Different Strokes for Different Folks: Tapping Into the Hidden Potential of Serious Games

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ABSTRACT

Digital game-based learning experiences are typically presented to a captive audience that *has* to play, as opposed to entertainment games that players can select themselves and choose to play. The captive nature of learning games introduces an interesting issue: not everyone may be familiar with the genre of the game they have to play or be motivated to play it. Students have individual differences that may make a learning game particularly ineffective, uninteresting, or inappropriate for some learners. We present work that frames important differences between students in terms of their game literacy, motivation, goal orientation, and mindset. This understanding leads us to envision game design variations to serve specific combinations of particular individual differences at the intersection of learning and gaming. We present our initial work on identifying and automatically accommodating these differences within a single digital game-based learning experience.

KEYWORDS

Player motivation, play style, adaptive games, learning games, mindset, genre, gaming literacy

INTRODUCTION

Computer games for entertainment are purchased from stores, played online at certain websites, or borrowed from friends as part of a selective, free market culture of choice. Game players decide what games they want to play, when and where they will play them, etc. In other words, playing games for fun is a voluntary and highly selective experience games for learning, on the other hand, can be quite the opposite. There are informal learning games, mainly distributed on the Web, which players can voluntarily choose to play, however there are many other learning games that are presented within the context of a school or training curriculum. Serious games played within a military training context, as part of a high

school curriculum, or used in corporate training are relatively involuntary mandatory learning experiences that are equivalent to assigned lab experiments, interactive training videos, simulation exercises, etc.

Games for learning face a much more diverse player audience than players of entertainment games because the audience is not self-selected. A learning game's audience may include those who rarely play any kind of game (i.e. "non-gamers") and those who dislike and normally avoid playing the genre used by that particular learning game. The ramifications of this are obvious, though surprisingly overlooked in the digital game-based learning community at present: while certain games may be fun for many people (e.g., the Civilization series of games are some of the best selling games ever and are widely used as educational games (Squire, 2005)), they may not be "fun," "engaging," and "motivating" for an entire class. Even the most wonderful learning games may capture some or most, but undoubtedly rarely all, of a target audience.

If the only consequence of using a learning game to non-gamers is a lack of fun, there would be little cause for concern. However, unfamiliarity with gaming in general or with a particular learning game genre can present barriers to achieving learning goals. A player must effectively master how to play a learning game in order to experience the desired learning content. From the perspective of cognitive load, we might infer that mental attention devoted to trying to figure out how to play is attention not devoted to the intended learning (Mayer, 2005a; Mayer, 2005b). Non-gamers need to exert much more effort figuring out how to play most games than do experienced gamers. Furthermore, feeling lost and incompetent trying to play a learning game introduces negative thoughts that can create performance deficits by diverting cognitive load (Cardinu, Rosabianca & Kiesner, 2005; Croizet et al., 2004), with negative consequences for learning (Covington, Omelich, & Schwarzer, 1986; Thomas et al., 2006). Other students may have extensive gaming experience, but may find playing a particular learning game uninteresting or even unpleasant, regardless of their interest in the subject matter the game is designed to teach. In other words, using games for learning as a one-size-fits-all educational approach leaves some students unmotivated and presents others with a distinctly unfamiliar and potentially inscrutable experience.

Individual Differences

This inherent disparity in the effectiveness of even well designed serious games is a problem that need be addressed by recognizing important individual differences between students and changing our game design and development practices to accommodate those differences. We contend that four key obstacles to digital game-based learning should be considered in this respect: gaming literacy, gaming motivation, gaming mindset, and the congruence of student's goal orientation with the game design. This is in contrast to Low (this volume), who states that goals, intrinsic vs. extrinsic motivation, interest, and self-schema are the main motivational principles.

Gaming Literacy

K-6 education teaches reading, writing, and oral language, carefully preparing students to learn from books and other forms of writing (ACEI, 2007). K-12 education does not teach gaming. Gaming literacy is acquired (or not) outside of school, through voluntary leisure activities. In order to learn from a game, players must learn how to play and they must experience the intended learning content by playing. Salen (2007, p. 10) points out that "learning about games and learning with games take place simultaneously." Players must figure out how to "read" the game. They must understand how systems operate within a game, what actions are and are not possible. Simple learning games tend to be designed with a goal of

providing the same learning experience to all players. Researchers have noticed that in the case of complex games like Rollercoaster Tycoon, different student players are motivated to develop specific areas of expertise (Foster & Mishra, 2009). Myriad obvious and not so obvious factors about the game and the learner contribute to successful learning from a game. Gaming literacy plays an obvious role.

Like other media, games are often categorized by genre. The classification helps audiences locate preferred content and provides designers with a core framework to work with. Each individual game has its own unique learning curve, but games in the same genre typically share similar mechanics and gaming conventions. A player who has a lot of experience playing games in a particular genre has developed genre-specific literacy. He or she will almost certainly have an easier pathway to learning how to play another game in that same genre than those unfamiliar with the genre. Learners who are less experienced with the genre used by a particular learning game will have to work harder to learn how to play the game than players experienced with that genre, before they can focus on learning the content the game is intended to teach.

Serious games that emulate a known genre inherit player expectations and player expertise. Serious games where the designers do not follow any common genre present all players with a new learning curve. Although unique game designs sound like they would equalize the gaming literacy disparity, designers start from scratch, inventing how play happen and thus fail to capitalize on decades of game design progress (This helps to explain why educational games have historically been considered not very fun). Gaming literacy, including game genre literacy, has deep implications for learning game design. The needs of novices and experts both need to be accommodated.

Motivation

Motivation refers to needs, goals, interests, concerns, and other kinds of pleasures or pains a learner experiences or anticipates experiencing as a result of trying to learn something; it is a central correlate to learning. Students who are more motivated either due to intrinsic fascination with the subject matter or extrinsic desire to earn good grades are more likely to learn (Lepper & Henderlong, 2000). Successful commercial games attract players because they are fun and engaging, using both intrinsic and extrinsic motivation to entice players. Consequently, a key reason that teachers consider using learning games in their classes is in hopes of motivating their students. The motivational benefit teachers anticipate from using a game can range from a modest hope that students find it "more fun than a boring lecture," (Winn & Heeter, 2007) to an idealized expectation that great games engender great pedagogy to such an extent that they "recruit learning as a form of fun and mastery" (Gee, 2007b). Different students may be intrinsically or extrinsically motivated to learn the subject matter (or unmotivated). Gaming adds another level of motivation. Players may be motivated by intrinsic and/or extrinsic rewards within the game, separate from their interest in the subject matter.

