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The Effect of Games on Engagement and Performance in Intelligent Tutoring Systems

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THE EFFECT OF GAMES ON ENGAGEMENT AND PERFORMANCE IN INTELLIGENT TUTORING SYSTEMS

by

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ABSTRACT

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The purpose of this dissertation is to assess the relation between game-like elements, individual differences in gameplay, and engagement within an Intelligent Tutoring System (ITS). The current studies examined the incorporation of a game into an existing ITS, iSTART. The game, Self-explanation Showdown (Showdown) added game-like elements into the iSTART practice sessions. Incorporating games was expected to increase engagement while not affecting participants' overall performance. However, the results of Experiment 1 indicated that game-based practice (Showdown) was more engaging than the non-game-based practice (Coached Practice), but produced lower quality self-explanation performance. The decrease in performance was attributed to the amount of pedagogical information available during the learning task. In Experiment 2, a second version of Showdown was created that added pedagogical feedback similar to the feedback provided in Coached Practice. The feedback-added version of Showdown (Showdown-FB) was expected to retain the benefits of engagement while mitigating the deficits in performance. Instead, Showdown-FB demonstrated a reduction in participants' engagement to a level which was no longer significantly different from Coached Practice, and did not increase performance relative to the original version of Showdown. Finally, Experiment 3 investigated whether opponent difficulty would affect gameplay and how those effects may vary as a function of different types of game players

(Achievers, Explorers, Socializers, Killers). The results of Experiment 3 indicated that opponent difficulty affected both performance and engagement. Participants were more engaged and produced higher quality self-explanations when playing against a highly skilled opponent. Follow-up analyses indicated that the differences in performance were likely a result of modeling responses from a highly skilled opponent. However, the effects of opponent difficulty were not affected by a participant's gamer type.

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The Effect of Games on Engagement and Performance in Intelligent Tutoring Systems

Introduction

Games and game-based environments constitute an area of rapid growth in private, public, and research sectors. In 2007, while industries such as music and movies saw either negative or stagnant growth (-10.0% and +1.8% respectively), the gaming industry reported dramatic gains (+28.4%; Combs, 2008). Capitalizing on this growth, researchers of Intelligent Tutoring Systems (ITSs) have begun to leverage the engagement and appeal of games by incorporating game-like features within learning environments (McNamara, Jackson, & Graesser, 2010).

While it is intuitively clear that games are engaging and can often sustain interest over extended periods of time, it is still relatively unclear how this process occurs and which specific features are essential to the essence of games. Previous research has attempted to identify and investigate specific gaming components such as challenge, fantasy, complexity, control, rules, strategy, goals, competition, cooperation, and chance (Crookall, Oxford, & Saunders, 1987; Garris, Ahlers, & Driskell, 2002; Malone, 1981). However, these components have been primarily observed within the context of entertainment games. Only recently have these components been implemented and observed, and even, sometimes tested, in the context of learning environments (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). Establishing the effects of game components on learning and motivation is important for those who are interested in developing systems that maximize learning benefits in computer-based systems such as ITSs.

The principal goal of most ITS technologies is to produce significant learning gains (i.e., learn a new skill or understand concepts within a specific domain). However, ITS developers and researchers often struggle to create just the right balance between implementing effective learning practices, while at the same time enhancing motivational aspects of the learning environment (Boyer, Phillips, Wallis, Vouk, & Lester, 2008; Jackson & Graesser, 2007) and addressing the individual differences of the user (e.g., Braten & Samuelstuen, 2004; Lorch, Lorch, & Mogan, 1987; O'Reilly & McNamara, 2007). These ITSs, though often effective at producing learning gains, are sometimes uninspiring to those who use them. Focusing on maximizing learning benefits can suffice for experimental purposes, but it creates a problem for systems that are used repetitively and over long periods of time. Additionally, improving motivational aspects of learning environments is likely to produce indirect gains in learning, particularly if the modifications result in heightened engagement on the part of the learner (Graesser, Hu, & McNamara, 2005).

The intersection of these two fields (games and ITSs) provides a fertile ground to develop effective learning environments that maximize learning while at the same time fully engaging the user and instilling a desire to interact with the system. The remainder of this paper describes an effort to combine an ITS with game-like elements. The end result of the combination is expected to be a system that is more engaging than the original ITS, while retaining the same effectiveness.

The role of engagement in ITSs has received more attention in the past few years especially given the amount of research that has been focused on engagement in other fields (Ennis, 2000; Marchese, 1998; Pintrich & De Groot, 1990; Trout, 1997). Bangert-

Drowns and Pyke (2001) define engagement as "the mobilization of cognitive, affective, and motivational strategies for interpretive transactions"(p. 215). Engagement is believed to play an important role in a variety of cognitive processes, such as memory (Brandimonte & Passolunghi, 1994) and achievement (Lee & Smith, 1995; Lee, Chen, & Smerdon, 1996; Nystrand & Gamoran, 1991). Engagement in classrooms has been shown to lead to improved achievement (Nystrand & Gamoran, 1991), suggesting that creating an engaging curriculum is relevant and important to all educators. While greater engagement has found to be associated with improved achievement, it has been documented that students are not as engaged in classroom material and educational curriculum as they are expected to be (Guthrie, 1997; Marchese, 1998; Nystrand & Gamoran, 1991). Nystrand and Gamoran noted that students are engaged in the procedural tasks of everyday school life (e.g., getting to class), but not the tasks related to actual schoolwork.

One can imagine a scenario where students are presented with a challenging and entertaining classroom task. For example, Corbett (2010) describes a classroom that incorporates a dynamic social media platform to encourage students to learn multimedia literacy skills. Instead of sitting in a lecture hall learning the skills, the students learn by interacting in the community and creating their own social network pages (Corbett, 2010). During this task, the student would encounter concepts that are important to the curriculum, but would not feel the negative effects associated with “boring” tasks. One scenario in which engagement occurs is when game-like elements are included in a learning session (Dickey, 2005; Saenz-Ludlow, 2006). This scenario creates a situation of interest and motivation, which increases the attention to the task at hand. Students in a

state of engagement are potentially in a scenario where interest and motivation would be increased, and would likely overcome the deficits associated with being disengaged (e.g., a decreased understanding of the topic).

