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Gaming Literacies: A Game Design Study in Action

KATIE SALEN
Parsons The New School of Design
USA
katie.salen@gmail.com

Educators and education advocates have recently acknowledged that the ability to think systemically is one of the necessary skills for success in the 21st century. Game-making is especially well-suited to encouraging meta-level reflection on the skills and processes that designer-players use in building such systems. Membership in a community of game producers means sharing thoughts and experiences with fellow players. This ability to gain fluency in specialist language and to translate thinking and talking about games into making and critiquing them (and vice versa) suggests that games not only teach literacy skills but support their ongoing use. Rather than imagining that education can be transformed by bringing games into the classroom, researchers should consider not only the effects of the thinking engendered by those who play, but also by those who design the play. This article offers an overview of the pedagogy and development process of *Gamestar Mechanic*, an RPG (Role Playing Game) style online game designed to teach players the fundamentals of game design. It will discuss some of the early results of the project, with an emphasis on the conceptual framework guiding the work, as well as the kinds of literacies and knowledge structures it is intended to support. [abstract ends]

Introduction

When someone reflects-in-action, he becomes a researcher in the practice context. He is not dependent on the categories of established theory and technique, but constructs a new theory of the unique case. His inquiry is not limited to a deliberation about means which depends on a prior agreement about ends. He does not keep means and ends separate, but defines them interactively as he frames a problematic situation. He does not separate thinking from doing, ratiocinating his way to a decision which he must later convert to action. Because his experimenting is a kind of action, implementation is built into his inquiry. (Schön, 1983)

Gamers are nothing if not reflective in action and, according to Schön (1983), operate as researchers in the practice context. No move is made without consideration of what the move *means* – both to an ability to make future moves and to the current state of the game. As a result, constant experimentation with the theories one builds through play defines the *modus operandi* of gamers. Game designers, too, share an affinity to reflection-in-action, as they deploy a reflective design process involving an iterative sequence of modifications to the rules and to the behaviors of game components. Game designers follow a cycle of design: playtest, evaluate, modify, playtest, evaluate, and modify. Not surprisingly, this sequence looks much like the process of play.

None of this is new. We know that play is iterative and that game design is a model rooted in reflection in action (Salen & Zimmerman, 2004, 2005). We also know that digital games and gaming practices have done much to shape our understanding and misunderstanding of the post-Nintendo generation and hold a key place in the minds of those looking to empower educators and learners. Beyond their value as entertainment media, games and game modification are currently key entry points for many young people into digital literacy, social communities, and tech-savvy identities. So what does this all mean for the dialogue around games and education?

For several months now, I have served as lead designer on *Gamestar Mechanic*[1], a game about game design funded through the MacArthur Foundation's new initiative in Digital Media and Learning (http://www.digitallearning.macfound.org/) and developed through a collaboration with Gamelab (http://www.gamelab.com/), a New York City-based game development company and the Games, Learning, and Society (GLS) group at the University of Wisconsin-Madison (http://website.education.wisc.edu/gls/). In *Gamestar Mechanic*, an RPG-style online game, middle and high school age players learn the fundamentals of game design by playing stylish 'mechanics' charged with the making and modding of games. This article will offer an overview of the pedagogy and development process of *Gamestar Mechanic*, with an emphasis on the conceptual framework guiding the work, as well as the kinds of literacies and knowledge structures we intend it to support. The first section outlines the situating context for the project, the discourses and ideas it engages, and presents a model for thinking about the intersection between game design, gaming, and epistemic learning. The second section documents initial testing with an extremely rough prototype of the core game experience and reflects on strengths and weaknesses of the current design. The third section offers an overview of the project and defines the key criteria and learning principles we are working to embed within the experience of play.

Design As Learning

Gamestar Mechanic began with a belief that the practice and production of game design enables a type of reflection in action that supports good learning. This approach has been mirrored over the years in the development of products like Mindstorms® and open-source tools and programming languages like Logo©, Squeak©, Scratch©, and Alice© designed to teach procedural thinking, problem solving, and logic, by learning to program. Seymour Papert and Michel Resnick pioneered thinking about how the acquisition of a programming language empowers a person to model knowledge and to see the world as a system of interconnected parts. *Gamestar Mechanic* shares in this approach not by teaching the language of *programming* but the language of *game design.*

This distinction is quite important for several reasons. First, many excellent game-making software products exist already and have been used, in limited cases, by teachers in K-12 and university contexts.[2] These tools include Game Maker®, RPG Maker®, 3D Game Maker®, Zillions of Games®, Toontalk®, Klik and Play®, and Adventure Game Studio® to name but a few,[3] with many more products currently in development. These tools have a proven track record of facilitating game production and have opened up the context of game making to those who are not professional game designers. Yet while each of these tools *enable* game design, they don't explicitly embed the practice or thinking of game design within the experience and often focus on game programming as the primary pedagogy. Within these tools, games emerge out of a set of programming procedures: make the ball bounce against a wall – *Make a wall sprite and a ball sprite;* manipulate the ball – *Add Event* > *Event Selector* > *Mouse* > *Left button*.

