DISTIL Interactive

Serious Games: Transforming Learning through Well-Designed Play

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Why Serious Games?

Educators have long realized the benefits of play in enabling childrens' learning (cf. the writings of Jerome Bruner, Jean Piaget, Lev Vygotsky). Through games, children learn not only the rules of the game but also how to employ logic, think strategically, and solve problems (Pepler & Ross, 1981). Games also enable children to practice soft skills such as navigating social heirarchies, employing communication strategies, and how to "fight fair" (Klugman & Smilansky, 1990). Finally, games provide intrinsic motivation – children participate willingly often just for the sheer joy of engaging in play, and require no outside incentives to continue playing (Gee, 2003). Unfortunately, the benefits of play are not as well adopted in dealing with adult learners, in which "playtime" is often discarded in favor of information-heavy, didactic approaches in which the ultimate goal is mere knowledge transfer. Recently, however, the growing popularity of computer games among both children and adults has sparked a renewed interest in the merits of game play for adult learners. This is hardly news to seasoned educators, who have long recognized the pedagogical value of hands-on exercises, problem-based learning, case studies, and paper-based simulations in the adult classroom.

The emerging field of serious games offers us the unique opportunity to create learning environments that are "hybrids" – a blend of experiential learning and entertaining activity that teaches adults by situating the learning in a real-world context. These realistic learning contexts provide the motivation to play, give players the opportunity to make decisions and solve complex problems, and allow for skills practice in an environment in which mistakes lead only to lost points, not more dire professional consequences. In short, serious games allow us to move beyond knowledge transfer and testing and into the realm of real-world competence. Questions remain, however, as to the efficacy of serious games as learning tools. In a recent review of the research conducted to date on the effects of computer games on learning, Egenfeldt-Nelson (2007) provides a cautiously optimistic outlook. He concludes that, in general, computer games seem to have beneficial effects on learning across a number of domains, but points to some consistent methodological flaws in the literature; namely the lack of data comparing games to traditional teaching methods. From our perspective, games are tools that supplement the learning experience, and not necessarily

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replacements for either qualified instructors or additional teaching materials, thus the argument for superiority of games over traditional methods seems unneccessary. Rather, we argue that games are particularly well-suited to helping learners aquire particular types of skills, for example, understanding complex processes (Reese, 2007), learning to react appropriately during high-stress situations (Rossett, 2004), and gaining experience in soft-skills competencies that would be either too costly or difficult to orchestrate in face-to-face sessions.

Egenfeldt-Nelson (2007) also acknowledges the difficulties inherent in comparing results from commercial off the shelf games with those designed primarily for learning. As an organization that creates games specifically for learning purposes, it is not the intent of this article to discuss the merits of entertainment games used in learning contexts. In regard to issues surrounding the lack of data, the fact remains that the field of serious games is in its infancy, and scholars are just now acknowledging the need for well-designed experiments testing their efficacy. All the while, organizations similar to ours are creating a variety of serious games environments, primarily for use in industry, and therein lies some of the gap between theory and practice. Once a game is in use within an organization, the type and quantity of data gathered are at the discretion of the organization, and are not generally publicly available. Indeed, many researchers are at a loss to find organizations willing to commit to the oftentimes intrusive process of becoming part of a large-scale research project.

Simulations vs. Games

We can certainly point to the efficacy of simulations (e.g., military strategy sims, flight simulators) used in primarily military applications, but simulations differ in several respects from serious games. Simulations strive for completely authentic, high-fidelity representations of reality. These products tend to be large-scale 3-D environmnents that take years to develop and have price tags that are out of reach of most organizations. Additionally, simulations are not necessarily games. Whereas simulations attempt to provide the learner with a completely accurate portrayal of everything that could possibly happen in a particular situation, games allow for more exploration and freedom of choice for the learner within the boundaries of what you want them to learn. Games provide rules and structure to an experience, in order to frame the skills that the player will acquire from interacting with the environment. Both approaches have their utility from an educational standpoint -- the advantage is that serious games are well within financial reach of most organizations, while full-blown simulations are not accessible. In addition, simulations are often not necessary for the type of learning outcomes required by most organizations. Simulations are expert tools, allowing a user to explore the unknown through an infinite number of possibilities, while games are novice tools, allowing a user to explore safely within the boundaries of the known. Finally, simulations do

not always contain the learning supports required by the novice user or learner who lacks the requisite background knowledge. Such supports are an integral part of the serious games design process, as they are the key to ensuring that learners master the required objectives.

Serious ID

In the fledgling field of "Serious ID" (i.e., instructional design of serious games), there are many questions that remain unanswered as to choosing the "right" model or instructional approach. Among the most common questions: do designers attempt to fit traditional models of instructional design to games; do they stick to game design principles with "added learning elements", or should the field adopt a novel instructional approach? The debate currently rages, and scholars tend to adhere to one of two positions: the belief in the need for one grand unified theory of instructional design that applies to serious games (broadly defined), versus the blunt assertion that there will never be one theory or model that can adequately cover the breadth of game genres that are currently used in the learning space.