Mindset

Achievement or goal orientation refers to how individuals perceive and respond to achievement situations (Dweck & Leggett, 1988). Theories about mindset and motivation suggest that some individuals welcome hard challenges and others avoid failure. According to Dweck (2006), mindsets can "change the meaning of effort" (p.39). She explains that people with a Mastery mindset relish challenge (Dweck, 2000, 2006). They find easy challenges boring and are resilient in the face of failure because they believe in their capacity to learn and improve. The converse is a Fixed, or Helpless mindset. People who have a Fixed mindset worry about how they are performing instead of whether they are learning. They seek easy challenges to avoid failure and validate their self worth. Dweck describes American popular culture as rein-

forcing the idea that people have to either be smart or hardworking, but not both, to succeed. Our culture expects and reveres effortless perfection. Mindset theories have deep implications for game design because players who play with a fixed mindset will be overly worried about failure in the game, whereas players with a mastery mindset will relish learning through trial and error.

Congruence of Goal Orientation

Matching teaching methods to learning styles has not been shown to impact learning (Coffield et al., 2004). However, a related psychological theory, the theory of regulatory fit (Aaker & Lee, 2006), does support the idea of matching goal orientation with process to increase motivation and learning. Higgins proposes "people experience regulatory fit when the manner of their engagement in an activity sustains their goal orientation or interests regarding that activity" (Higgins, 2005, p. 209). The theory distinguishes *eager* and *vigilant* goal orientations. Someone with an eager goal orientation is trying to satisfy a need for accomplishment; he or she seeks positive rewards from an activity. Someone with a vigilant goal is trying to satisfy a need for security or to fulfill a sense of duty; he or she wants to avoid negative consequences.

Individuals have a predilection towards either vigilance or eagerness but researchers have also found they can manipulate goal orientation based on how instructions for a task are described. These variations seem subtle but have profound consequences. Regulatory fit between goal orientation and task behavior strengthens engagement. It has a magnifying effect – it makes you feel worse about a bad thing, or better about a good thing. The idea of regulatory fit has interesting implications for learning game design. Learning games could either cater to individual differences by providing two distinctly different modes of play, each designed to maximize either eager or vigilant play or they could frame game play to help induce the goal orientation that best suits the game mechanics.

Proposed Solution

These four critical ways individual learners may differ when they are exposed to a new digital game-based learning experience are likely to impact engagement with and learning from a game. Unfortunately, games for learning are not typically designed with these individual differences in mind. The game industry has begun to consider how games might appeal to diverse player preferences in the entertainment realm such as gender- and age-related predilections (for example, see Kafai et al., 2008); but the kind of fine-grained analysis of student needs and interests (and resulting design accommodations) we introduce in this chapter has simply not been done to date. Once we reach a sophisticated understanding of the variations in gaming literacy, motivation, and mindset that students can have, what can be done with that knowledge to design better, more effective games for learning?

The initial step to improving the efficacy of learning games is to map the most important individual differences among students noted above to possible game design features. For instance, we need to understand how a game should be different for those with extrinsic versus intrinsic motivation or what features of games such players enjoy (and dislike) the most. We need to arrive at a set of design principles that can help designers better target a varied student population (a similar approach is described in (Low, this volume)).

Once we have a firm understanding of how individual student differences can map to potential variations in game designs, we have to answer the question of how these different design principles can be incorporated into the design of games for learning. The obvious, brute force approach is to simply publish

multiple versions of a game that reflect the different combination of learner motivations and gaming literacy (e.g. one for intrinsically motivated gamers, one for intrinsically motivated non-gamers, extrinsically motivated gamers, one for extrinsically motivated non-gamers, etc.). Developers could then ship these multiple versions as distinct games.

Alternatively, the variations could be shipped as a single game with different "modes," giving the player the power to choose the learning mode they prefer. This approach would essentially allow players to self-diagnose their individual differences and decide what kind of game would be best for them. This approach does have possible drawbacks, however. For instance, player self-perception of differences may not be terribly accurate, thus failing to optimally match game style with a player's true motivational and literacy needs.

An alternate approach to self-selection of game variation would be to automatically identify or detect each student's individual differences (i.e. game literacy, motivation, goal orientation, and mindset) and assign game mechanics based on that assessment. Automatic assessment could be done in one of two ways: asking the player to answer a questionnaire before playing the game that would help map the player to a certain player type or to have them play a diagnostic game that provides enough feedback through gameplay for the system to recognize their player type from observation. The former is a much more straightforward, though obvious and obtrusive, approach while the latter is much less direct, but more difficult to execute. The end result with either approach will be a seamless game experience where students begin with an assessment period and then are provided with a game experience that is accurately mapped to their player type.

This chapter will explore in more detail the individual differences in motivation, mindset, and goal orientation we have highlighted here and how those can potentially relate to game design. We explore the mappings from player types to design principles. Finally, we present a prototype game, called S.C.R.U.B., which employs our theories on player types and game design, and discuss future work.

BACKGROUND

Motivation to learn varies from student to student and it can be different for each individual depending on the topic. Students' motivation to achieve at school can be based on extrinsic goals external to the learning content such as earning good grades or teacher approval. Intrinsic goals can also motivate learning, such as the pleasure of mastering a new topic or content being learned, curiosity about the subject matter, or the sense of expertise as knowledge grows. Intrinsic and extrinsic motivation can coexist, but as we will discuss later, offering learners extrinsic rewards can have a detrimental impact on intrinsic motivation (Lepper & Henderlong, 2000). Studies show that students generally have higher intrinsic than extrinsic motivation, but that intrinsic motivation declines significantly between third and eighth grades (Henderlong & Lepper, 2000).

Adding motivation possibilities to a game for learning adds complexity to an already complex milieu. In general, games are motivating for students who love games. However, games are likely to interfere with learning for students who dislike games. Games also vary in the extent to which they offer intrinsic and extrinsic rewards (Heeter et al., 2009). Some game genres appeal more to extrinsically motivated player types (called Achievers) who enjoy earning high scores and winning, while other game genres attract intrinsically motivated players who enjoy discovery, collecting, and role play (called Explorers)

(Bartle, 1991; Yee, 2006). As we will discuss in this section, research shows that the individual student differences of motivations, mindsets, and goals affect a student's learning experience.