Gamestar Mechanic contrasts this approach by situating the making of games within a larger game world, where the making and modding of games is not only the primary play mechanic or mode of interaction, but also the means by which game design thinking and practice are modeled and performed. Players take on the role of mechanics, brought into a steam-punk inspired world to repair and contribute games to the economy on which the now broken-down world runs. Every element in the world constitutes a game component – embodied as *creatures* – that can be used to design and repair games. Through a series of carefully scaffolded challenges, players are introduced to the rules governing the behaviors and relationships between creatures and earn the ability to access the creature's DNA to modify basic parameters like speed, movement pattern, intelligence, health, loops, and conditionals (if this, then that). Players enter and play through the game from the point of view of design. So while they emerge from the experience understanding aspects of game programming, it is not the dominant paradigm.

Clearly, this is not a superior approach to the programming-as-design strategy taken up by other tools, but simply a different one. The approach is unproven, experimental, and will undergo revision as the project is developed and tested with kids. This cannot be overemphasized: the state of our current thinking is primarily speculative, and a design spec does not a game make. The real work begins when the game gets in the hands of the players. While much of what I share here sounds reasonable, we will only know for sure how well the theory translates into practice once players, educators, and researchers have given it a go and observed what transpires. I will discuss the design model in the third section, but first want to expand on the thinking that brought the project into being.

Thinking Like a Game Designer

The initial proposal made some claims that seven months later still hold true. *Gamestar Mechanic* allows young people to design digital games – to be game designers – not in order to train them for game industry jobs, but to give them a platform on which to build technical, technological, artistic, cognitive, social, and linguistic skills suitable for our current and future world. This approach to learning is one that the GLS group refers to as *epistemic games* or *professional practice simulations* (Beckett & Shaffer, in press; Shaffer 2004, 2005; Shaffer, Halverson, Squire, & Gee 2004; Gee 2005a). *Gamestar Mechanic* is an epistemic game or professional practice simulation that speaks quite directly to the issues of being tech-savvy in the modern world and displaying media literacy in both old and new forms of reading and writing. Rather than approaching the discussion of reading and writing in terms of games as multimodal texts we are instead exploring game design itself as a form of procedurally-based, multimodal literacy, which allows for the reading and writing of symbolic systems but does so through the qualities and characteristics of the medium itself as activated through play.

Game design as a domain of professional practice involves a rich array of knowledge and skills. Knowing how to put together a successful game involves system-based thinking, iterative critical problem solving, art and aesthetics, writing and storytelling, interactive design, game logic and rules, and programming skills. The designer must also be a socio-technical engineer, thinking about how people will interact with the game and how the game will shape both competitive and collaborative social interaction. Designers must use complex technical linguistic and symbolic elements from a variety of domains, at a variety of different levels, and for a variety of different purposes. They must explicate and defend design ideas, describe design issues and player interactions at a meta-level, create and test hypotheses, and reflect on the impact of their games as a distinctive form of media in relation to other media. And each of these involves a melding of technological, social, communicational, and artistic concerns, in the framework of a form of scientific thinking in the broad sense of the term (e.g., hypothesis and theory testing, reflection and revision based on evidence, etc.). Designers are making and thinking about complex interactive systems, a characteristic activity in both the media and in science today.

Connected to an embodiment of practices undertaken by a game designer in the real world are the practices taken up and enacted by *players,* who are equal stakeholders in the *Gamestar Mechanic* experience. In the same way that reflection-in-action requires an integration of thinking and doing, *Gamestar Mechanic* combines playing with making, connected activities situated in a social world. While players have the run of their own Factory, they must connect with other players in the *Gamestar Mechanic* community, both to share expertise and to play together via the games they build. Situating learning within a community of learners is critical, as members of the New London Group (2000) wrote in regard to the concept of multiliteracies: "…if one of our pedagogical goals is a degree of mastery in practice, then immersion in a community of learners engaged in authentic versions of such practice is necessary" (p. 84). This immersion is important not only in making the experience an engaging one, but in expressing the absolute connection between kinds of literacies and learning that take place in and around the play experience itself. It is the mobilization of these forms of learning that are at the heart of our exploration, and have led me to consider further how we might talk about the concept of gaming literacies, both in relation to the *Gamestar Mechanic* project, and to the field of games and learning more generally. Game design may be a way to rethink approaches to other media and the literacies that run across them.

