the diagonal in Figure 1). Each lane has three defensive towers followed by a barracks that must fall sequentially. From the barracks, streams of AI-controlled "creeps" spawn every thirty seconds and mindlessly march up or down the lanes. Next, player-controlled heroes enter the picture. Two teams of five heroes start on opposite ends of the map, kill creeps, destroy towers, and clash with enemy heroes from the opposite team. The game ends only when one team pushes into the opponent's base and destroys a large central structure called the "Ancient."

This is *Dota 2* at its core — a team game with a relatively direct common goal, albeit one that sits within a collection of complex systems that must be managed to achieve this goal. For some, it's a model multiplayer "sport," in which the game's complex and balanced design ensures a level playing field, and winning is based on execution, experience, and sometimes a little luck. "Well play" of *Dota 2* is implicit in the nuanced details of the tactics employed by players and the players' understandings of the game's multiple, interlocking systems. In the next section, we'll look in more detail at how the systems of the game interact, and consider the ways that *Dota 2* play might be understood through a focus on systems thinking.

Systems Thinking

Contemporary learning research has highlighted systems thinking as a critical skill in our increasingly complex world, and as a form of reasoning that can be supported through games in particular (see Squire, 2002). Facility in systems thinking is a difficult skill to obtain, and there are varied approaches to improving the teaching of systems thinking. By their very nature, the dynamics of what we typically label as "complex systems" exist outside of everyday familiarity, appearing as phenomena that appear random or, in some cases, hopelessly arcane to the casual outside observer. The nonlinear relationships present within such systems in the natural and social world — weather systems, the stock market, ecological interactions — make them difficult to predict, and often quite perturbable by small disruptions at critical junctures (e.g., the well-known "butterfly effect").

Understanding complex systems involves identifying the interactions of many systemic elements, and grasping deeply non-linear systems requires developing an extensive knowledge of function, relationship, and structure (Hmelo-Silver & Azevedo, 2006). Yet, we desire to learn about complex systems to satisfy common human needs and curiosities to solve real world problems of consequence. Formal classroom environments can have trouble developing the conceptual backbone required to understand these systems, because individuals tend to focus on one-way causal relationships, while in the presence of dynamic and complex relationships. In light of this, game play and game design has been identified as potentially a useful means through which to acquire systems thinking skills (Torres, 2009), as games provide a degree of consequentiality to the player — if you fail one's team in *Dota 2*, you'll hear certainly about it from the teammates you let down.

And so, single-player videogames are artificial but defined problem spaces, where players navigate complex systems of interacting parts as part and parcel of playing within them, and where the state of a game can be described in terms of a system's conditions. The player can move through the game, iteratively testing and receiving feedback against an artificial (albeit often stochastic) system. The player has limited control over the variables that influence the system, and to the extent in which the player has authority of variables, this can be thought of as the game's "dynamic range" (Arsenault, 2005). This range exists within complex structures that can be further defined as "emergence" or "progression" frameworks (Juul, 2002). Emergent game systems are nonlinear and grounded in a simple rules that when compounded lead to variation, whereas a progressive game system the player is offered a series of predetermined challenges. Though complex, both emergent and progressive systems are relatively static and predictable. *Dota* 2 should thus be considered an *emergent* system; however, it adds a distinct layer of complexity, as it is designed for a strictly competitive, multiplayer environment in which players' decision-making processes are influenced by the game's system(s), and the player's resulting actions change the state of these system(s). Multiplayer games present a dynamic problem space, with systems that *need to be* transformed through player interaction.

Therefore, understanding the role of the player's learning of systems and action within sets of systems in complex gaming environments necessitates an understanding of player intent, the impact of player action, and player goals. Understanding systems in gaming environments thus may help us to situate ourselves in dynamic, complex systems, understanding how we develop a grounded sense of "systems thinking," and also how we see our roles as players who can change these systems toward one's own ends. This goal, while perhaps incommensurate with certain perspectives on, say, complex thinking in ecological systems that do not value the disruption of such systems, may be important for understanding how games may foster a different understanding of complexity than are found in other systems thinking literatures. And, as we will explore further, the case of *Dota 2* highlights that these games inherently involve accommodating the goals and intents of other players, and even the goals imparted by economic and cultural framings of the gaming activity ("e-sports").