Intrinsic Motivation and Learning

Intrinsic rewards arise from the process of learning or play and extrinsic rewards from the results (grades, points, winning, or approval). Intrinsic goals internal to the act of learning can motivate learning, such as the pleasure of mastering a new topic, prior personal experiences related to the subject matter, or the sense of expertise as knowledge grows. Fostering intrinsic goals can create self-directed learners and expand a student's productivity into other areas (Low, this volume). Experimental schools such as Montessori schools are rare exceptions, which nurture intrinsic motivation to drive learning. Rather than structuring a learning progression through standardized curriculum and standardized grades, Montessori tries to instill an internal sense of purpose. They avoid setting learners up to compete for the highest grade in the class. According to Montessori president Tim Seldin, "Students learn not to be afraid of making mistakes; they come to see them as natural steps in the learning process." (Seldin, 2008, p. 2). Maintaining this level of intrinsic motivation is important as removing it may hinder the student's learning experience (Low, this volume).

Beswick (1971, 1974) found that intrinsically motivated individuals need time to explore. He explains that intrinsically motivated individuals "tend [to] be more aware of a wide range of phenomena, while giving careful attention to complexities, inconsistencies, novel events and unexpected possibilities. They need time and freedom to make choices, to gather and process information…" (Beswick, 2007, p.1). Therefore, intrinsic motivation and extrinsic motivations cannot always be equally well served. For example, meeting the need of time to explore can directly compete with competition based on a time limit.

Extrinsic Motivation and Learning

Formal education tends to be structured to use the threat of poor grades to motivate homework and learning. At the beginning of a semester or school year, teachers describe how standardized grades will be fairly assigned. Students are expected to do what is necessary to "pass" or better yet to excel on the exams and other kinds of performances. Report cards document standardized achievement, informing students and parents about the learner's performance. In the context of this kind of achievement-focused education, learning scientists have looked at the impact of *achievement orientation* on learning, which refers to how individuals perceive and respond to achievement situations (Dweck & Leggett, 1988). People who have a high achievement motivation enjoy challenges much more than those with a low achievement motivation (Lee, Sheldon, & Turban, 2003).

Additionally, Elliot and Church (1997) considered two quite different reasons individuals might have for pursuing extrinsic, performance goals such as grades. *Performance-approach goals* are linked to displaying competence and earning a favorable judgment. *Performance-avoidance goals* focus on trying to avoid failure. Elliot and Church found positive outcomes for performance-approach goals including positive emotions and absorption in the given task. Performance-avoidance prompted efforts to escape potential consequences of failure and was associated with anxiety. Performance-avoidance interfered with mental focus, blocking the individual's ability to concentrate and become absorbed in an activity, while the performance-approach goals approach enhanced mental focus.

Mindset

Dweck (2006) made similar observations as to Elliot and Church's work. She studied how people approach or avoid challenge in a school context. She found that about 42% of students have what she calls a growth, or Mastery mindset. These people believe that intelligence is malleable; that they are capable of improving if they try. Another 42% have a Fixed or helpless mindset. They believe that intelligence is fixed at birth and cannot improve. They avoid situations that they cannot easily do well at. Failure undermines their confidence and if they fail, they become depressed and ineffective. (The remaining 16% could not be classified as either Fixed or Mastery mindset.) Having a Fixed mindset can undo a natural love of learning. In contrast, effort and learning make mastery-motivated students feel good about their intelligence; easy tasks waste their time rather than raising their self-esteem. Dweck describes the conundrum of the Fixed mindset. "If you're in a Fixed mindset, both positive and negative labels can mess with your mind. When you're given a positive label, you're afraid of losing it. When you're given a negative label, you're afraid of deserving it"(Dweck, 2006, pp 75-76).

Mangels worked with Dweck and other colleagues to measure brain activation among individuals with a Fixed and Mastery mindset (Mangels et al., 2006). Participants completed a pretest that allowed researchers to classify them as one or the other mindset. They answered a series of knowledge questions, and were given feedback about whether their answers were right or wrong and what the right answer was. Brain scans revealed people with a Mastery mindset paid close attention to what the right answer was. Those with a Fixed mindset showed activation of the limbic, or emotional system, but paid much less attention to learning the right answer. In other words, Fixed mindset people focused on their own emotional response to being told they were right or wrong, whereas Mastery mindset people paid most attention to learning new information.

Having a Fixed mindset is considered dysfunctional for learning because it focuses learners on performance instead of mastery. Educators who are aware of the research look for ways to ease learners out of a Fixed mindset and into a Mastery mindset. They also craft feedback to focus on ways the learner can improve, rather than on labeling the person a success or failure (Dweck, 2006, Lepper and Henderlong, 2000).

Combining the research discussed, fixed mindset, performance-avoidance individuals are likely to experience anxiety when faced with achievement situations. Impression management is a similar psychological construct that refers to ways individuals consciously and unconsciously try to influence or control other people's perceptions of them (Goffman, 1959). Those with a Fixed mindset might be considered *Validators* because when called upon to perform on a test at school or in a game, they worry about their impression in front of others if they fail; not failing is a way for them to validate their existence with the group. This concern may motivate studying, but this preoccupation with appearing to be successful can also interfere with performance.

Regulatory Fit and Goal Orientation

In a series of studies between 1995 and the present, Higgins and colleagues have developed and tested the theory of regulatory fit (Higgins, 2000, Higgins, 2005). When people pursue a goal, such as earning a good grade in a class, they begin with a motivational orientation. That motivational focus may be prevention-oriented (the need to get a good grade because doing so is important to get into medical school) or the focus may be promotion-oriented (getting an "A" would provide a personal sense of accomplishment).

Those with a prevention-orientation will experience regulatory fit when they pursue a vigilant strategy, carefully completing all course requirements. Those with a promotion orientation will experience regulatory fit when they pursue an eager strategy (such as reading extra materials).

Regulatory fit has been shown to improve motivational strength, task performance, and changes in attitude and behavior (Higgins, 2005; Forster, Higgins, & Idson, 1998; Higgins 2000). When regulatory fit occurs, people also feel better about what they are doing. These results have been found when study participants natural motivational predilections are used, and when a prevention or promotion orientation was experimentally induced.

Higgins work strongly supports the idea of matching player motivation with learning game features to enhance learning. Higgins' work echoes Dweck's fixed versus mastery mindset and Elliot and Church's performance-approach versus performance avoidance extrinsic motivations. However, rather than considering promotion-focused need for achievement as superior to prevention-focused need for vigilance and caution, Higgins has proved that matching an individual's goal orientation (either prevention or promotion) with the task can enhance task performance (Higgins, 2006).

Motivation Dichotomies

Let's review the motivation, mindset and goal orientation dichotomies that have been discussed so far.

Extrinsic motivation vs. Intrinsic motivation – These represent whether a student is motivated to learn material because of an external reward (extrinsic) or for the pleasure of learning (intrinsic). Intrinsic and extrinsic motivations can exist, and, unfortunately, students may not be motivated at all. Self-determination theory also explores the relationship between extrinsic and intrinsic motivation (Low, this volume).