The current dissertation assesses the validity of the claim that there is an observable relation between game-like elements, individual differences in gameplay, and engagement within a task. Few researchers have investigated these issues in a single study, which presents an area ripe for investigation. This dissertation begins with a description of engagement and its relation with game-like elements. Then a discussion of the growing field of individual differences in gameplay and their interactions with both game-like elements and engagement will be presented. To explore this research area, three experiments were conducted that manipulate different scenarios of game-like elements in order to determine the potential effects on engagement. This dissertation will discuss the findings of these experiments and how they address the following research questions. First, does adding game-like elements increase engagement within an ITS? Second, do differing levels of pedagogical feedback in educational games affect performance or engagement? Then finally, does varying the opponent difficulty produce differing levels of engagement or achievement while playing an online educational game, and do those differences depend on the player's gamer type?

Engagement

It is well documented that students do not find educational tasks engaging (Ennis, 1999; Ennis et al., 1997; Marchese, 1998; Nystrand & Gamoran, 1991; Trout, 1997). Interesting and stimulating tasks are considered engaging, though they are often not related to education. However, when educational tasks are engaging, they typically

produce deep level comprehension (Fredricks, Blumenfeld, & Paris, 2004; Hedberg, 2003). In order to illustrate the difference between an engaged student and a disengaged student, Nystrand and Gamoran (1991) presented a case of students shallowly performing classroom activities with no regard for the actual outcome of their performance other than simply completing "busy work." The students expected the satisfaction of completion for their performance regardless of the effort that they put forth. In this example, the students' goal was simply to get a completion grade. By contrast, when the authors find that students are engaged, they are actively participating in learning tasks with the goal of succeeding in learning specific tasks and skills. The authors described the students as engaged because they were actively evaluating their performance and altering their effort to achieve a predefined goal.

As Nystrand and Gamoran (1991) point out, students are rarely engaged in the classroom. Several possible explanations as to why students are not engaged in the classroom include the task, the environment, and the characteristics of student. First, students may not be engaged due to the absence of an interesting task. As pointed out by Hedberg (2003), an engaging task is expected to involve giving the learners the opportunity to assess their own understanding as opposed to sitting in a classroom simply waiting to be given the information.

A second possible explanation for a lack of engagement might be that there is a lack of external motivation within the classroom environment. Specifically, the student's environment might not require the student to be motivated. For example, the reward structure in a classroom may not be conducive to engagement. In particular, some classrooms may reward students with free time, while others may reward students with

enhanced classroom materials. These two environments may produce widely varied responses from students.

Finally, the third possible cause for students' lack of engagement is a lack of intrinsic motivation. Intrinsic motivation does not rely on any external cues and typically is driven by the student's interest or enjoyment in the task (Deci, 1975). Research has shown that over time, students' intrinsic motivation towards academic tasks wanes because of a wide variety of reasons (e.g., Anderman & Maehr, 1994; Harter, 1981). Because individual differences such as intrinsic motivation vary greatly between students, experimental manipulations likely cannot focus on making the student more internally motivated. Instead, effective motivation manipulations may need to focus on external, curriculum-based manipulations. There is little doubt that students have a difficult time becoming engaged on their own, but there is reason to be optimistic. For example, engagement perspective literature suggests that under some circumstances (e.g., social status, teacher relationship), engagement can significantly increase (Elsacker-Bok, 2002). But, if students have to struggle too much, then they will disengage (Guthrie, 1997; Guthrie & Alao, 1997).

Carini, Kuh, and Klein (2006) investigated the link between student engagement and academic achievement. The purpose of their study was to determine the link between the two factors on a large scale. The sample consisted of 1,058 college students. Self-report engagement scores were compared to the RAND test and a writing subset of the GRE (Klein, Kuh, Chun, Hamilton, & Shavelson, 2005), as well as standardized SAT and GPA scores. All scores were converted to a standardized SAT metric. Carini et al. (2006) found that these academic measures were often positively related to student engagement

measures, supporting the notion that student engagement is positively linked to academic traits such as critical thinking and grades. However, these relations are typically in the form of weak correlations and regressions that account for minimal amounts of the overall variance. While previous research (Ewell, 2002) presents weak relations between engagement and academic achievement, Carini and colleagues established that there is a reliable relation that can be used as the foundation for further study.

Porter (2006) also explored the relation between engagement and academic performance as well as possible interactions with individual differences. During the study, 5,114 students in 329 different universities responded to a survey about their engagement and academic performance. Porter operationalized engagement as a student's response to a scale featuring items such as "Attended study groups outside of classroom" and "Met with an advisor concerning academic plans." The author concluded that the results, though not directly supporting causation, indicated that SAT scores and academic engagement are positively related. In addition, the results indicated that full-time students, on-campus residents, students on financial aid, females, Blacks, Hispanics, and science and humanities majors are more engaged than other students. Also, institutions which spend more on student resources tend to have less engaged students, as students have more resources available. Having more resources available allows the student to disengage from the learning task as a whole, as having fewer resources would require the students to work harder to accomplish their educational goals and requirements. Essentially, a more challenging situation can be more engaging to a student. These results suggest that engagement is affected by the task, the environment, and the background of the student.

Bangert-Drowns and Pyke (2002) investigated student engagement while interacting with educational software. The purpose of the study was to determine if engagement could be judged consistently through qualitative observation. Three raters were asked to judge engagement as one of seven different types (i.e., disengagement, unsystematic engagement, structure-dependent engagement, self-regulated interest, critical engagement, and literate thinking). These seven types of engagement were also rated on the frequency of their occurrence. Students interacted with computer-based tools, simulations, tutorials, games, and browsers. Teachers rated the student engagement independently. An analysis of the ratings revealed that students exhibited functional (i.e., positive) forms of engagement with higher frequency than dysfunctional forms of engagement (i.e., disengagement). Students enthusiastically engaged in computer-based tasks in a manner that teachers were able to observe. This engagement is consistent with literature that suggests that computerized or other digital media foster active engagement for learning (Prensky, 2001).