Assessment goals. *Gamestar Mechanic* is governed by a set of assessment goals, which point to specific outcomes we hope to see. These goals are critical to the project, as they guide the design and inform the claims we eventually will make about its successes and failures. On a general level, we want to provide opportunities delivered as part of the game experience for players/learners to constructively critique what they are learning, creatively extend and apply it, and eventually innovate on their own within old communities and in new ones (New London Group, 2000). We must be able to demonstrate what children are learning through the game, including specialist language. After playing the game, are children talking like game designers, using terms like *core mechanic*, *rules*, and *goals*?

Several assessment goals were established at the onset of the project. One goal defines the need to characterize the ways of thinking, valuing, and acting that are built into the game. We will need to argue that what is built into the game is a good and accurate portrayal of how game designers think, value, and act. This helps to construct validity. Next, the assessment outcomes must argue convincingly that the ways of thinking, valuing, and acting built into the game – ways that set up certain forms of problem solving – are good for something society and its policy-makers care about and are fair in how they work for different populations. This is related to consequential validity. We will need to show that the players actually learned to solve the kinds of problems the game presents them with and that players set up various degrees of transfer. That is, they can solve similar problems outside of a game format, as well as less similar ones and even dissimilar ones (*far transfer*), including school-based problems. And we must make sure this learning lasts. As Jim Gee noted (2003), it would be particularly nice if we could show the game encouraged innovation in the sense that players could offer innovative solutions to problems outside the game (for example, show they can "break set" in approaching a problem). Last we must be able to assess whether the game works – when kids are doing it together and as part of a learning system – to develop academic forms of language, the sorts of language associated with school and success in school. This is a tall order and one of the reasons that throughout this article I will continually qualify the work as in-progress. We have lots of ideas but not a lot of evidence, yet.

Gaming literacies. Justin Hall, a recent participant in a set of online dialogues on the subject of kids, games, and learning[4] wrote, "I continue to believe that literacy, language, and personal expression, will stem from increasing exposure to flexible rule sets and iterative systems for solving small problems." Like Hall, the team behind *Gamestar Mechanic* shares in the belief that exposure to the flexible rule sets and iterative play embodied in both design and gaming practices are critical for thinking about literacy in the 21st century. More specifically, we are exploring the idea of literacies specific to gaming and domains of media produced by games and supported through attitudes brought to bear on their play.

Gaming literacies emerge from what I call a *gaming attitude,* which Jay Lemke (2006) refers to as a "stance of playfulness," an attitude tied directly to the creative, improvisational, and subversive qualities of play. I intentionally use the term *gaming* literacies and not *game* literacies as my interest is not simply in how digital games work (formally, socially, culturally, ideologically) but in how they support a performative and often transgressive learning stance based in play, which in turn, owes much of its specific character to the status of games as dynamic, rule-based systems. As designed systems, games offer certain terms of engagement, rules of play that engender stylized forms of interaction. Gamers not only follow rules, but push against them, testing the limits of the system in often unique and powerful ways.

Learning to read a game system in order to play with it points toward a specific kind of literacy connected, in part, to the ability of a player to understand how systems operate, and how they can be transformed. Modding and world-building, which form the basis for much of the play of Massive Multiplayer Online (MMO) games and virtual worlds, for example, might be one such literacy, while learning how to navigate a complex system of out-of-game resources, from game guides, FAQs, walkthroughs, and forums to peer-to-peer learning, might represent another. A third literacy might be seen in the learning that takes place in negotiating the variable demands of fair play: players must become literate in the social norms of a specific gaming community learning what degree of transgression is acceptable and when a player has crossed the line. A fourth in learning how to collaborate within a multiplayer space, where knowledge is distributed and action is most often collective.

For those of us that design digital games, understanding the ways in which the structure of the medium itself elicits particular attitudes toward action and interaction with the medium is endlessly beneficial. This interest is heightened when the desire for understanding is cast into the context of learning and games. Because games are *already* robust learning systems, we must begin to tease out the intrinsic qualities and characteristics that guide the types of learning gaming and games advance. Some of this work is being done by the GLS group around *Gamestar Mechanic*, but there are a number of researchers worldwide engaged in similar work, many of who appear in this volume. Yet what is of even more interest is to discover how these attitudes and modes of interaction are being transcribed or enacted elsewhere – beyond games – if we can make that claim at all. Does game design translate into a way of thinking about the world and if so, in what contexts does this form of thinking apply? If we see evidence, perhaps, we will have a more clear idea of what forms of learning and modes of literacy are general and specific to games and be able to take advantage of this understanding in the creation of both new games and learning environments.