Achievement goal orientation vs. Performance goal orientation – Students who strive for achievement goals may either work for extrinsic achievements (an "A" grade) or intrinsic ones ("I have learned something new"). Performance goals are strictly pursued for extrinsic motivations, and can be split into two types (stated next).

Performance-approach goals vs. Performance-avoidance goals – These extrinsic goals are related to how students manage their image in front of other students. Students pursue Performance-approach goals when they wish to show competency in the learning content (showing they understand the material to other students) while Performance- avoidance goals are pursued when a student does not wish to fail in front of their peers (for instance, not raising their hand if they are unsure about an answer).

Mastery mindset vs. Fixed mindset – Students who have Mastery mindsets relish challenges and can accept failure as a learning experience. Fixed mindset individuals experience failure and success as evidence of low intelligence rather than as a learning experience. They enjoy the validation of success but would choose safe challenges to.

Prevention-oriented goals vs. Promotion-oriented goals – The reason for pursuing a goal states whether a person's goal is prevention-oriented or promotion-oriented. A prevention-oriented goal focuses on the extrinsic rewards for accomplishing a goal and promotion-oriented focus on the intrinsic

The motivations, mindsets and goals of a student can vary wildly, given the dichotomies shown. Extrinsic and Intrinsic motivations are one of the major factors in determining the student's best learning experience, but a student's mindset and chosen goals have just as much effect on the type of learning experience that will help that student the most. However, we are also missing the last student difference, game literacy, which may affect the design of the learning game the most considering since understanding how to play a game itself is the main barrier of entry for any learning game.

This means that instead of focusing solely on the type of learning experience a student should have in order to learn we must focus on the type of game experience they should have as well. Combining learning and game experiences means we must leave the research that revolves around understanding motivation's effects on learning, and explore how motivation (as well as mindsets and goals) effects how individuals play games.

MOTIVATION, PLAY STYLE AND GAMES

Most of the research on motivation and mindset reviewed in the previous sections looked at motivation in relation to learning, particularly learning in the context of formal education. Turning to the realm of games, is there such a thing as gaming motivations, gaming mindset, and gaming goal orientation? Games and learning scholar James Gee writes, "good computer and video games are complex, challenging, and long; they can take 50 or more hours to finish" (Gee, 2007a, p. 45). In this respect, game players follow the same motivation and learning dichotomies that we discussed above. For instance, Gee points out that failing is part of playing a video game; failure in video games "allow[s] players to take risks and try out hypotheses…" (Gee, 2007a, p. 153). In other words, playing entertainment games is wrought with the same kinds of performance and achievement issues and intrinsic and extrinsic motivations that have been studied in relation to classroom learning. We find that gaming motivations have indeed been a focus of some academic and game industry research, studied primarily in the context of player types and games for entertainment.

Player Types

Player types, a term that is sometimes used interchangeably with player style, categorize players based on their motivations for playing. We differentiate player type from play style, which can be defined as a particular "styles of play" available within a particular game, or the style of play a player enacts while playing a particular game. Hence, player type is conceived of as a trait or underlying characteristic of the player, whereas a player's play style is actual play behavior enacted while playing a specific game. Play style is constrained by the mechanics available in a game. Particular game genres only offer players certain game mechanics and tactics. Thus players may not be free to engage in the play style that fits their player type, a play style we assume they would most prefer if it were available. The tug of intrinsic and extrinsic motivations for an individual may depend on the circumstance of play and the nature of the game. In her research on motivation and learning, Dweck points out that people tend to have a mastery mindset in some realms and a helpless mindset in other domains (Dweck, 2006). Furthermore, players may sometimes choose a play style inconsistent with their player type, whether for variety, for mood management purposes, or other reasons. In general, studies suggest players can be classified by player type. An individual does not necessarily fit a single player type all of the time or across all game genres.

Previous studies on player types have categorized the different motivations that players experience while playing games. Richard Bartle researched player behavior in Multi-User Dungeon (MUD) games in 1996 and classified players into four general categories of motivation (1996). Two player types focus on the player's relationship with the game's environment. The first, Achievers, enjoy acting in the game, scoring points and winning the game. The second, Explorers, are motivated by interaction and wish to learn about how a game functions. Bartle's other player types focus on the social aspects of MUDs and include Socializers, who interact with other players, and Killers, who impede on other players in a game (for example killing another player or helping another player without being asked).

Nearly a decade after Bartle's research, Nick Yee's Daedalus Project (2008) focused its attention on the new wave of social games, which have become known as massively multiplayer online games or MMOs. Yee's project surveyed thousands of MMO players and found three main motivating factors for play: achievement, socializing, and immersion. While socializing proved to be similar to Bartle's social player type, these new motivations categories found were in some ways similar to Bartle's four player types but in other ways different.

The two motivation areas that Yee declares as achievement and immersion include multiple subcategories. These subcategories contain a mix of both the Achiever and Explorer player types laid out by Bartle. Players that were motivated by achievements included the motivations for Advancement (progress, power accumulation, and status), Mechanics (numbers optimization, templating, and analysis), and Competition (challenging others, provocation, and domination).

Players motivated by immersion included motivations for Discovery (exploration, lore, finding hidden things), Role-Playing (story line, character history, roles, fantasy), Customization (appearances, accessories, style, color scheme), and Escapism (relax, escape from real life, avoiding real-life problems). Motivations such as mechanics, discovery and customization have similar traits but can be found in different motivation categories. Players thus do not always adhere to a strict player types or set of motivations. For our purposes we use *Achiever* and *Explorer* as loose player type titles that focus on whether the player is extrinsically motivated or intrinsically motivated, respectively.