The correlational evidence from these three studies (Bangert-Drowns & Pike, 2002; Carini et al., 2006; Porter, 2006) supports the claim that challenging computer-based games can increase engagement and, in turn, achievement. However, these effects could likely depend on the characteristics of the individual. These previous results along with the finding that students are more engaged by computerized activities (Prensky, 2001) indicate that turning a learning activity into a computer-based game could be an effective method for manipulating engagement and achievement.

Engagement and Performance

In recent years, the relations between engagement and performance have received the attention of researchers in education and psychology (Jones, Valdez, Norakowski, & Rasmussen, 1994; Schlechty, 1997). Simple studies in the field of memory have shown that engagement can affect performance. First, Voogt (1987) investigated the relation between engagement and performance in boys and girls and their computer literacy using CAST, a Dutch version of the Minnesota Computer Literacy Awareness Assessment. The boys' and girls' ($N = 873$) computer literacy was compared to their subject-specific engagement. The author found that boys were more engaged and exhibited higher computer literacy than girls. Second, Brandimonte and Passolunghi (1994) found that performance on specific memory tasks (e.g., prospective memory tasks) was adversely affected when the researchers introduced a task that required a shift in engagement away from the memory task. Finally, Kirsch et al. (2002) compared 14-15 year-olds from various countries using the PISA student questionnaire. They compared attitudes toward reading achievement (i.e., attitude towards reading, reading performance) across all students based upon a number of factors including engagement. The authors found that regardless of the participants' country of origin, engagement was the most important factor associated with higher reading performance.

Although, these studies (Brandimonte & Passolunghi, 1994; Kirsch et al., 2002; Voogt, 1987) do not address deeper level cognitive tasks, which rely on individual differences such as prior knowledge and reading skill (Best, Rowe, Ozuru, & McNamara, 2005), they do suggest that engagement can directly affect performance on a wide range

of activities. As a result, developing activities with the specific purpose of capturing student engagement would be an effective method for increasing classroom performance.

Serious Games

One such engaging activity might be a serious game. Serious games are games with educational goals (i.e., subject matter, problem solving strategies, cognitive skills, social skills) as their main objective (McNamara, Jackson, & Graesser, 2010; Michael & Chen, 2006). Serious games include the features of: rules, actions, uncertainty, and feedback. Numerous researchers (e.g., Gee, 2003; Rieber, 1996; Shaffer, 2004) have established how games and pedagogy are aligned. These games are intended to be an immersive environment with clear problem solving goals (Shute, Ventura, Bauer, & Zapata-Rivera, 2009). These immersive environments have characteristics that promote intrinsic motivation within the players; they are challenging, give the player control, and create fantasy to create curiosity and engage the player (Lepper & Malone, 1987; Malone, 1981; Rieber, 1996).

Many serious games incorporate a narrative style that allows the player to interact in a multi-linear story-telling manner (Gee, 2004; Van Eck, 2007; Young, 2006). The area of non-narrative serious games that focus on a short-term goal is a relatively unexplored field. Serious games have the potential to be engaging to learners and lead to more sustained learning in an educational setting (Gee, 2004; Steinkuehler, 2006; Van Eck, 2007; Vorderer & Bryant, 2006). However, there is little research in the area of serious games in comparison to the effectiveness of traditional ITS environments (O'Neil & Fisher, 2004; O'Neil & Perez, 2003; O'Neil, Wainess, & Baker, 2005). Because previous research has shown games to be engaging, the conclusion can be drawn that

adding serious games into ITSs would likely increase engagement within the systems.

Based on the current trend towards computer games, researchers have been investigating how to integrate computer games into classroom curricula (Annetta, Murray, Laird, Bohr, & Park, 2006; Bowman, 1982; Bracey, 1992). By incorporating serious computer games into the curriculum, educators are hoping to re-engage their students by providing them with more attractive options for completing assignments and objectives for the course.

Febretti and Garzotto (2009) investigated the relation between long-term engagement and "long" computer games. They defined long-term engagement as the degree of intentional, non-trivial use over an extended period of time. Long games are those that are intended to engage the user for any amount of time longer than one session. These games are often capable of being potentially unlimited in their gameplay (activities within a game session). Febretti and Garzotto evaluated games based on engagement and usability. Participants played the long games for 60-70 minute sessions, while observers made qualitative observations (i.e., excitement, commitment, intensity) about their engagement. The researchers found that engagement was weakly but significantly related to usability factors (i.e., ease of navigation). This finding may indicate that usability issues in long games could become distracting to the user. However, this finding does not lead to direct conclusions about shorter games that would only last between five and ten minutes. Whereas off-task activities may be extremely distracting in long games, these off-task activities may be tolerable in shorter games. However, while playing serious games, some of these distracting characteristics may be more problematic than others.

Further research is required to determine which would be most detrimental to performance.

Shute et al. (2009) made the claim that aspects of serious games can be found in more common quest-type games such as *Elder Scrolls IV: Oblivion*. First, the authors claimed that elements of persistence are demonstrated in character skill modification tasks. When serious games allow players to create a character and modify the character's abilities, the player is then motivated to perform a task to greater lengths, even in the face of failure, in order to gain useful skills for later gameplay. Second, there were elements of problem solving in completing the various quests that are required in the game. Quest-based games such as *Oblivion* require the player to explore all aspects of the game and synthesize information from those aspects to progress through the game. For example, a player may need to talk to a character to get information on where to find an item, then go find the item using their abilities to navigate the world, and finally once they find the item, use it to solve a puzzle. This scenario is not uncommon in quest-based games, but exhibits positive problem solving skills that many serious games would strive to elicit from a player. Finally, in many quest-based games, players engage in combat. Shute et al. see combat as a means of practice in attention and multitasking. The authors consider simple attention to the task at hand as something that serious games struggle to instill in players. By intensively presenting players with multiple variables (e.g., enemies), players must practice evaluating all possibilities and make decisions as to which is most threatening. Combat can be seen as a simple entertaining task, but the authors claim that serious game developers would be better served by considering the attention grabbing nature of combat and the multitasking practice environment that combat affords.