Player as Producer. While *Gamestar Mechanic* takes on the issue of gaming literacies modeled in other game experiences – supporting activities like reading game systems in order to act within them or operating within the complex information networks which define many player communities – one literacy has been intentionally foregrounded for many of the reasons mentioned above. *Gamestar Mechanic* explicitly supports a literacy of *production:* players design games, write game reviews, mod game components, and produce knowledge around the games they create. As Mizuko Ito has noted, “The promises and pitfalls of certain technological forms are realized only through active and ongoing struggle over their creation, uptake, and revision” (2005, p. 2). Gaming as a production-oriented literacy moves to the forefront within this discourse, with several styles of participation in evidence. In what ways are we seeing youth empowered through their participation in the creative production, uptake, and revision of games? What roles do gamers take on through game production and to what extent do they experience a mixing of specialized roles, which may or may not occur outside a gaming context? In what specific ways can a game turn players into game producers?

This emphasis on production may be misleading within a larger conversation around gaming literacies, as it might seem to present the argument that players can only be truly considered literate in relation to games if they manipulate and produce their own. This is one criticism I myself hold in regard to some recent writing that has been done around the concept of participatory culture: it can seem as if there is an implicit assumption that to be a full participant, one must also produce. If we follow this argument, only gamers-who-mod would be considered full members of the current culture of participation. This is simply not true. While a good percentage of teens, for example, produce some sort of online content – a recent report indicates 57% of online teens create content for the internet[5] – the production of game artifacts (skins, levels, fan fiction, etc.), is just one of the many ways that players participate in the robust knowledge networks that constitute the ecology of games. So while *Gamestar Mechanic* relies on production as a primary basis for play, it simultaneously supports other literacies as well, including reading and writing, critical thinking, problem solving, negotiation of complex social and material economies, and technology-associated literacies like computer programming. Production is therefore not the only mode of participation, but just one of many ways in which players engage.

Engagement is, first and foremost, a way into learning, as the many champions of games and education are quick to remind us. But beyond developing *Gamestar Mechanic* as an experience engaging young people in the practice of game design, we are also keenly aware of the need to use game design itself as a potential strategy for young people to meet their own social objectives. If we argue that production can be empowering (and there is a lot of data suggesting this to be the case) then we most certainly need to try and explore the specific ways in which *Gamestar Mechanic* can support not only game production but also the production of knowledge, attitudes, relationships, and skills. It is paramount to ask how the deployment of what is produced, be it a game or game artifact, supports what is learned and gained more generally. Sometimes the making of the game itself is of less importance than the deployment and use of that game by others (Pelletier, 2006). Here is where the idea of situated learning again comes in, for the uptake and revision of what is made by a community of players is part of the kinds of literacies we hope to produce. Situated learning is

> "…constituted by immersion in meaningful practices within a community of learners who are capable of playing multiple and different roles based on their backgrounds and experiences. The community must include experts, that is people who have mastered certain practices. Minimally, it must include expert novices, that is people who are experts at learning new domains in some depth. Such experts can guide learners, serving as mentors and designers of their learning processes." (New London Group, 2000, p. 33)

By embedding game making activities within a robust social community *Gamestar Mechanic* hopes to leverage the expertise not only of the game designers who have imprinted their knowledge on the design of the experience itself, but that of other players. Much of the play of the game takes place in the exchange and critique of games by the community of players. Players advance toward membership in the Council of Master Mechanics by earning better than average ratings on the games they make. Games are reviewed both by other players and by members of the Council itself. The narrative conceit of the Council allows teachers who may be working with the players to act as mentors within the learning space, reviewing games and giving feedback through a fictional avatar integrated into the overall narrative of the world. Professional game designers can also be invited in to take on a role as a master mechanic, for a short or extended period of time. In this way, *Gamestar Mechanic* allows players to assume different roles within a community of learners and invites in expertise across a range of channels.

Prototype Testing

Testing with an early prototype took place over two days on December 1 and 2nd, 2006, in the GLS labs at the University of Wisconsin-Madison. Sixteen kids participated in the workshop, ranging in age from 6th to 8th grade. Slightly more boys than girls participated, all had played games before, and at least half considered themselves gamers. Only one or two had made a game before – board games made as part of a school assignment. Several of the kids knew each other and arrived in small groups. We were interested in whether the kids wanted to make games alone or with their friends, and to what extent they wanted to share what they made: with their friends, with their parents, and with other kids in the workshop. We were similarly interested to see if there were distinct differences in how girls and boys approached the design of games, and if these differences translated into different attitudes about why they wanted to make games in the first place. Last, and most importantly, we wanted to learn if we had created something that interested them. If they turned their noses up at what we had built, we would need to rethink our whole approach.

We used two different formats during the workshop. In the first, two or three kids worked with me directly designing games on two computers. During the session, I tried to simulate the kind of in-game prompts and dialogues that will be present in the final version of the game, and the kids worked both with structured challenges and in open play where they could design games from scratch. In the second format, kids were given a quick introduction to the game, were shown the editor, and were then allowed to work on their own in a shared lab, sometimes with one kid to a computer and other times with two kids per computer. We were curious how quickly they could pick up the fundamental idea of the tool when left to their own devices, and how they might teach others about things being discovered as they made their games. We also wanted to know how long they would remain engaged and at what point they might wander off to play Guitar Hero or any of the other console games present in the game lab next door. Members of the GLS team observed through a one-way mirror in the first scenario and came in and out of the open lab in the second. All sessions were videotaped and recorded.