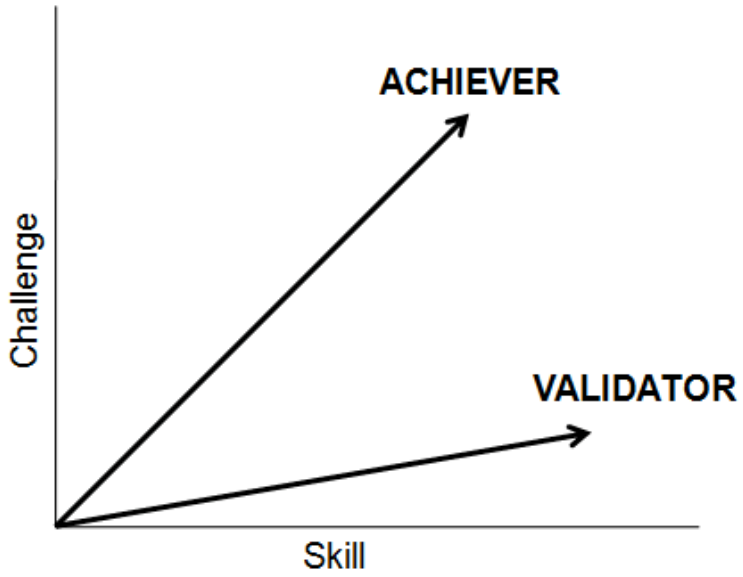
Along with Achiever and Explorer player type we have proposed a third type, *Validators*, not found in any previous player type studies (Heeter et al., 2009). In proposing this new type, we integrate Dweck's mindset theories; Validators are players who approach gaming with a Fixed mindset. Validators enjoy the validation of positive feedback, but experience failure as a commentary on their worthiness. They seek easy challenges where positive validation is likely and avoid hard challenges so as not to risk failure. Validators face a vicious cycle when it comes to digital games for learning. Validators who try playing an unfamiliar entertainment game genre and fail in their early attempts would probably avoid the genre. Overall, Validators probably play easier games for entertainment or choose easier levels within a game, so that playing and winning becomes rewarding validation of self worth. This results in Validators having lower gaming literacy in game genres based on hard challenges. When forced to play a learning game in a genre they already avoid, Validators are less literate in the genre and by definition they are more devasted by negative feedback. Even if a Validator has simply never tried a game genre, his or her unfamiliarity makes failure more likely, while aversion to failure makes failure more painful. Validators are the player type most at risk of not learning from a learning game.

Gender intersects with gaming literacy and mindset. Boys spend more time gaming than girls do – an average of at least 100 more hours per year from middle school through college (Winn & Heeter, 2009), and they play more different genres (Lenhart et al., 2008). The result is boys develop more diverse and extensive gaming literacy. Dweck notes that boys encounter more criticism and girls more praise at school, setting girls up to equate other people's feedback with their sense of self worth and encouraging a helpless mindset (Dweck, 2006, p. 78). Girls are probably more likely to be Validators and for that reason as well as more girls' limited gaming literacy are more at risk of not learning from a learning game. We feel that designing games that address the needs of Validators, along with the Achievers and Explorer player types, is key to developing universally accessible learning games.

The figure below (Figure 1) maps hypothetical "flow" trajectories for our two extrinsically motivated player types: Achievers and Validators. The chart reflects the interests of pure types. The Y Axis represents challenge and the X Axis represents player ability. There is an assumption that a player's skill will improve as they play; therefore, the challenge should also increase to maintain optimal engagement.

Keeping different player types motivated requires different trajectories. Achievers thrive on difficult challenge, and as they learn while playing, the challenge needs to increase at a fast pace to accompany their growing skill. Validators follow a much gentler trajectory. Challenge can increase slightly as their skill increases, but should always be within reach. The idea of "easy fun" would appeal to Validators, but these players would likely prefer that the fun not be labeled "easy." It might be better to use a less humiliating label for players concerned about saving face. Explorers may experience a mix of extrinsic and intrinsic motivation or they may be purely intrinsic. Pure Explorers may prefer not to be distracted from their exploration by irrelevant challenges. Explorers interested in extrinsic rewards could be either Explorer-Achievers or Explorer-Validators.

Figure 1: Trajectories of Optimal Challenge and Skill by Player Type



Each player motivation implies a different trajectory for optimal amount of challenge relative to growing player skill. Figure 1 shows hypothetical trajectories over time for each player type. Compared to Achievers, Validators prefer a much gentler increasing of challenge, ensuring easy victories. For explorers challenge is irrelevant. Their primary interest is the intrinsic curiosity of discovery, whether it is easy or difficult. Of course, players may be part Explorer and part Achiever or Validator. Most players probably do not fit a single pure type.

Our discussion extends player type research to characterize player types that are grounded in theories and research on motivation, mindset, and goal orientation, as discussed in the introduction. Achievers, Explorers and Validators are the three player types we arrived at when we combined the motivation and player type research. Moving forward, we must now attempt to combine our player types with the idea of automatically assessing and adapting to these player types in a serious game.

MAPPING INDIVIDUAL DIFFERENCES TO GAME DIFFERENCES

Given that players may be motivated by extrinsic or intrinsic rewards and have fixed or mastery mindsets, how do these translate into game content? Can game designers support Achievers, Explorers and Validators at the same time or must they focus their attention on a smaller subset of them? Understanding the differences between the player types helps answer these questions and discover design principles for building games to match each player's motivation and mindset.

The main difference between motivating players with extrinsic and intrinsic rewards is how the reward itself relates to the game's content. Extrinsic rewards are represented by concepts like points, health, mana, or any other arbitrary numbers given to the player. Acquiring more points or keeping a character's health high offers challenges for the extrinsic player or Achievers. Having quantitative number systems like 'points' or 'damage dealt' allow game designers to alter difficulty level much easier. Achievers are then motivated by these difficult challenges and by giving Achievers specific goals a designer helps these players understand what they need to do. Scoreboards and ranking systems are an easy way to set goals for Achievers and are used to support the competition between players. Competition with a game's community ultimately offers the greatest, and dynamic, challenges for a player that is extrinsically motivated.

Intrinsically motivated players, or Explorers, focus on the specifics of a game's content. They do not need specific challenges that are offered to Achievers (in fact, such challenges may interfere with free exploration) but they do need a rich enough environment to explore. Allowing Explorers to customize their avatars or game world, incorporating discovery and collection, or providing authoring tools would appeal to these players. Extended storyline information or having a diverse set of game mechanics could also give Explorers other dimensions to explore. These features can engage Explorers much like a scoreboard challenges an Achiever, except Explorers may prefer to invent their own challenges and rewards.

Achievers follow a mastery mindset; they seek new challenges in the environment and as a result, if the game is well designed, grow and learn with their new experiences. Rewards are just as desirable for the Validator as they are for the Achiever but they must be more prevalent and easier to win. Achievers want rewards that they have earned for mastering difficult tasks while Validators want to be told that they are wonderful and to avoid failure. Validators may also want control over the exposure of these rewards. Hiding bad performances could be a welcomed feature for these players, as they just want to prove to

themselves that they can play a game. They do not want to receive negative feedback for performing tasks slower or differently than other more experienced players.

Genre Preferences and Player Types

The authors' research has determined that commercial games tend to specialize in pleasing a single player type (Heeter et. al., 2009). For example, role play games (RPGs) and first person shooters (FPS) strongly support extrinsic motivations. Life simulation games support intrinsic motivations. In a prior content analysis study we classified eight entertainment games by genre and whether they primarily offered extrinsic or intrinsic player rewards. (See Table 1.)