Shute et al. (2009) claim that the overall game environment not be centrally important to the goals of the serious game. Instead, the specific skills and strategies that the game is attempting to instill are likely the most crucial to the educational task and can be implemented through multiple avenues. These avenues could be of varying durations (e.g., Febretti & Garzotto, 2009; Young, 2006) and are intended to engage the student by presenting more options for digesting a curriculum (Annetta et al., 2006; Steinkuehler, 2006; Van Eck, 2007; Vorderer & Bryant, 2006). However, the elements within a game are likely very important to the overall gaming experience. Jefferson, Moncur, and Petrie (2010) evaluated the effect of adaptive opponent difficulty on immersion and engagement in a game using a survey designed to assess response to gameplay (Jennett et al., 2008). The authors created a "constraint-based" game which required players to solve puzzles given a predetermined number of parameters before each round started. The game required participants to arrange blocks with each block needing to project a laser to another block in a desired pattern. The lasers needed to all align between appropriate blocks before the level was considered completed. The authors created an adaptive difficulty system that took into account the previous trials for each user to set the difficulty level for each new level. If participants were quickly completing the previous levels, then the subsequent level would be more difficult by skipping the player ahead to more difficult levels. If the participants were having difficulty completing the previous levels, then the subsequent levels would be easier. The authors divided the participants into two groups: one with the adaptive difficulty algorithms and one that simply allowed participants to complete the levels in order. The authors found that there was a marginally significant difference in the participants' enjoyment of the game. Participants who played

the game with the adaptive difficulty opponent showed a trend of enjoying the game more than those who did not. These results indicate that the game environment as well as the game characteristics are likely responsible for a portion of the overall reaction to the game.

Individual Differences

The previous studies address the game as a whole. However, possibly the most important aspect of the gameplay experience is the player. The predispositions between the game players may be more powerful than the allure of the educational game. Specifically, a student may not enjoy games overall, may not be engaged by educational tasks, or may have a lower threshold for performance in an educational task. Therefore, designing games with these differences in mind may lead to more effective serious games.

Individual differences in gameplay. Individual differences in academic predisposition have been shown to be very important in any learning activity (Braten & Samuelstuen, 2004; Lorch et al., 1987; O'Reilly & McNamara, 2007). Therefore, any effects of an educational manipulation, such as inclusion of serious games in a curriculum, on engagement may depend on the individual characteristics of the game player. Charlton and Danforth (2007) investigated the relation of addiction and engagement in the context of computer games. The authors had players of an online multiplayer game, Asheron's Call, respond to a questionnaire that assessed both their engagement and their addiction to the game (Charlton, 2002). The questionnaire separated players into two categories: addicted players and highly engaged players. Players who were both addicted and engaged played the game for 31.92 hours per week,

while players who were engaged, but not addicted, only played for 16.08 hours per week. Because addiction led to such a large difference in gameplay, the results of this study led to the conclusion that there is an observable difference in behavior between types of computer game players. Specifically, these differences indicate that engagement can manifest differently among different types of game players.

Individual differences in personality can also affect gameplay. Boone, De Brabander, and van Witteloostuijn (1999) found that a game player's personality type could affect the way in which a player responds to the prisoner's dilemma scenario (Rapoport & Chammah, 1965). Boone et al. (1999) explored four different personality traits (i.e., locus of control, self-monitoring, type-A behavior, and sensation seeking) to determine if the personality traits would affect their behavior (i.e., cooperative vs. competitive) while playing a competitive game. The researchers found that internal locus of control, high self-monitoring, and high sensation seeking were all associated with cooperative behavior, while the presence of a type-A personality decreased the probability for cooperation in certain instances. This study supports the claim that individual personality types can produce predictable patterns within a serious game.

Bartle (1996, 2004) also makes the claim that all game players follow predictable paths depending on their gamer type. Bartle defines gamer type as a categorical set of preferences for online gameplay. These gamer types are expected to engage in predictable patterns of behavior during gameplay. Based on these gamer types (Achievers, Explorers, Socializers, and Killers), game designers can expect players to interact with their system in one of four ways. According to Bartle, Achievers tend to set their own goals; Explorers like to elicit all possible system responses; Socializers tend to

enjoy interacting with other players; And Killers tend to dominate all other players. These actions taken by each gamer type are expected to be systematic in nature. For example, when taking into account player attrition, some gamer types would likely quit games that they find to be too challenging. However, different types of game players could meet a challenge with different responses.

Based on the characteristics outlined by Bartle (1996, 2004), each gamer type is expected to respond in a different manner to challenges within online multiplayer games. Achievers are interested in gaining points and levels within the game. Explorers are interested in exposing the internal mechanisms of the game. Socializers are characterized by wanting to hear what other players have to say during the game. Killers are characterized by imposing their will on other players. Bartle claimed that these gamer types would dictate the interactions within, and ultimately the outcome of gameplay sessions. For example, Killers tend to easily dominate Achievers. However, Killers need a challenge in a game. If the challenge is not there, then the Killer will likely disengage from the game. Bartle's research suggests that individual differences in gameplay personality can affect the actual gameplay. These players even respond differently to events within the game. For example, Achievers like to gain status icons that often have little or no consequence to the game goals. Explorers quickly learn and exploit tips and tricks about a game. Bartle's results also indicated that Killers prefer to battle with human players as opposed to computer-based players and enjoy causing mayhem among opponents. Finally, Socializers enjoy interacting with other players in the game. While it is clear that gamer types have predictable behaviors, the research is unclear as to what events trigger these behaviors. Likely, these events are related to the amount and type of

challenges the game presents to the player. Too much of a challenge could cause some players to disengage, while too little challenge could cause others to disengage. Further study could investigate the possibility of gamer type and their response to challenges within a game.