The results of the tests were very encouraging. While there is not space to document everything we discovered, I can offer some general observations. Please note that while future testing will include quantitative analysis with test groups of a much larger size the results presented here are primarily qualitative. Further, these early notes should be read as preliminary observations rather than actual research findings.

- The kids were deeply engaged in game making; when given the option to play a mini-game that came with the software or to build a game of their own, every child chose to build their own game.
- When given the choice to mod a game in progress or begin with a blank screen, approximately 90% of the kids opted to start from scratch. Players quickly learned that they could erase all of the elements of a partially built game; once this feature was discovered they moved immediately to erase all elements from the play area in order to create a new game 100% of their own design.
- An average session lasted 90 minutes and only ended when we needed to change groups. The kids did not lose interest during this time, and worked on their games throughout the entire session without stopping. Approximately 80% of them asked if they could keep working on their games; this group continued to make games in the computer lab, without an adult facilitator. When we gathered all the participants together at the end of the testing session, this group was eager to share their new games with the others.
- A small percentage of the kids who continued making games at the close of their official session chose to build levels for the game they had completed. Because there was no formal way to link levels in the prototype, players who decided to make levels had to come up with the idea on their own. They tended to name their games as a series (e.g., *Incredible 1, Incredible 2, Incredible 3*), and indicated on the game labels they prepared for each game that the games were part of a single, larger game.
- There were significant differences in how the boys and girls designed their games. In general, the girls were initially more thoughtful in their designs and spoke at the beginning of a session (as well as throughout) about what they wanted to happen in

their game. The boys shied away (at least initially) from describing their game concept at the outset and almost always immediately filled the play area with enemies. They also tended to build games that were less strategic and simpler than those of the girls. This is not to say that the boys were not thoughtful, but that it took them a bit longer to settle in to thinking about the kinds of games they could make. Once the boys filled their games with enemies and recognized that they hadn't made a very good game, in every case they erased what they had done and explored other approaches. In the end, the boys and girls made equally interesting games from a game design perspective, and we perceived no qualitative differences in the games they designed.

- There were other gender differences as well. For example, one group of three girls all built games without a shooting avatar. When asked why, they said that it made the game "too easy if you can shoot the enemies." Several of the girls also took advantage of the paint feature of the tool – the mouse could be used to paint tiles in the play area – and created game spaces that looked like an image of something. For example, two 8th grade girls created images of a teddy bear face and a spiral as the basis of their game board. We will need to find ways to allow kids to build play spaces with meaning; complex spaces that look like something, for example, whether these are "detailed spaces with ghosts," as was requested, or spaces with representational appeal.
- The kids tended to spend up to 15 minutes building their game before pressing Play to test it, even when prompted several times to do so. If we want to teach the principle of iterative design, and we do, we will need to build in a content structure that addresses this initial behavior. Because the software makes it incredibly easy to toggle between Edit and Play mode, we recognize that this behavior is closely connected to the way a kid thinks about the game design process. Kids clearly have some model in their mind as to the kind of process needed to create a game. For these game design novices, a game can't be played until it is nearly complete.
- One extremely effective challenge was to ask kids to design a game for their friend. This request seemed to focus them in a different way (the boys made really, really hard games for each other; the girls thought about the kind of game their friend might like). It appeared that the kids enjoyed playing each other's games, and continually chatted to each other while playing their friend's game,

comparing designs, talking about new game ideas, and speculating on what the next level or version of the game might look like. This type of challenge caused the social groups to mix, with boys and girls playing each other's games, and broke down the distinctions between those that knew each other prior to the workshop and those that didn't.

- There were no distinct differences in how quickly the kids picked up the skills to use the editor, between the facilitated and non-facilitated sessions, and the kids in the non-facilitated session were quick to turn into teachers for one another, yelling out things within minutes to starting that they were discovering and moving between computers to help each other out.
- About half of the kids preferred to build a game alone and the other half liked to build it together with a friend. There were no differences in gender here, with boys and girls equally split on how they wanted to design games. All, however, wanted their friends to play their games and every kid asked if they could continue to work with the game once they left the workshop. We are allowing the kids to do so, as we want to track how long they remain interested, and how the kinds of game they make either change or remain the same over time. If we want kids to use the game long-term, we must discover what new behaviors and needs emerge with ongoing use. This is an exciting aspect to consider and will require us to leverage the community and social dimensions of the experience.