Table 1: A list of the eight games that were analyzed, including their genre and whether the game caters to extrinsically or extrinsically motivated players (Heeter et al., 2009)

Game	Genre	Player Motivation
Bioshock	FPS	EXTRINSIC
Guitar Hero	play along	EXTRINSIC
Keep It In Mind	brain game	EXTRINSIC
Puzzle Quest	puzzle/RPG	EXTRINSIC
Animal Crossing	virtual life	INTRINSIC
Budget Hero	budget simulation	INTRINSIC
FlOw	sensory experience	INTRINSIC
Play The News	current events	INTRINSIC

Four of the games, Bioshock, Guitar Hero, Keep It In Mind and Puzzle Quest, offer extrinsic rewards to the player and thus may support the Achiever and Validator player types. The other four games, Animal Crossing, Budget Hero, FlOw, and Play the News mainly offer intrinsic rewards and thus may support Explorer player types. The genres examined include first person shooters (FPS), play along, brain games, puzzle/role play games (RPG), virtual life, sensory experience, current events, and budget simulation.

Research on player types has so far only looked within a particular game or game genre. We do not know the extent to which players may have a different player type when they play different game genres, or if people tend to only choose game genres that accommodate a single underlying player type. We do know that people don't simply play games; they tend to specialize in one or a few genres of game. One consequence is they are likely to be unfamiliar with how to play the genres they avoid, which they probably rejected because they are unappealing.

There are also gender differences in genre preferences, which have implications for creating universally accessible learning games. According to a recent Pew Foundation study of teens and gaming (Lenhart et al., 2008), 97% of American teens play games (Table 2 reports the results). Boys play for more time and they play more different genres of games than girls do (an average of 8 different genres compared to an average of 6 genres). Boys play more action, strategy, sports, adventure, first-person shooter,

fighting, role play, survival-horror, and multiplayer games. Girls play more puzzle games. There is no difference in amount of play of racing, rhythm, simulation or virtual worlds games. Girls who are frequent gamers tend to play the same games as do boys who are frequent gamers. Gender differences in genres played are found primarily among girls who game less frequently. Table 2 also characterizes each genre as tending to favor extrinsic or intrinsic player motivations, extrapolating from our earlier research.

Table 2: Player percentages by gender per genre (Lenhart et al., 2008) and tendency to favor extrinsic or intrinsic rewards. A "" in the table indicates that males play significantly more than females. A "+" indicates that females play significantly more than males. Grey rows reflect genres not significantly different by gender..*

	% boy gamers	% girl gamers	Favors
*Action games	84%	48%	EXTRINSIC
*Strategy games	83%	55%	EXTRINSIC
*Sports games	80%	55%	EXTRINSIC
Racing games	77%	71%	EXTRINSIC
*Adventure games	75%	57%	EXTRINSIC
*First-person Shooter	74%	17%	EXTRINSIC
*Fighting games	67%	29%	EXTRINSIC
Rhythm games	58%	64%	EXTRINSIC
+Puzzle games	58%	87%	INTRINSIC
Simulation games	46%	52%	INTRINSIC
*Role playing games	45%	26%	EXTRINSIC
*Survival-Horror games	45%	18%	EXTRINSIC
*MMOs	30%	11%	EXTRINSIC
Virtual Worlds	11%	10%	INTRINSIC

Most entertainment genres orient towards extrinsic rewards. The exceptions are puzzle games (played more by girls), simulation games, and virtual worlds. Two of the three more intrinsic oriented genres are played significantly more by girls than boys.

While it may be efficient for game developers to focus on one player type, which allows them to focus on the core game features, it also means part of their potential game playing audience will likely not want to play their game. Commercial games can get away with this so long as their game reaches enough players to be profitable. Learning games have less leverage; students are required to play these games and if a game is not engaging students may be discourage from learning the game's material. One option for learning games would be to offer a series of games on the same topic and students can pick which game version to play. However, due to time and cost factors there may be better ways to achieve the same breadth of player type coverage for learning games.

ADAPTIVE GAMES

Building games to reach a wider audience is not new. Challenge in games is moderated in at least in two ways: selectable difficulty and levels. Games for entertainment often offer players a selection of difficulty levels (such as easy, medium, or hard). Within a difficulty level, the challenge of the game may

ramp up as the player succeeds. Sometimes ramping up is overt – the player completes one level to advance to the next. Exactly how quickly and how much to ratchet up the challenge within and between levels would presumably be different for Validators and for Achievers, but games today do not make that distinction. These changes in difficulty are usually quantifiable, meaning that Achievers gain the most out of these systems because they can crank up the difficulty for more extrinsic rewards (Validators also benefit by being allowed to choose their difficulty). Serious games are less likely to incorporate selectable difficulty in part due to their typically smaller scale and lower budgets. In fact, we argue that accommodating Achiever and Validator player types is even more important in a serious game than in a game for entertainment, because play is required rather than voluntary.

Incorporating game mechanics to appeal to Explorers could also enhance the palatability and effectiveness of serious games. Some subject material may be considered advanced but categorized material will not correlate to each student's current body of knowledge as some students may find 'advanced' material easy. Offering extra content in a game (side quests, extra levels, more material, user generated content) can make up for categorizing material. This helps Explorers in commercial games by offering more content to search through and alter. Learning games that can provide an extra content benefit from having lots of material for a student to explore. This will enhance a self-directed learner's experience with the game, or students with a mastery mindset, but too much information may scare fixed mindset learners. Players should not always be expected to know what they want from a game and learners should not have to guess as to which material they should cover next.

There have been approaches created in educational digital media that attempt to alter the learning experience to better suit the individual using it, such as intelligent tutoring systems (ITSs), which are built for helping with a student's aptitude in various subject domains (Gomez-Martin, Gomez-Martin, & Gonzalez-Calero 2004; Johnson, Vilhjálmsson, & Marsella 2005). The defining feature of an ITS is that it carefully oversees a learner's work on problems to provide needed guidance and content selection. ITSs identify the need for instructional interventions by comparing a model of expert performance with a model of the learner's performance (Koedinger, et al. 1997). ITSs traditionally employ a model trace, which is a cognitive model designed to help identify what strategies a student is employing to solve a problem. When the student is having trouble arriving at the correct answer, the systems can use the model trace to identify what is strategy is being employed and then decide what kind of guidance or feedback would best fit that specific situation. A traditional ITS will also measure student aptitude in the concepts being taught (called a knowledge trace) and will select content to address student deficiencies.