The previous literature indicates that engagement and performance can be affected by the type of task being performed (Charlton & Danforth, 2007; Febretti & Garzotto, 2009) and the personality of the gamer (Boone et al., 1999). Specifically, games have characteristics that lead to engagement (Dickey, 2005). However, the effects associated with the engaging characteristics are likely subject to individual differences in gameplay.

Individual differences and engagement. Available research suggests that there is another plausible explanation for the relation between engagement and performance. As mentioned previously, studies have indicated that engagement is clearly linked with performance (Kirsch et al., 2002; Voogt, 1987). Furthermore, a dominant stance in current literature is that individual differences in personality play an important role in engagement (Klein et al., 2005; Langelaan, Bakker, Schaufeli, & van Doornen, 2006).

A study that addressed the potential link between engagement, performance, and individual differences in personality was conducted by Pintrich and De Groot (1990). The researchers had 173 students respond to a self-report questionnaire assessing their motivation, cognitive strategy use, metacognitive strategy use, and management of effort. The self-report responses were combined into factors of self-efficacy, intrinsic value, and test anxiety. The researchers found that self-efficacy and response to challenge were related to cognitive engagement and academic performance. These findings indicate that there is an observable link between performance and engagement and that they were

affected by challenge. However, these measures are correlational and point to the need for replication of these types of results with more direct measures such as a controlled manipulation of engagement. Pintrich and De Groot's (1990) results suggest that not only are engagement and performance related, but together, are affected by individual differences in personality. More specifically, the results provide evidence that challenging situations may affect engagement and performance.

Drawing from the results of Pintrich and DeGroot's (1990) study, a possible hypothesis is that when students with high self-efficacy encounter a challenging task, they are likely to become more engaged because they have a higher tolerance for success. However, if a student with low self-efficacy were given a challenging task, they may disengage and therefore not perform well. When students are presented with a challenging situation in a game environment, their engagement or disengagement will likely depend on their predispositions to games or gameplay style. The engagement or disengagement is particularly important in educational settings as serious games are being integrated in the curriculum.

iSTART

The current challenge is to create a more engaging educational task by adding game-like elements to educational tasks in an ITS. The ITS that will be used in the following experiments is iSTART (Interactive Strategy Training for Active Reading and Thinking). iSTART is an ITS created to teach reading strategies and improve students' reading comprehension. The iSTART system, originally modeled after a classroom-based program called SERT (Self-Explanation Reading Training: McNamara, 2004; McNamara & Scott, 2001; O'Reilly, Best, & McNamara, 2004), has consistently matched the gains

found in studies based on the human-based SERT program (Magliano et al., 2005; O'Reilly, Sinclair, & McNamara, 2004; O'Reilly, Best, & McNamara, 2004). iSTART is designed to be an automated, self-paced, and adaptable system that can be distributed to any school or individual with access to the Internet. To accomplish this goal, iSTART combines the use of pedagogical agents and underlying automated linguistic analysis to engage the student in an interactive dialog and create an active learning environment (Bransford, Brown, & Cocking, 2000; Graesser et al., 2005; Graesser, Hu, & Person, 2001; Louwerse, Graesser, & Olney, 2002). The following sections describe the iSTART components utilized in the current study.

iSTART training. iSTART training consists of an introduction module followed by demonstration and practice module. The format of the iSTART introduction is a trialogue between an animated teacher and two animated students. During the iSTART introduction module, participants are given a general description of self-explanations and taught five specific strategies for producing self-explanations. The five strategies are comprehension monitoring (being aware of your level of understanding about the text), paraphrasing (restating what you read in your own words), prediction (making an educated guess about what the text might say next), elaboration (adding your own world knowledge to what you are reading), and bridging (making logical connections between ideas in the text). Participants are given an example of each strategy to help understand how to use them. During the training, the teacher agent describes a strategy and the student agents ask questions and give an example of that strategy use for the teacher agent to correct. During this module, users are instructed on what the strategies are, when

they need to use the strategies, and why the strategies will help with their overall reading comprehension.

The demonstration module features a teacher and a student agent producing self-explanations and requires the student to identify the strategies used in each. The demonstration module features two different agents: Merlin and Genie. The teacher agent (Merlin) gives instruction to the student agent (Genie) before, during, and after each example self-explanation produced by Genie. Each time Genie produces a self-explanation, the student (user) is asked to identify the strategy used in the self-explanation as well as in what part of the text and self-explanation the strategy is being used. This module is adaptive to the student's skill level and provides more assistance after repeated poor performance. The student is given assistance by further explaining the strategies or reducing the number of choices for identifying the strategies used. The demonstration module also increases the difficulty as performance increases. To increase the difficulty, more choices are given for identifying strategies, as well as locating where strategies are being used.