Rather than wade into the debate, we prefer to acknowledge that design for games is fundamentally different from standard instructional design, as it involves elements that blend traditional instructional design with game design in a manner that best fits the needs of the learner. The design process for serious games is an iterative interaction between these (sometimes opposing) approaches, requiring the talents of a multidisciplinary team that works together to create the right synergy between learning elements and gaming environments. Such an approach requires adopting elements from several instructional models -- utilizing those elements from each that best support learning outcomes across a variety of game genres. It is through such a blended model that designers can create experiences that are fun and engaging, and at the same pedagogically sound.

In crafting our design philosophy, we have drawn primarily on the work of three educational scholars. Our focus on motivation comes from Knowles' (1980) early work on adult learning, our basic framework draws from Merrill's (2001) instructional principles, and the approach to providing feedback and guidance comes from Gagné's events of instruction (Gagné & Briggs, 1992). It has been our experience that elements from these various theories work best when used together to craft the learning experience. To that end, our games contain four types of learning elements: the game environments themselves, the content that is presented to players, the game elements designed to enable learning, and the educational supports that provide feedback and guidance to the learners.

Learning Environments

The goal behind the design of our learning environments is to create psychological realism for the player in order to facilitate real-world thought processes. This aligns well with Merrill's (2001) principle of "engaging the learner in solving real-world problems". We understand that players don't always require photorealistic, 3-D settings, as it is more important for them to feel psychologically immersed in a situation than to have graphics that appear perfectly lifelike. Indeed, we strive to minimize the extraneous cognitive load that can arise from situating learners (especially those who are not technologically sophisticated) in overly complex environments that detract from the learning objectives, while retaining sufficient challenge to inspire thoughtful engagement in the game (cf., van Merriënboer & Ayers, 2005). Our aim is thus to provide settings and situations that mirror learner's real world experiences, in terms of the characters they interact with and the problems they are faced with solving. These settings and situations are then placed within an environment designed for easy navigation, clear expectations for performance, and enough supports to enable the player to guide themselves through the learning at their own pace.

In describing our learning environments, we use the term "genres". Much like different film genres that elicit particular kinds of responses from viewers, our game genres are carefully designed to create different kinds of learning experiences for players. The different genres each reflect careful attention to the work of Knowles (1980), who contended that adults must be treated as independent, motivated, creative problem-solvers with a wealth of prior life experience. These genres acknowledge the unique talents that adult learners bring to the table, and allow for very sophisticated interactions with the gaming environment. The current genres include: awareness games designed for knowledge transfer and internalization; evidence games in which the player seeks and evaluates information that supports their mission objectives; procedural simulations designed to invoke real-world decision-making under pressure; process management games that immerse the learner in a complex process or system; and soft-skills games in which learners must use effective communication skills to gather information from engaging avatars.

Awareness. The primary purpose of awareness games is knowledge transfer. While some might argue that traditional methods of content delivery are sufficient to support the transfer of content, we propose that games provide a vehicle that helps learners to personalize the experience. In our awareness games, players must make decisions about courses of action, and provide advice to in-game characters. In the process, the learner internalizes the information presented. This allows the transfer of knowledge to move from the lower cognitive levels such as Bloom's (1956) levels 1 & 2 to the higher thought processes such as application, analysis, synthesis, and evaluation.

Evidence. Evidence games ask the player to find important information, whether through environmental observation, careful review of records and documentation, or discussions with in-game characters. Once evidence has been gathered, players must make judgments about the relevance and utility of the information, and then make overall evaluations and recommendations based on the evidence found. Players are challenged to use their skills in first locating the relevant information, and then must demonstrate their knowledge in evaluating their evidence against relevant criteria, thus showing their expertise with regard to the standards which they are evaluating against.

Procedural Simulation. In procedural simulations, the learner is placed in a situation in which they directly affect a course of events through careful decision-making and subsequent actions taken as an event unfolds. In the case of emergency preparedness and response, for example, players go through a hazard analysis process in order to unlock a series of procedures they can use during an emergency. In the simulation part of the game, an emergency unfolds and the player must apply the procedures at their disposal in order to react to events as they arise. The true learning in this game takes place through failure: as players watch an emergency spiral out of control, they can go back and re-evaluate their hazard assessment, thus gaining additional and/or different procedures. Upon repeated run-throughs of the emergency, players come to understand the optimal ways of responding to events, and refine their skills at conducting a hazard analysis.