The Systems of *Dota 2*

Next, however, we should elaborate exactly how the systems within *Dota 2* "work" to craft sets of experiences for the player, and how these experiences situate the player in the middle of a number of consequential systems that he or she must manage to succeed at the game.

From the perspective of an individual player, the set of systems embedded within *Dota 2* can be broken down into a series of layered micro-systems, three of which can be described as: *creeps*, *hero interactions*, and *economy*. Each microsystem independently fulfills one part of the system's purpose but remain interconnected. Uncovering systems thinking within *Dota 2* means first understanding how each system that the player has direct contact with interacts in relationship to each other. Other than through communications with other players, a single player only has agency over his or her hero; all other systems are predictable and only change only based on player actions, from which the system offers feedback. Meadows (2008) defines a system as "a set of elements or parts that is coherently organized and interconnected in a pattern or structure that produces a characteristic set of behaviors" and, in *Dota 2*, these "behaviors" are revealed through player agency. Given that ten players are simultaneously interacting with the same deterministic systems, complexity can arise very quickly.

As each of these micro-systems interacts with each other in significant ways, it would be impractical (and perhaps impossible) to list every interaction. However, we can see a simplified depiction of the structure, behavior, and function of *Dota 2* systems in Figure 2, below, which grossly reduces the complexity of the interactions to a single path for the sake of explanatory simplification. In this example, the economic system (represented in game as gold) stays in equilibrium for all players, i.e., every player reliably receives 0.6 gold per second. However, players can increase their gold by *killing creeps*, which is not a reliable and regular accrual of gold, but one that occurs due to the player permuting the game's systems. This unreliable gold feeds a heroes ability to buy items (increasing stats and/or offering unique abilities, increasing a hero's overall power and, therefore, ability to accrue more unreliable gold. Moreover, certain heroes are considered to be item dependent, and such heroes are inherently tied to the game's economic system, influencing the behavior and decision-making of the player. This example demonstrates the potential inter-dependency of the *creeps*, *hero interaction*, and *economy* systems and how changes in their interactions connect to changes in player behavior. These nuanced systemic interactions can be seen most clearly in *Dota 2* through player actions tied to the game's "creep system."

Figure 2: A linear mapping of *Dota 2*'s economic system

Understanding Creeps

Creeps are units that interact within the game's systems and with players in the game, but are unable to be controlled directly by players. Unlike troops in *Starcraft* or pets in *World of Warcraft*, creeps are completely automated. The structure of the creep system (see Figure 3, below) illustrates a hierarchical clustering of factors that influence creep behavior in *Dota 2*. Yet, interactions with other systems have an affect on the behavior of the creep system. Player agency interfacing with the creep system can generate noticeable transformations. There are a variety of creep control techniques players can use to manage this system, enabling a team to build strategic advantages over their opponents. Strategies have emerged, known as "creep control," which allow players to indirectly influence map control, hero advantage, and economic reward.