Finally, in the iSTART extended practice module, users begin to generate self-explanations on their own. The extended practice module in iSTART allows users to work with the system over a long-term interaction (over the course of a semester) and receive adaptive feedback for each self-explanation that they produce. This interaction requires time and practice, but fosters the development of deep knowledge. The mastery of content and learning strategies that will generalize to multiple contexts and tasks does not happen in hours, but rather in weeks, months, or even years. Proficiency in content and strategies requires multiple sessions, across months of time (Jackson, Boonthum, &

McNamara, 2010; Newell & Rosenbloom, 1981). However, over time, this extended practice can become boring and tedious to users, particularly for those who need tutoring the most (Bell & McNamara, 2007). Because of the nature of the task, activities that increase or promote engagement are much needed. However, these engaging activities must not detract from learning or achievement within the system.

iSTART Coached Practice Module. The iSTART Coached Practice module (see Figure 1) is the original version of the iSTART extended practice module. Participants are presented with the text in the text box (upper left), type their response in the self-explanation box (lower right), and given points-based feedback (lower left) which is tracked through the entire session (upper right). Participants are guided through practice by Merlin, an animated wizard who provides qualitative feedback for user-generated self-explanations. Merlin reads sentences aloud to the participant and then asks the participant to self-explain each target sentence. After the participant completes each response, Merlin provides feedback on the quality of the self-explanation based on automatic algorithms that assess length, similarity, and overlap with the target text. The algorithm also assesses the answer based on outside information and returns a score to the participant that ranges between zero and three (McNamara, Boonthum, Levinstein, & Millis, 2007). Self-explanation quality is assessed through computer-based algorithms that compare the response to the current target sentence, the previous sentences in the text, as well as the relevant topic information pertaining to the text. Self-explanations are evaluated using a combination of LSA and lexical approaches. Responses that feature either bridging to previous information in the text or elaboration by adding relevant outside information receive a higher self-explanation quality score. Coached practice also

returns iSTART points ranging from 0-70, which are based on the self-explanation quality score (originally 0-3) and the participants' consistency (streak).

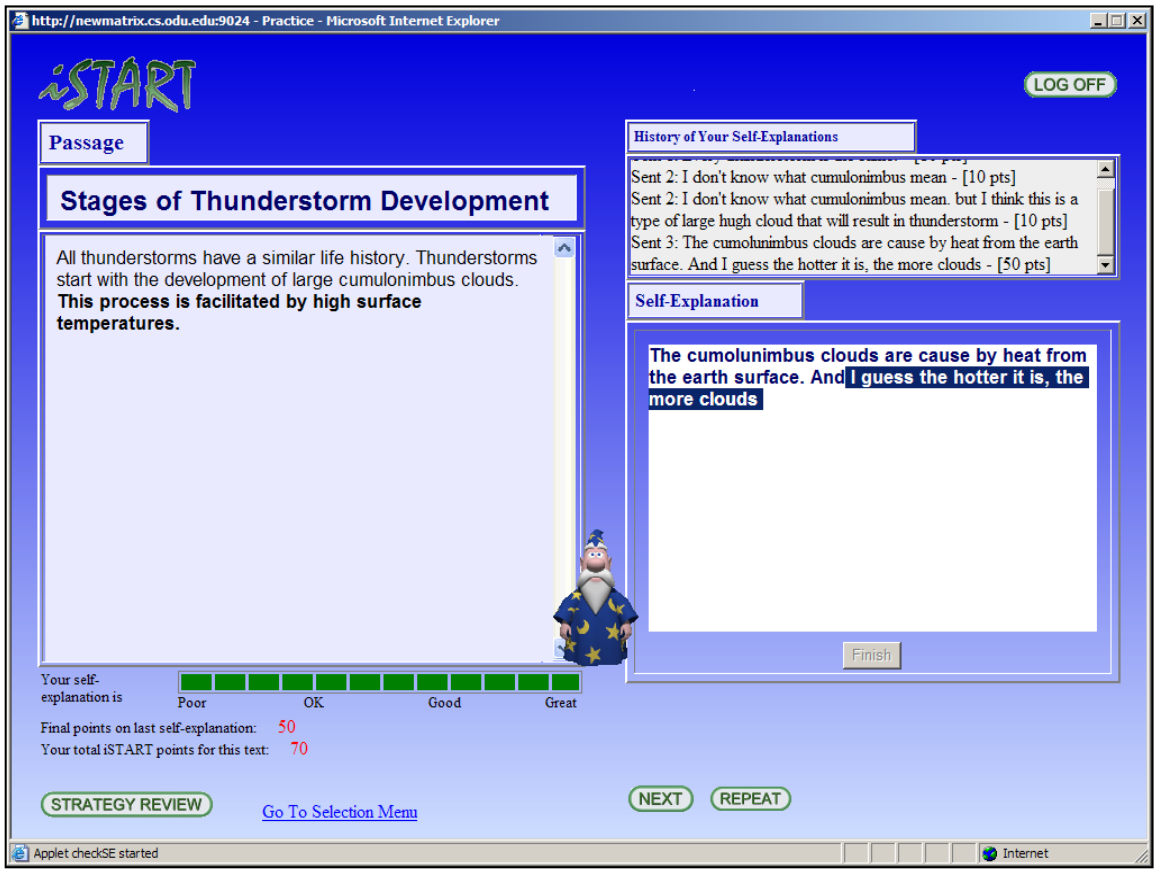

Figure 1. Coached Practice

Showdown. Showdown (as seen in Figure 2) is a game-based practice module. Participants compete against a computer player to win each sentence by writing better self-explanations. Participants are guided through the game by text-based instructions (generated by "Mr. Smiley" at bottom). Each text is presented one target sentence at a time (center). After the participant completes each self-explanation, the computer scores the self-explanation on a scale of 0-3 (using the same algorithm as Coached Practice) and displays the score as stars (on right) along with iSTART points (0-70; top left). The opponent's self-explanation is also presented and scored (0-3). Opponent self-

explanations are randomly selected from a database of user-generated self-explanations. The self-explanation scores are compared and the player with the highest score wins the sentence. In case of a tie score, the player is given another target sentence worth two sentences instead of one. The player competes against their opponent until all target sentences within a text are complete. The player who wins the most sentences (displayed at top as sentences won) at the end of the game is declared the winner.