Process management. Process management games are designed to help players understand complex processes from the inside – by being immersed in the management of the process from start to finish. This creates a problem-centred environment (Knowles, 1980), and allows for learning in an environment where an 18-month process can be compressed into a one-hour play session. Players learn about the inner workings of a complex system by being immersed in managing the process for implementing the system, and are faced with increasing challenges in the form of resource, time, and staffing constraints encountered in subsequent game levels.

Soft-skills. Soft-skills games involve two key competencies: managing interpersonal interactions, and achieving the informational goals involved in the interaction. Players are given the task of extracting some form of information from their conversational partner, but must ensure that the techniques they use are valid both in terms of proper questioning (as defined by the appropriate organizational protocol) as well as management of the overall emotional tone of the interaction.

Learning Content

The content creation process for serious games is one area in which our process differs somewhat from standard ID practice. For many

instructional designers, the course content already exists through documentation, manuals, and standardized tests, and the challenge for the designer is to "bring the content to life" through innovative delivery. Our process requires that we have general content outlined at the start of the game design process, but we retain some flexibility in working with our clients to craft content that fits the game environment perfectly. The technical content for our games comes directly from an organization's subject matter experts (SMEs). We realize that many SMEs are not content designers, so we are very careful to guide them through our own content design process, which is a blend of applied cognitive task analysis (Militello & Hutton, 1998) and heuristic task analysis (Lee & Reigeluth, 2003). The goal of our content design is to involve the SME during the early planning stages to ensure that the game environment will support their needs, then conduct a series of interviews designed to extract expert knowledge of the general game interactions and situations. Following the interviews, the SME is guided through content templates designed to extract information that is increasingly more specific and technical. This content is then incorporated into the game, and modified in consultation with the organization to enable smooth game play.

Gagné and Briggs (1992) stress the importance of calling on a learner's prior knowledge and presenting the appropriate stimuli to learners. To that end, we ensure that we cover learning content across a number of levels of sophistication and detail. The technical knowledge embedded in our games comes primarily through organizational documentation (including previously-generated learning materials) and SME-generated game-specific content. This material involves the generic information about the simulated environment, e.g., the kind of organization or location for the game play, the specific standards, guidelines, or corporate materials that are to be incorporated into the game, the personality descriptions of the in-game characters, etc. In addition to this information, we pay careful attention to the audience model, and target the content to the appropriate organizational levels and job roles.

As we drill down through the content design process, we work with SMEs to create the knowledge that an expert in a particular professional role would have – we can then embed this expertise in the game through a number of scaffolding and feedback mechanisms. This role-relevant knowledge also allows us to create plausible action paths (both correct and incorrect) for the games, and provides some guidance about game balancing and scoring based on competence demonstrated by the learner during game play. We realize that learners come to the game environment with varying levels of background knowledge and preparation. We ensure that SMEs provide sufficient detail about processes, roles, and terminology so that we can create learning aids that provide basic, intermediate, and advanced support to learners. To that end, we layer the content throughout the game environment in varying levels of complexity. We create general-level definitions, explanations,

and "hints" that can be accessed by learners who need additional support, but these learning elements can easily be ignored by more sophisticated players.

Serious games offer an interesting forum in which to enable sophisticated learning objectives. Much like programs involving mentoring or apprenticeship, the gaming environment allows the learner to demonstrate behaviors and complex problem-solving within the game. This implies that serious games are an ideal medium in which to expand beyond content mastery and demonstration of factual knowledge. Each game genre lends itself to different kinds of learning objectives: awareness games involve some content mastery, but also allow for more affective understanding that involves internalization of values and personalization of the material; evidence games allow the learner to master their skill at detecting and evaluating complex information against set criteria; procedural simulation games allow learners to demonstrate good judgment under pressure and increased sophistication in problem solving as the game progresses; process management games allow learners to demonstrate their understanding of situational constraints and trade-offs, and their ability to implement an effective system from start to finish; and soft skills games provide an arena for learners to demonstrate their skill at managing interactions with varying personality types, and their competence in extracting relevant information from different sources.

Learning Elements

We believe that game elements serve two primary purposes: to enable the player to achieve the desired learning objectives, and to ensure that the game is engaging and interactive enough to encourage motivation and immersive play. In choosing appropriate gaming elements, we adhere to Knowles' (1980) ideas about the independent nature of learners and Merrill's (2002) principle of application: in which people need to demonstrate their knowledge by applying it to problems. At the same time, we must never lose sight of the fact that learning, while it can be immensely rewarding and satisfying, is not typically seen as enjoyable. Despite this, the cardinal rule of game design is that games must be *fun*, even if the games are designed for the much more serious purpose of education (Aldrich, 2005).

In achieving the desired learning objectives, our games must be designed to enable the player to safely explore options, try out strategies, and problem-solve in an environment in which failure is a critical part of the learning process. Some games offer players the freedom to navigate through the environment and learn from the people they meet along the way. Other games provide more structure, with decision points that impact the flow and outcomes of the game. Still others ask players to interact one-on-one with in-game characters, in order to gather evidence or demonstrate their skills at communicating.