This first small test demonstrated that kids are interested in the kind of game making *Gamestar Mechanic* offers. While there is still much to be done to translate many of the things observed into the game's design and associated curriculum, we feel that the basic project assumptions are solid, and we can move forward in refining our approach. We will hold a rigorous series of playtests with kids over the course of the next year, and look forward to learning more about what it is that kids are learning through design.

Design from Mini to Meta

Before digging into the specifics of the design principles governing *Gamestar Mechanic* and its associated pedagogy, it is useful to briefly explore the concept of *design,* and the fundamental principles of game design on which the project is predicated. We must remember that *Gamestar Me-*

chanic does not model game design generally, nor embody the game design process of all game designers. Like any game, it is an artificial system that models a specific ideological perspective, in this case, a perspective on how games work, and what it might mean to design them. More than anything else, *Gamestar Mechanic* models the way *some* game designers think – it models the way other members of my team and I think. While this might be seen as a weakness, it is hopefully a strength. If we want to show that a game can teach a particular way of thinking, it is better to begin with a specific perspective rather than an overly generalized one. So how does one think about design?

Donald Schön regards design as a material conversation with the forms, substances, and concepts of a design problem as they are being used. His design approach is both *process-driven* and *reflective*, emphasizing the iterative qualities of design. "In a good process of design, this conversation is reflective…the designer reflects-in-action on the construction of the problem, the strategies of action, or the model of the phenomena, which have been implicit in his moves" (1983, p. 79). Design historian Clive Dilnot, on the other hand, suggests that design *transforms* by exploring the tension between the existing and the potential.

> What design, as a mode of transformative action, allows us to see is how we negotiate the limits of what we understand, at any moment, as the actual. In design, in other words, we begin to see the processes whereby the limits of the actual are continually formed and re-formed. (1998, p. 69)

Consider a game of Tag. *Without* design we would have a field of players scampering about, randomly touching each other, screaming, and then running in the other direction. *With* design we have a carefully crafted experience guided by rules, which make certain forms of interaction explicitly meaningful. *With* design, a touch becomes meaningful as a "tag" and whoever is "it" becomes the one to avoid. The same is true of digital games as well. As game designer Doug Church has said, "The design is the game; without it you would have a CD full of data, but no experience" (2000, p. 3). In some sense, *Gamestar Mechanic* embraces each of these definitions, as it is structured around the concept of iteration. From a learning perspective, it is designed to enable a deep understanding of how a system of rules, behaviors, and relationships guide the design of an interactive experience, activated through play.

Embedding knowledge in practice: Principles, practices, roles. *Gamestar Mechanic* embodies a particular set of ideas, roles, and practices associated with game production. This is a way that as designers we embed knowledge in practice, capitalizing on the kinds of reflection-in-action that will undoubtedly take place. *Gamestar Mechanic* aims to teach basic game design fundamentals, as well as model basic practices of a game designer. Because designing games is a complex, multilayered design activity, the process of design is scaffolded through game design challenges, with game modification being the primary way players are introduced to both the elements of a game, and game design core principles.

In determining the knowledge base that forms the basis of the experience, we considered not only the core design principles to be taught, but also the range of activities players would need to experience if we were correctly modeling the practice of a game designer. In addition, we thought about the kinds of game design roles a player would need to take on during the experience, in order to fully embody the multiple roles a game designer assumes in their field. Taken together, this list of fundamental principles, best practices, and roles provide a blueprint for the *Gamestar Mechanic* experience, giving specific guidance to the testing and assessment components. Since we know the nature of the specific practices and concepts that define the kind of thinking we want to reproduce, we can work to embody these as best we can within the structure of the game itself. We can also test directly for evidence that players are taking on these roles: are they learning to speak, act, and think like game designers? Reproduction of these principles by players will help us to measure to what degree our design is working to teach.

Core game design principles to be taught. Game design is a complex, multilayered design activity, whereby systems of meaning (games) are created through the design of rule sets resulting in play. As products of human culture, games fulfill a range of needs, desires, pleasures, and uses. As products of design culture, games reflect a host of technological, social, material, formal, and economic concerns. Because rules, when enacted by players, are embodied as the experience of play, game design can be considered a second-order design problem. A game designer only indirectly designs the player's experience by directly designing the rules of play.

The real domain of game design is the aesthetics of interactive systems. As dynamic systems, games produce contexts for interaction with strategic and quantifiable outcomes. This interaction is often digitally mediated (videogames are played on computers, consoles, or other digital platforms) but not always, as much of the knowledge basic to the practice of game design applies to the design of non-digital games as well. Long before computers existed, designing games meant creating dynamic systems for players to inhabit. All games, from Chess or Go to *The Sims* and beyond, are spaces of possibility for players to explore. Designing this space is the focus of game design. Game designers construct gameplay, conceiving and designing systems of rules that result in meaningful experiences for players.