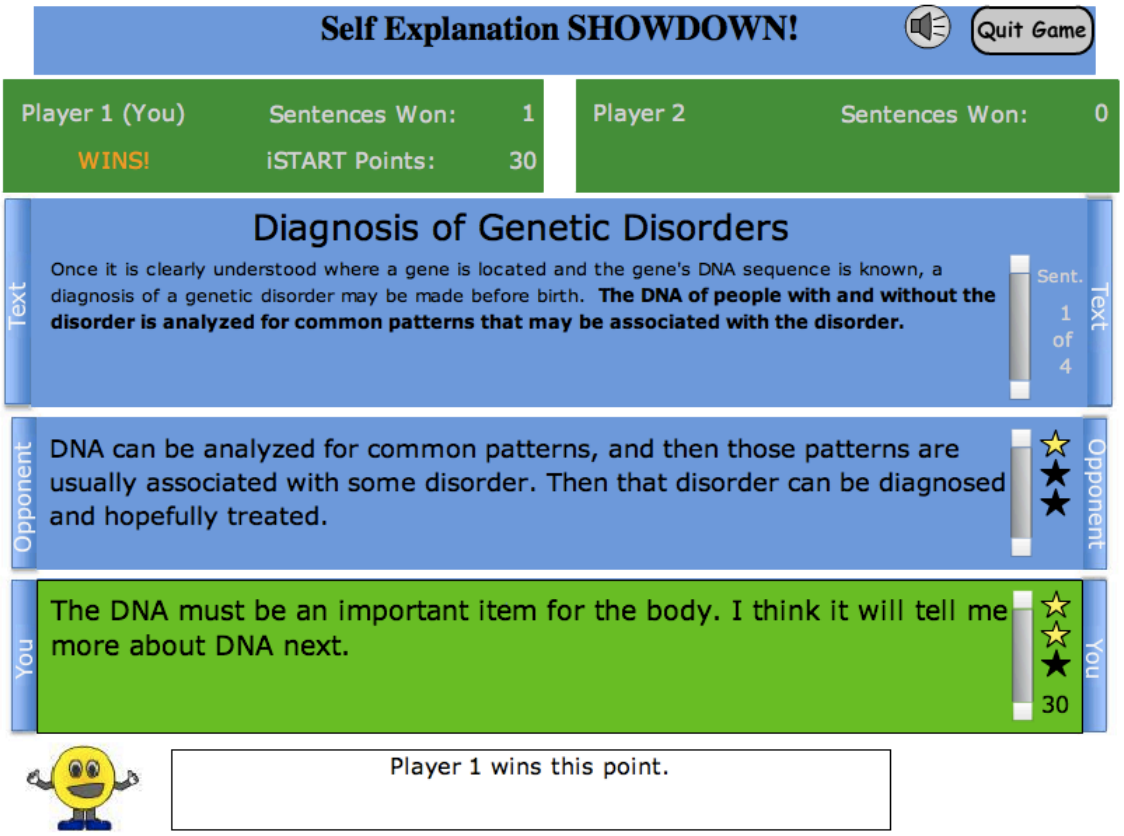

Figure 2. Showdown

Feedback

Both Coached Practice and Showdown feature a feedback system for self-explanation quality. Coached Practice provides feedback to the participant both in speech and text bubbles, and as a skill bar at the bottom of the module (as seen in Figure 1).

Merlin provides formative verbal and text-based feedback. The feedback addresses the aspects of the self-explanation that could be improved and provides tips on how to address the errors in the next attempt. The skill bar displays a meter that fills up depending on the self-explanation quality score. The score (0-3) is matched with a qualitative scale ranging from "poor" to "excellent" as well as a color-coded scale that turns from blank to red, yellow, or green. The module also provides the participant self-explanation quality feedback through a point-based system. Participants are given points based upon the quality of their self-explanation as well as their persistence in writing quality self-explanations.

Showdown's feedback system is a star-based system using the same algorithms as in Coached Practice. Self-explanation quality (0-3) is matched with the number of stars awarded for a self-explanation (0-3). The stars are then compared against the opponent's self-explanation score to determine the winner for each sentence. The participant also receives a point-based score as in Coached Practice.

A potentially interesting difference between Coached Practice and Showdown is the opportunity for modeling present in Showdown, but not in Coached Practice. While Showdown shows a self-explanation generated by another player, Coached Practice only displays the participants' responses. Fudenburg and Levine (1999) make the claim that during competitive gameplay, players are inclined to produce a response based on the level or content of the most recent opponent response. Specifically, game players model the responses of their opponents. This may be engaging or beneficial overall, as research has shown that students would rather receive modeling opportunities as opposed to

informative feedback (Bardine, 1999; Straub, 1997). This opportunity is available to Showdown players, but not to Coached Practice players.

Experiments

This dissertation included three experiments that investigated the presence of game-like elements and individual differences on engagement and performance. The purpose of Experiment 1 was to determine if the inclusion of game-like elements affected engagement and performance. The purpose of Experiment 2 was to determine if the inclusion of formative feedback in the game-based presentation affected engagement or performance. The purpose of Experiment 3 was to assess the effect of gamer type on the engagement and performance within an educational game. Specifically, Experiment 3 investigated how challenging scenarios (easy opponent vs. difficult opponent) within an educational game affected performance and engagement across different gamer types (Achiever, Explorer, Socializer, Killer)..

Hypotheses

In Experiment 1, varying the game-like elements in an ITS was expected to produce differences in performance. Specifically, when a student is using a game-based system in lieu of a non-game-based system, there is expected to be a benefit of increased engagement (Gee, 2004; Steinkuehler, 2006; Van Eck, 2007; Vorderer & Bryant, 2006). However, including game-like elements could also be distracting to learning goals (Gredler, 2003). While engaging, the distracting aspects of gameplay increase the possibility that adding games to iSTART could decrease self-explanation quality.

In Experiment 2, the amount of pedagogical feedback in the game system was expected to positively affect the performance within the system while not affecting

participants' engagement (e.g., Febretti & Garzotto, 2009). By including similar pedagogical feedback from Coached Practice, Showdown with feedback (Showdown-FB) was expected to be just as engaging as Showdown, but produce higher performance than Showdown.