Games have already employed intelligent tutoring systems to teach such topics as language (Johnson, Vilhjálmsson, & Marsella 2005), computer programming (Gomez-Martin, Gomez-Martin, & Gonzalez-Calero 2004), and interpersonal and intercultural skills (Lane et al., 2007). However, these systems employ model and knowledge in the same way as ITS systems have been used in non-game-based media; individualized feedback is given and content selection to address student deficiencies is given. This approach does not try to alter the features of a game experience that are most closely tied to player motivation (e.g. game mechanics, game goals, story, etc.). Instead, we need to move the state-of-the-art in learning games beyond the "games plus intelligent tutoring" approach that has existed thus far in games research and will fundamentally change how learning games are developed and their efficacy in classrooms across the country and around the world. This approach, which we call "adaptive games" is discussed below on page 18.

Identifying Player Type

When building an adaptive game, a crucial element of the system is the recognition of the relevant individual differences about the player who is using the game. Once this recognition occurs, the game can then configure itself to accommodate those differences. Three possible approaches could be used to determine player type: giving the player a survey, allowing the player to customize the game on their own, or identifying player type by observing play behavior.

Surveys - Participants could complete a short survey prior to playing an adaptive game, in order to quickly assess their gaming motivation, mindset, and immediate goal. If games for learning are going to be used frequently, perhaps learners could complete a gaming motivations profile once, and then simply select ACHIEVER, VALIDATOR, or EXPLORER mode when the start a game.

Customization – An interface could be created to allow participants a large amount of control over how the game functions. Some entertainment games already permit considerable customization before play. Customization features related to motivations, mindset, and goal orientation could include control over how the game functions (e.g. how points are award, how much time is allotted to perform certain actions, etc.), how the user interface appears to the participant, whether intriguing extra content is included (for explorers), and how learning information is presented to the participant, if at all.

Research on customization could also provide insight into whether players the selections players make result in the same game adaptations as would have happened if the game adapted based on a player motivation survey. Which approach leads to the more optimal learning experience? It is unclear whether students are aware of their motivation and mindset (when completing a survey) and whether they the game configuration choices they make do in fact result in their most preferred game. Furthermore, allowing players to choose prevents the gaming system from making configuration choices based on what is best for learning rather than what is most enjoyable.

Automatic Adaption - Instead of asking the participant survey questions or allowing them to change the game personally, this method opts for intelligently tracking a student's gameplay. There could be a short "initial calibration game" players play as a warm-up activity or introduction to the adaptive learning game, which is used by the system to define that participant's player type. Tracking players in this way is similar to tracking a user in a recommendation system where a user's preferences are continually recorded and updated (Medler, 2008). We hypothesize that this will be the least obtrusive and potentially most accurate method for identifying player type, since the measures will be based on the observation of behavior rather than relying on self-report.

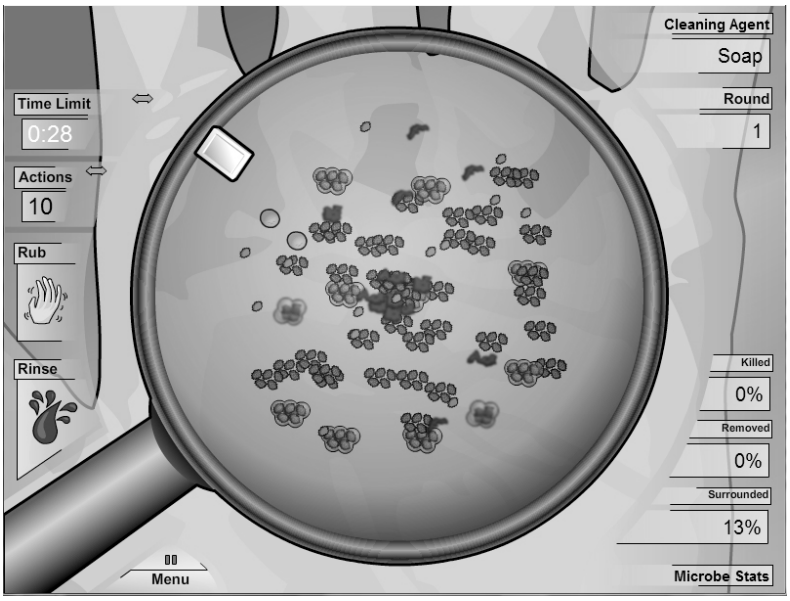
S.C.R.U.B.

We created an adaptive game prototype called S.C.R.U.B. (Super Covert Removal of Unwanted Bacteria) (Magerko et al., 2008). This mini-game focuses on the topic of microbial pathogens and is intended to teach players about the effects of hand washing (see Figure 2). S.C.R.U.B. is envisioned to be a simple arcade game, incorporating typical arcade values like ammunition, kills, time limits and points. Players play through three rounds using soap and three rounds using antibacterial gel, permitting players to experience and compare the effects of each hand washing approach for getting rid of microbes.

Within this basic game design, we identified game mechanics that could be added to or subtracted from the game mechanics to meet the needs of Explorers, Achievers, and Validators. Table 3 presents

five potential adaptive game mechanics that could be changed for different player types. Explorers, who are intrinsically motivated, would benefit from an explore mode which turns off the game clock and opens extra exploration tools such as a microscope view. A timer would interfere with explorer's game play. Extra content, which in the case of S.C.R.U.B. takes the form of trivia questions, would appeal to explorers. Explorers might also enjoy a "show me" option to see deeper explanations, while Achievers

Figure 2. Screenshot of the S.C.R.U.B. mini-game.



and Validators simply want to win quickly without extraneous distracting information. Leader boards, bonus points and the tutorial are irrelevant but not harmful to Explorers. Achievers and Validators have common interests but there are important differences in optimizing their game mechanics. Both enjoy speed bonus points, but the more delicate Validators would do better if they do not face failure for not finishing in time.

If player monitoring were built into S.C.R.U.B., we could use that information to adaptively display these different features and mechanics to offer somewhat different gaming experiences. Players that are found to score a lot of points and beat each level's time limit could be given harder challenges (we would guess that they are Achievers). Players who take their time during each round and spend time on the trivia questions would be classified as Explorers. These players could be offered extra information about S.C.R.U.B.'s subject matter and time constraints could be removed.

Players who choose to watch the tutorial might be classified as Validators since they are choosing to learn to play in this way instead of by trial and error. Their error messages might be gentler, and their time limits a bit longer. Validators must be dealt with carefully because these are players who may find games difficult to play, dislike the way the game is presented or have a fixed mindset. The game could offer hints or choices that point the player in new directions. For instance, if a Validator continues to play each round very slowly we may offer them a choice to try and play the game with a time constraint to see if we can interest them in more extrinsic rewards. Another example is when Validators finish a round they may be given a new hint or technique to use the next time they play (e.g. rinse your hand before applying soup to remove more microbes). Hinting at how the player can move forward will help those players gain more confidence in their gameplay.