Depending on the high-level learning objectives, the games may involve a mission structure, a free-form environment, simulated events, or process maps or combination hereof to aid in understanding complex systems. The key is in crafting the game elements in a manner that best supports the kind of learning that will take place within a particular environment.

In addition to all the serious learning elements, games must still be fun and engaging in order to maintain the learner's interest and desire to interact with the environment. To that end, game elements must include humor, encourage interactivity wherever possible, and be pleasing to the player from both a visual and auditory perspective. Our games are designed to maximize visual impact, and sound is used sparingly to highlight key actions, as bombarding the player with stimuli from too many different modalities (e.g., text, graphics, animations, sound) can lead to an increase in extraneous cognitive load, which in turn will actually decrease engagement and retention (Mayer, Hegarty, Mayer, & Campbell, 2005). To create maximum visual impact, our games involve custom designed environments and characters, which are housed in an easily navigable format which encourages exploration without frustrating novice gamers.

Where relevant, games include scoring, which instils a sense of accomplishment and acts as a reward to the player. Scoring is not used in a punitive manner, however, as one of the advantages of learning through games is the ability to learn from your mistakes in the form of failed missions or unmet objectives. Some games include time constraints to increase the sense of urgency and immerse the player in the environment. This encourages rapid-fire decision-making under a moderate amount of stress. Once the timed portion ends, however, players have the opportunity to reflect on their decisions and craft a new strategy in a non-timed game segment.

Learning Support

Players need help not only navigating their way through the game environment, but also guidance that is designed to help them to reflect on their learning and understand the implications of their decisions, which ultimately leads to achievement of the desired learning objectives. Included in Gagné's events of learning (Gagné & Briggs, 1992) are three elements regarding guidance: providing learning guidance, providing feedback, and assessing performance. In DISTIL's games, we view this in-game guidance as a form of mentoring, and use it to help players incrementally improve their understanding, decision-making, and ultimately their performance. Our games employ several techniques for providing just-in-time information, advice, and performance feedback.

Supplementary information is provided to players through a number of game mechanisms. For those who need help understanding concepts

and terminology, the games provide glossaries that can be accessed as needed. The games also involve scaffolding elements through pop-up information boxes and advisor characters that provide just-in-time hints and information to guide play. In games involving complex procedures and technical documentation, players need access to large amounts of text in aiding their decision-making. Our games embed this documentation through the use of pdfs and images that are easily accessed within the game environment. We believe that asking players to "leave the game" in order to access reference materials disrupts the flow of game play and leads to a less immersive experience. We do acknowledge however, that different types of learners have different preferences for accessing information, and as a result, we also offer a print option for players who prefer to have hard copies of information at their disposal. Beyond merely accessing information, our games are designed to encourage players to refer to their documentation at relevant times during the game play, to ensure that those who might not understand how the documentation is to be used are prompted to do so appropriately.

In terms of assessment of game play, our focus is on using targetted performance assessment to provide timely guidance, much like an instructor providing formative assessment during classroom activities. This kind of on-demand feedback provides learners with a powerful tool in guiding their future behavior and decision-making, and significantly enhances the learning experience (Sadler, 1998; Moreno & Mayer, 2005). Our methods for assessing performance are varied, depending on the game genre, and may include in-game scoring, just-in-time praise (or warnings) from in-game advisors, and post-game evaluation, or some combination of all three. The key to our assessment is in mining player data to assess demonstration of the key learning objectives and providing the players with feedback that not only points out shortcomings, but also praises good performance and provides strategy hints for improved results on subsequent game plays. Our assessment also provides instructors with data regarding the performance of learners, and can be used to evaluate overall impact of the learning tool in an educational program. We believe that at its core, educational assessment should involve quantitative performance data that goes beyond what can be provided through standard knowledge testing. Serious games are the perfect medium to provide us the opportunity to gather and analyze such data and pass it along to the client organization.

Summary

While serious games provide an ideal option for organizations looking to bring innovation into their learning program in the form of competency-based skills training, games alone are not a learning panacea. The art of making engaging and interactive games must be combined with the science and techniques from the field of instructional design. Game genres, combining proven game and instructional design elements,

provide players with a variety of learning environments tailored to the specific needs of both the learner and the organization delivering the learning. A systematic approach to generating the learning content, using proven techniques like cognitive task analysis and heuristic task analysis, ensures that what is in the game supports the learning outcomes. Learning elements and support, such as scaffolding, mentoring, and assessment, must be carefully considered to support the learning outcomes without interfering with the intrinsic motivation – the fun – of the game. When these elements come together, as they do in DISTIL's learning games, the result is a new way of enabling students to learn skills and behaviors that is built on proven learning principles.

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