While it is very challenging to describe the fundamental principles of game design, an abbreviated list can help establish the groundwork for an understanding of this highly interdisciplinary practice. Fundamentals include understanding design, systems, and interactivity, as well as player choice, action, and outcome. They include complexity and emergence, game experience, procedural systems, and social game interaction. Finally, they include the powerful connection between the rules of a game and the play the rules create, the pleasures games invoke, the ideologies they embody, and the stories they tell.

Rules are a fundamental part of any game. Defining the rules of a game and the myriad ways the rules fit together is a key part of a game designer's practice. When rules are combined in specific ways, they create forms of activity for players, called *play*. Play is an emergent property of rules: rules combine to create behaviors that are more complex than their individual parts.

Because games are dynamic systems, they respond and change in response to decisions made by players. The design of the rules that guide how, when, and why a player interacts with the system, as well as the kinds of relationships that exist between its parts, forms the basis of a game design practice.

Game design is the design of systems of meaning. Objects within games derive meaning from the system of which they are part. Like letters in the alphabet, objects and actions within a game gain meaning through rules that determine how all of the parts relate. A game designer is responsible for designing the rules that gives these objects meaning.

There is a connection between the form and content of a game. Games are made up of game components, which include all of the objects that make up a game world. Components include game characters or markers, the play area, the scoring system, and other objects defined as part of the game system. Game designers must choose which components make up the game and assign behaviors and relationships to each of these components. Behaviors are simply kinds of rules that describe how an object can act. A game character might be able to run or jump – two different kinds of behavior. A door might be assigned an *invisible* behavior, which means that it cannot be seen on screen.

Game design – when done well – results in the design of meaningful play. Meaningful play in a game emerges from the relationship between player action and system outcome; it is the process by which a player takes action within the designed system of a game and the system responds to the action. The meaning of an action in a game resides in the relationship between action and outcome. The relationship between actions and outcomes in a game are both discernable and integrated into the larger context of the game. Discernability means that a player can perceive the immediate outcome of an action. Integration means that the outcome of an action is woven into the game system as a whole.

Players want to feel like the choices they make in the game are strategic and integrated. Game designers must design the rules of a game in such a way that each decision a player makes feels connected to previous decisions, as well as to future decisions encountered in the course of play. Degrees of randomness and chance are two tools that a game designer has at his or her disposal to balance the amount of strategic choice a player has in a game. Choice is related to the goal of a game, which is often composed of smaller sub-goals a player must meet to win the game. All games have a win or loss condition, which indicates what must be achieved in order to end the game. Because all games must have some kind of quantifiable outcome to be considered a game by traditional definitions, defining the win and loss states for a game is critical feature of a game's design.

Game design models player interaction on several levels: human-to-human interaction, human-to-technology interaction, human-to-game interaction.

- The Core mechanics are the experiential building blocks of player interactivity, which represent the essential moment-to-moment activity of the player, something that is repeated over and over throughout the game. During a game, the core mechanic creates patterns of behavior, and is the mechanism through which players make meaningful choices. Mechanics include activities like trading, shooting, running, collecting, talking, capturing territory, etc. Game design relies on the design of compelling, interactive core mechanics.
- Interaction between the player and an input device allows the player to control elements within the game space. Design of the input device is connected to the design of the game interface, which organizes information and allows a player to play the game. A game interface can be simple or complex, but should always provide a player with access to the elements and activities of the game.
- Interaction between different game components is defined by rules that describe what happens when these components interact. Does the ball (component) bounce (rule) off the wall (component) or smash (rule) a hole (object) in it?

Game design uses an iterative design process: a game is designed through an iterative sequence of modifications to the rules and to the behaviors of game components. Game design follows a cycle of design: playtest, evaluate, modify, playtest, evaluate and modify. It is through iteration that game designers achieve the right balance between challenge, choice, and fun.

Game designers tune or balance their game, so that it is not too easy or too hard for players to play, and work to create just the right amount of challenge. All games are made up of challenges or obstacles a player must overcome in order to reach the goals set forth by the game rules.

Game design involves the design of resources, or game components used by players during the game. Resources can include things like money, health, land, items, knowledge, or ammunition, for example. In some games, resources are parts of systems known as *game economies*, which determine how resources are managed and circulated, and how many of each resource might exist within a game. In defining economies, game designers must consider both the formal make-up of the economy and how players interact with it.

Games reward players in many different ways, which is one way that a game communicates, or gives feedback, to a player about their performance. Game designers have to make decisions about the kinds of rewards they want in their game on both a moment-to-moment level (did the player know that they killed the monster?) and on a game level (did the player know they won? Or that they raced faster than the last time they played?).