Finally, while each player may exhibit one player type over another we do not lump players into one static type. Players that both beat the rounds under the given constraints and spend a lot of time in-between levels looking at extra content might be classified as both Achievers and Explorers. In this case features and mechanics suitable to both player types could be offered, so long as those features are not incompatible. If at any time the player begins to exhibit the signs that they are only interested in one type or the other (say they stop playing the game competitively) then that player type's features could be scaled back, leaving the features that the player is still interested in. Each feature would be modular and scalable being turned off and on as they are needed in the game.

Table 3: Inclusion or Exclusion of Game Mechanics for Player Types.

	Intrinsic	**Extrinsic**	
	Explorer	**Achiever**	**Validator**
mindset	*can be either*	*Mastery*	*Fixed/Helpless*
goal orientation	*can be either*	*Eager*	*Vigilant*
Explore Mode	**Yes**	**No**	**No**
Timer			
speed bonus	**No**	**Yes**	**Yes**
fail if too slow	**No**	**Yes**	**No**
Leader Board			
always		**Yes**	**No**
if I'm doing well			**Yes**
Trivia Qs			
bonus points		**Yes**	**Yes**
extra content	**Yes**	**No**	**No**
show me option	**Yes**	**No**	**Yes**
Tutorial			**Yes**

DESIGNING FOR ADAPTIVE GAMES

One of the products of our preliminary work on S.C.R.U.B. is the unique process that has arisen from building a game that represents a space of possible game features and mechanics as opposed to what is conventionally considered a typical game design. This process involved several additional steps to the typical iterative process we normally take: analysis, identification, and mapping.

When building the S.C.R.U.B. prototype game, we first analyzed the game experience to identify the different features that make up the gameplay, the interface, and the knowledge presented to the player (e.g. having a high score, the visualization of facts about MRSA, and having a time limit). Once these different features have been identified (which of course may change during iterative design), we then identified what alternate approaches could be taken within each of these features (e.g. having a high score

vs. not having one) and finally how each of those differences mapped on to possible player preferences (e.g. having a high score fits an achiever profile).

We ended up with six initial adaptive features of particular importance to Explorers, Achievers, or Validators. We found that it is important that Explorers have enough time provided to them to explore. Therefore, a countdown clock and bonus speed points are omitted for them. The countdown is also left out for Validators, on the expectation that added pressure only further interferes with their mental focus. Explorers also have a means of entering an "explore mode", in which gameplay ceases and they can more closely examine aspects of interest in the interface (while learning more about MRSA). Achievers get bonus speed points and a prominent Leader Board. We avoid distracting Validators with superfluous options or pressures, guide them into the game with a built in tutorial, and offer a "show me" alternative to answering trivia quiz questions.

FUTURE RESEARCH DIRECTIONS

Player Motivation Survey

Our theoretical approach integrates player types, mindset, and the theory of intelligence. Extensive research on player types supports the validity of Achiever and Explorer player types. Our own preliminary survey research on play behavior and related educational research provides strong evidence of and rationale for considering the additional ”Validator" player type. Essentially, extrinsically motivated players are divided Achievers (mastery mindset and an eager goal orientation) and Validators (fixed mindset and a vigilant goal orientation).

Further research is needed to development survey instruments to measure gaming motivations and gaming mindsets and to determine the distribution of Explorers, Achievers, and Validators in different populations and in relation to different game genres. Games for learning perversely conjure up individual’s entertainment gaming motivations and their formal education learning motivations and mindset. These two worlds collide. What is the relationship between learning and gaming motivations? How do players reconcile potential conflicts? Which predilection wins out, when playing a game for learning?

Identifying Player Motivation

Work on player motivation is needed to design and apply adaptations in a finer-grained manner, such as weighting features with "how much" they relate to a particular style or assigning features proportionately based on the model of the player (e.g. assigning 60% of the features for Achiever and 40% for Explorer, or better yet, deciding which features can coexist and which must remain true to the player’s primary type). We need to understand how individual differences in players change over time and if any of the aforementioned techniques need to accommodate these changes over time. One way to determine individual differences may be to use a motivation framework. The ARCS framework is discussed in (Low, this volume) and notes that the principles of motivation are attention, relevance, confidence and satisfaction. Using these principles the question remains how a game can accommodate different players and change as that player’s motivations fluctuate.

Design Process for Adaptation

Our initial work focused on an arcade-style game. It has been fairly straightforward to conceptualize adaptive features of S.C.R.U.B. since it is a simple mini-game. This process needs to be generalized for

other game genres or larger games. How such a design process applies to other kinds of games appears straightforward for some (e.g. first-person shooter-style games) but less obvious for others (e.g. turn-based strategy games). Ultimately, a pan-genre design process could be developed that addresses the individual differences in gaming and learning motivations and how those differences could be mapped to design decisions for adaptive games in general and serious games in particular.

CONCLUSION

The ramifications of serious games that adapt to player motivations, mindset, and goal orientation are potentially large. Computer games are gaining increasing use every year as platforms for learning experience, whether they are off-the-shelf games co-opted for an unintended purpose (Van Eck, 2006) or multi-user virtual environments created for communities of elementary and middle school students (e.g. Barab, et. al, 2005). These and other digital media approaches to education have the same opportunity that intelligent tutoring researchers saw in computer-based education-computers have the ability to model and adapt educational content to fit the user's needs.

Adaptive serious games can potentially help serious games, including digital game-based learning, more effectively motivate and teach a much broader player audience. Intrinsically motivated players would be able to exercise their curiosity and go beyond the minimum content mastery necessary to complete and win the game without being rushed by timers and without being limited by the competitive interests of achievement oriented players. Validators, a group which likely includes non-gamers who would be distracted by fear of failure at an unfamiliar task as well as more experienced gamers who enjoy games as validation of their competence but whose mindset is oriented towards avoiding failure will find a gentler game. Achievers will be able to immerse themselves in hard challenges and well deserved success, indulging their mastery mindset.

If different students respond differently to different game situations, genres, etc., then progress in the games for learning community will surely be slowed until we can experimentally identify these differences and accommodate them in our games. The future is bright for digital game-based learning. However, we contend that the future can be even brighter when games are designed to identify and accommodate the differences in students who wind up playing them. We have the potential to engage more players in a more effective manner by creating learning games that adapt to the individual differences that each player brings with them to the gaming experience.

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