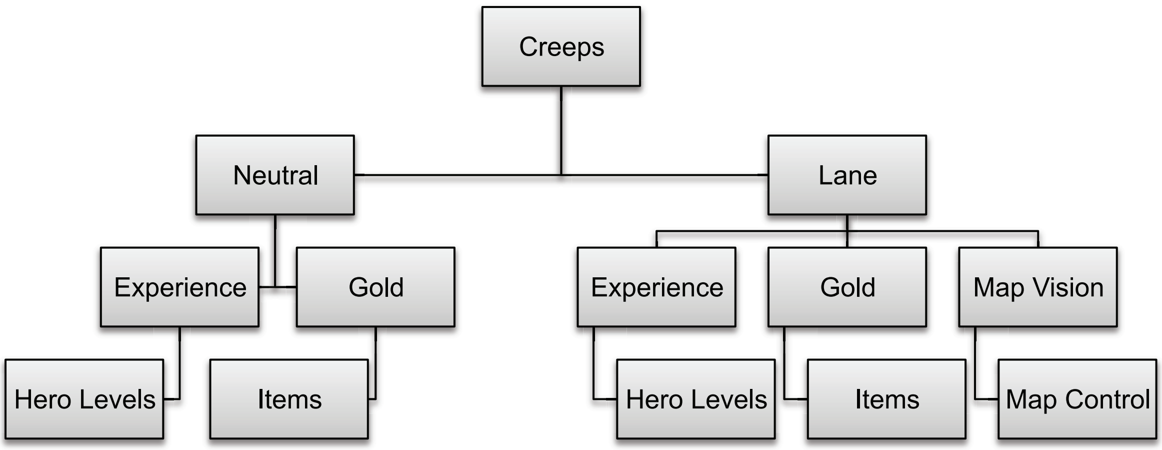

Figure 3: The creep system of *Dota 2*.

As seen in the figure, there are two varieties of creeps on *Dota* 2: "lane creeps" and "neutral creeps." Lane creeps spawn every thirty seconds from both teams' barracks and march toward the opposing base, only stopping to fight enemy creeps and heroes, or to help destroy towers, barracks, and the opposing Ancient. There are three categories of lane creeps: melee, ranged, and siege. As the game progresses, "creeps waves" increase in size and receive permanent statistical bonuses. Additionally, both sides of the map contain camps of neutral creeps. These creeps do not leave their camp unless provoked. Lane creeps and neutral creeps provide heroes with gold (for purchasing beneficial items) and experience points (level progression). Neutral creeps do not provide vision on the mini-map.

Lane creeps interact with other systems in a variety of ways. First, they give players vision on the mini-map (part of the *Dota 2* "heads-up display"). Mini-map vision allows a player to "see" what is happening on that corresponding area of the map, including the presence of enemy heroes and influencing *hero interactions*. Knowing the location of one's enemy is, of course, tactically advantageous and vision is fundamental to map control or the ability to influence or limit one's opponent's location and mobility. Players can influence the creep system of by killing enemy creeps, thus "pushing" the creep wave to deny access to important areas of the map. Moreover, each base contains three barracks at the beginning of each lane. If a team is able to reach and destroy an opposing barracks, the creeps in that lane gain a permanent bonus. These "super creeps" are able to push the lane without the help of heroes, giving a team significantly more map control.

Lane creeps demonstrate a fundamental mechanism of systems and a key element of systems thinking that can be learned through *Dota 2*: a *feedback loop*. Until players interact with the creep system, the feedback loop remains in equilibrium. By players influencing the creep system, such as “pushing the lane,” one creep wave will have a stronger impact on subsequent actions. This “shifting dominance,” or change of the relative strengths of competing feedback loops, is a primary characteristic of complex systems (Meadows, 2008). “Shifting dominance” in the creep system is complex and can be either a strategic benefit or disadvantage, depending upon timing, location, and a multitude of other factors. And, we note that it is to players’ advantage to not just perceive these feedback loops, but to learn to *exploit them*, in order to gain advantage in the game.

Creeps maintain equilibrium independently: creep waves will continue to meet in the middle of a lane until disrupted by the player or other factors. As heroes attack creeps, they push a creep wave down the lane. Though seemingly counter-intuitive, quickly killing creeps may be detrimental, as it can put your lane out of position. Early in the game, being far away from the safety of your tower may leave you susceptible to being killed by the opposing heroes. In fact, creep equilibrium is so important that players will intentionally obstruct the pathing of creeps in order to “creep block,” forcing creeps to meet closer to their tower. In these cases, players apply *negative feedback* to their creep wave to achieve a positional advantage. Understanding the inter-dependent relationships between the creeps and the system’s other structures helps players make tactical decisions such as determining the best moment to push for map control, how to maintain a safer state of equilibrium, or even where to purposefully apply negative feedback to the creep system.