A highly interdisciplinary endeavor, game design involves collaboration between experts in graphic design (visual design, interface design, information architecture), product design (input and output devices), programming, animation, interactive design (human computer interaction), writing, and audio design, as well as experts in content areas specific to a game. Game designers must know how to speak the "language" of each of these fields in order to see the possibilities and constraints of their design. The intersection of constraints from each area with the rules of play shapes the game in innumerable ways and drive the design process forward.

CONCLUSION

When kids learn to design games they not only learn how to explore the possibility space of a set of rules but also learn to understand and evaluate a game's meaning as the product of relationships between elements in a dynamic system. In the rudimentary testing we did with the initial *Gamestar Mechanic* prototype, we observed kids thinking and speaking as designers of systems. We saw them able to articulate a set of rules that gave their system meaning and we watched as they shared their knowledge of this system by successfully playing and reviewing each other's games. Perhaps most importantly we witnessed their coming to an understanding of a design system and instantiating this understanding through the creation of fun, playable, and inventive games.

Educators and education advocates have recently acknowledged that the ability to think systemically is one of the necessary skills for success in the 21st century. We believe that game-making is especially well-suited to encouraging meta-level reflection on the skills and processes that designer-players use in building such systems, be they games or communities of practice. Membership in a community of game producers means sharing your thoughts and experiences with your fellow players. This ability to gain fluency in specialist language and to translate thinking and talking about games into making and critiquing them (and vice versa) suggests that games not only teach literacy skills but support their ongoing use. Rather than imagining that education can be transformed by bringing games into the classroom, researchers should consider not only the effects of the thinking engendered by those who play, but also by those who design the play.

There are additional implications as well. As a learning system, *Gamestar Mechanic* encourages risk-taking and learning in a low-risk setting. Learners can dive in first and learn through critical experimentation, developing hypotheses about how things work and testing out these theories within an iterative framework. They don't have to "play for keeps" until they are ready, and can rely a little or a lot on the expertise of peers within the community of developers. Each kid in our test group went about their design a bit differently, yet all saved and shared their games with immense pride and almost no prompting to do so. Such an attitude should mean a great deal to those invested in shaping the future of education. Agency and a sense of affiliation are most certainly two of those most difficult things to achieve, with or without the lure of games.

In closing, I am reminded of something the writer Jonathan Letham (2007) wrote in regard to the discovery of ideas and the importance of finding originality and creativity through building on existing knowledge. He talks about the idea of "undiscovered public knowledge," coined by Don Swanson, a library scientist at the University of Chicago. Swanson showed that standing problems in medical research might be significantly addressed, perhaps even solved, simply by systematically surveying the scientific literature. Left to its own devices, research tends to become more specialized and abstracted from the real-world problems that motivated it and to which it remains relevant. This suggests that such a problem may be effectively tackled not by commissioning more research, but by assuming that most or all of the solution can already be found in various scientific journals, waiting to be assembled by someone willing to read across specialties. While the production of new projects like *Gamestar Mechanic* are critical in our quest to better understand what it means to bring games and gaming literacies into any thinking about the future of education, it is equally important to continue to reassess what it is we already know and to bring our different disciplinary expertise to bear on our object of study. In doing so we can begin to develop hybrid frameworks that tie together theories developed for the study of text to theories developed for the study of habits, practice, and activity. I'd like to see this happen sooner rather than later and look to all those engaged in this debate as primary players in this endeavor.

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Notes

[1] Gamestar Mechanic Project Team: Alex Games, Jim Gee, Betty Hayes, Kyron Ramsey, Katie Salen, Eric Socolofsky, Greg Trefry.

[2] There are several different initiatives taking place worldwide focused on teaching kids to make games. Some include work with the software Game Maker® (www.gamemaker.nl), including work I have done with university level students (retroredux.parsons.edu; dt.parsons.edu/mobilegamemosh), the Game Making in Education project in Australia (http://www.groups.edna.edu.au/course/view.php?id=81), as well as the Summer Game maker competition, run by Education World (http://www.education-world.com/At_Home/student/student029.shtml). The Making Games project, run out of the Centre for the Study of Children, Youth and Media by Caroline Pelletier, Dr. Andrew Burn, Professor David Buckingham, used a piece of custom designed game making software. (www.lkl.ac.uk/research/pelletier.html)

[3] Other precedents for the project include games based on level editing like Line Rider© (2006), Bridge Builder© (1998), Junkbot© (2002), Block Action© (2006); games where design is the basis of play: Okami® (2006), Magic Pengel: The Quest for Color® (2003); software experiences based on user-customizable parameters: Polly's World© (2000), Sodaplay© (2001); and games about game design: the Game Game© (2005).

[4] "Everyday Now: Kids, Games, and Learning online dialogue" (2006). "Dialogue 1: Power, Play, Participation." http://community.macfound.org/openforum

[5] PEW Internet, Teens and Technology report (2005). http://www.pewinternet.org/report_display.asp?r=162