Finally, the creep system is inter-related with game’s *economy*. *Last-hitting* is a term used by players to describe landing the killing blow on a creep. This is the only way to receive gold from creeps and accounts for the majority of the gold earned by heroes. Therefore, the ability to last-hit creeps is fundamental to how much gold a player can accrue. Items can provide significant bonuses to stats and offer unique activated abilities. A player’s ability to efficiently last hit creeps is manifest in their ability to acquire items at a rate faster than their opponent. *Denying* is last-hitting your team’s creeps in order to prevent the opponents from gaining gold and the full amount of experience. Evenly *last-hitting* and *denying* will maintain *creep equilibrium*. Put together, players and their team gain a tactical advantage by understanding how to utilize the creep system and manage feedbacks in order to gain gold, map control, items, and experience points.

The creep system illustrates how just a few of the micro-systems of *Dota 2* interact with each other to create a complex system that is greater than the sum of its parts, and embed the player in a series of interlocking systems that he or she must manipulate to gain advantage in the game. And yet, while a nuanced system-level understanding of the game is vital to successful play, the games most vibrant “system” may in fact be the ten players collaborating or combating with one another in the virtual space of *Dota 2*. Unlike other multiplayer online games, MOBAs’ competitive, player-versus-player structure is *mandatory*, and there is no such thing as a meaningful single-player version of *Dota 2*. There is no avoiding the intentions, behaviors, and goals that other players will project into the system, unlike many other multiplayer games where a player can proceed through the game without deeply interacting with other players (say, “player vs. environment” servers in *World of Warcraft*). In *Dota 2*, players are assigned roles, objectives, and strategies based on hero selection, style of play, and experience. And as with any inter-personal experience, the intent and emotion behind the play can heavily impact the experience.

Learning in MOBAs

Gee (2007) characterizes one of education’s greatest dilemmas as how to overcome learning through overt “telling” by forwarding a model of situated learning that values immersion in practice. To learn, humans need a balance of information upfront and practice in context. Gee identifies the potential of videogames to deliver just this experience, arguing that videogames stick to a model of distributing information incrementally and when appropriate in concentration. This allows the player to practice a skillset in context and receive “just-in-time” information (Collins & Halverson, 2010). The videogame is, in and of itself, the teacher, the content, and the framework. Many videogames have nearly perfected this model, and deliver a gratifying learning and play experience.

What is notable about this case is that *Dota* 2’s model of instruction is virtually entirely *practice in context*. Tutorials and practice rounds versus AI-controlled “bots,” offer minimal forms of basic instruction: understanding the interface, controlling a hero, demarcating rules, and defining objectives. But then in the player’s first real match (and perhaps with cruel intentions), Valve gives players the entire complex system without explanation or further tutelage. A player can play or play against any of the over one hundred available heroes – each with four unique abilities – and must navigate a deep pool of items. In response to this depth of choice, the *Dota 2* community has produced an endless stream of guides, hero builds, and advanced tactics. Player-created guides are available in game and can be up-voted and bookmarked. These detailed guides advise item choice, skill progression, and tactics. Right now, Steam’s community forums hold over 115,000 guides for *Dota 2*.

Still, even for the most dedicated player, practice in context is insufficient. Mastery of *Dota 2* hinges on a variety of factors: the execution of skills and abilities (fine motor skills), awareness, positioning, decision-making (strategy and tactics), and management of the game's systems (systems thinking). Practice in the specific virtual context of the game can potentially lead to improvement in execution and decision-making; however, no experience or instinct can lead complete system level understanding (e.g. creep control strategies, the nuances of items, or hero synergy). Learning *Dota 2* requires entering the game's affinity space (Gee, 2005; Duncan & Hayes, 2012) as a participant. This involves doing one's homework, by engaging with the game's paratextual, instructional materials: YouTube contains a wealth of material ranging from basic strategies for beginners to detail guides for advanced play. Popular YouTube channels have guides with views in the millions.

And, after learning the basics, perhaps the best way to improve play is to watch the best. With the increased prominence of e-sports and academic interest in them (e.g., Taylor, 2012), we need to account for the learning potential of professional *Dota 2* players streaming live matches, coaching players, and playing in live tournaments.

Toward an "E-sports and Learning"

And so, how useful is the term "game" for understanding this kind of social and technical space? Certainly, there is an interesting set of mechanics in the game, as we've described around creeps (and dozens of other systems in the game which we do not have the space here to describe). *Dota 2* is marketed as a game, but does the term "game" do it justice? Does the term "game" put undue focus on *Dota 2* as a technical artifact, and not as sets of activities and as a community of gamers?

If *Dota 2* represents an interesting case of complex systems which necessitate some form of systems thinking in order to develop competency in the game, then we need to investigate what keeps players involved, drives their learning of the game, and pushes them to further master the game's intricate systems. Why would anyone jump into a game that provides little instructional content, requires a great deal of individual and group participation in the game's systems to learn, and can be brutally competitive? What motivates continued, repeated, and dedicated play of *Dota 2*?

Perhaps the framing of an e-sport allows us some provisional ways to answer these questions. Second only to *League of Legends*, *Dota 2* is an extremely well followed e-sport, with professional competitions, and rather sizable prize pools. In 2013, *League of Legends* grossed a prize pool of over $5,700,000 USD, while *Dota 2* followed close behind with a total prize pool of over $4,400,000. The growth in popularity of e-sports can be seen through its rise as a form of public, internet-streamed *competitive performance* — professional and amateur games from across the globe are streamed live on Valve's *Dota 2* interface and via online streaming services, such as Twitch.tv. Over the course of the last year, Twitch has reported that *Dota 2* viewership has seen an increase in minutes watch at a growth rate of 508% (Morris, 2013). As such, gameplay must be clear and recognizable. Those who are able to navigate the system should be able to clearly keep score, navigate unfolding events, monitor advantages or disadvantages, and make predictions. E-sports are increasingly big business, and viewership is a potentially strong way to drive players into the game.

Much like the design of Activision Blizzard's *Starcraft 2* (Browder, 2011), *Dota 2* was explicitly intended to be used for team-based competitive, professional play. And, as Kow (2013) claims, studying learning within competitive e-sport communities raises a number of questions regarding the lived experiences of players, as well as the influence of a shared, competitive purpose on the learning practices within a game community. Valve has paid particular attention to assuring *Dota 2*'s success as an e-sport (LaFleur, 2012), and in doing so, have shaped communities driven to not just play but also *watch* the game. The consideration of *Dota 2* as an e-sport has affected the game's design, and we suggest is a key motivator and factor in helping some players to improve.

And yet, e-sports are not interesting simply because they are viewable rule systems, no more than non-e-sport digital games are simple programmed embodiments of these rule systems. The *Dota 2* case illustrates that even while we attempt to account for the systems thinking practices of players of the game by detailing the elements of the game, we still miss a major part of the picture. The "systems thinking" of *Dota 2* is not completely explicable until we consider *why* players are involved in *Dota 2*. The framing of *Dota 2* as an "e-sport" thus further opens the door to considering the social, cultural, and economic factors that influence the systems thinking found within games.

While the games and learning world has focused its efforts on understanding the designed elements of "games" as a way of understanding the "well play" of these experiences, perhaps we should begin seriously considering how we might want to revise our framing of "games and learning." *Dota 2* is clearly intended to be more than just a "game," at least a game in the way that much of the games and learning community tends to conceive of them — technical artifacts, understandable primarily through reductive analysis of the game's mechanisms. The *context* within which a game is presented to a player can be of consequence not just in leading them to the game experience, but also in driving their persistence toward learning the game. Difficult, complex, and complicated e-sports such as *Dota 2* raise the possibility that social organizations around the game are part of how the game drives players to learn its systems, and that the design of games for learning can gain from further exploration in this area.

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