Finally in Experiment 3, it was hypothesized that the overall effectiveness of a game-based practice system would be affected by opponent difficulty due to the opportunity for modeling high quality performance, and the differences would be based on participants' gamer type (Bartle, 1996; 2006). Specifically, those gamer types who enjoy defeating opponents (i.e., Killers) were expected to find less challenging opponents to be more engaging and more challenging opponents who they cannot defeat to be less engaging. Gamers who enjoy exploring the system (i.e., Explorers) were expected to show similar scores regardless of the challenge because of their inclination to explore all possible outcomes. When given a challenge, engagement within the system was expected to decrease for players (i.e., Socializers) who enjoy a social and non-adversarial interaction while playing games. In addition to engagement, there are several hypothesized trends for self-explanation performance. Social players were expected to be non-adversarial players and produce self-explanation scores similar to their opponent. By contrast, adversarial gamer types (Killers) have an inclination to produce high impact responses regardless of opponent. Because of this inclination, Killers were expected to produce high quality self-explanation scores against any opponent. Finally, Achievers tend to set goals for themselves outside the scope of the game goals. Because Achievers set their own goals, they are not expected to differ on performance or engagement based on opponent difficulty.

Experiment 1: Manipulating Self-Explanation Entry Format

Experiment 1 was a pilot study designed to assess the feasibility of investigating the effect of game-like elements on engagement and achievement within an ITS. Participants were given an abbreviated version of the iSTART introduction, which eliminated intermediary quizzes and reduced the numbers of examples for each strategy. After the brief introduction, participants then interacted with one of two practice modules, Coached Practice or Showdown. After the sessions, participants responded to an engagement scale (Jennett et al., 2008). Adding game-like elements to practice tasks in an ITS was expected to increase engagement. However, increased engagement might also decrease performance (self-explanation scores) if increased attention to the game comes at the sacrifice of attention to the pedagogical task.

Method

Participants

In this study, 36 participants from a Southern United States University participated in exchange for course credit. These participants were native English speakers and had no prior experience with the iSTART system. Participants were randomly assigned to either Coached Practice or Showdown. Previous reading strategy training studies investigating self-explanation quality demonstrated average effect sizes of $\eta^2 = .15$ ($\eta^2 = .05$, O'Reilly et al., 2004; $\eta^2 = .24$, McNamara, O'Reilly, Best, & Ozuru, 2006). A power analysis reveals that this sample size yields the power to reliably detect an effect size of $\eta^2 = .15$ (a = .05) with a power of $1 - b = .65$. Hence, this pilot study has a moderate amount of power to detect effect sizes observed in previous studies. Notably, however, both of these prior studies accounted for the prior knowledge of the reader,

which was not included in this study. No prior studies have examined engagement in the context of iSTART.

Design

Experiment 1 is a between-subjects design with participants assigned to one of two conditions (Coached Practice or Showdown). Because this study was a pilot study for further studies, in-depth demographics and other data were not collected. The dependent measures were self-explanation quality, engagement, enjoyment, and turn duration.

Procedure

This experiment consisted of two phases, the training phase and posttest phase. Both phases were completed during the same session. Participants signed an informed consent form upon arrival. During the training phase, participants engaged in an abbreviated iSTART introduction module (described earlier) for approximately 30 minutes. After the iSTART training session, participants were randomly assigned to either a Coached Practice session or a Showdown session, as described earlier. Both Coached Practice and Showdown are self-paced, but are expected to last approximately 30 to 45 minutes. During both the Coached Practice and Showdown sessions, participants completed the same two texts ("Sex Determination" and "Convection and Radiation") with the order counterbalanced to ensure there were no text order effects. After completing the training phase, the participants continued on to the posttest phase where they rated their overall engagement within the system (Jennett et al., 2008). Participants were asked to answer questions based upon their experience within their practice condition (Coached Practice or Showdown). Once the participants completed the posttest,

they were verbally debriefed by being explained the purpose of the study and were allowed to ask any questions.

Materials

iSTART Training. The iSTART training section used in the current study was an abbreviated version of the iSTART introduction. The abbreviated training module is the same as the full training module except without additional quizzes to assess strategy knowledge and any dialogue referencing the quizzes are removed. These quizzes are intended to assess the strategy knowledge as well as provide further clarification when the student does not fully understand the strategies. Also, while the full practice module features multiple examples of how to use each strategy, the abbreviated module contains only one example of each and lasts approximately thirty minutes. The abbreviated version of iSTART introduction is used in the current study to keep the time requirements shorter and standardize the material delivered to the participant.

Texts. The two texts used in the experiment were "Sex Determination" (see Appendix A) and "Convection and Radiation" (see Appendix B). These texts were selected from a larger corpus of age-appropriate texts (based on Flesch-Kincaid grade level). The texts were selected for their similarity in terms of linguistic features. Based on a statistical analysis, they are texts of similar length, difficulty level, and lexical complexity. Table 1 provides a more detailed description of the text characteristics using Coh-Metrix (Graesser, McNamara, Louwerse, & Cai, 2004).

Table 1
Text Characteristics

Measure	Sex Determination	Convection and Radiation
Number of Words	484	496
Number of Sentences	33	39
Words per Sentence	14.667	12.718
Syllables per Word	1.595	1.655
Flesch Reading Ease	57.011	53.913
Fleisch-Kincaid Grade Level	8.951	8.899
Argument Overlap, Adjacent Sentences	0.656	0.763
LSA Sentence-to-Sentence	0.609	0.512
Avg. Words before Main Verb in Main Clause	5.758	3.436
Celex, Mean for Content Words	1.975	2.008

Performance Measure. The achievement measure used in this study was the average iSTART score. Because Coached Practice requires participants to make subsequent attempts at poor self-explanations, only first attempts at a self-explanation were considered. Therefore, the performance score for each participant was calculated as the sum of all first-attempt self-explanation scores divided by the number of sentences completed. Previous studies have indicated that the iSTART algorithm score is a reliable measure of self-explanation quality and is comparable to human ratings (McNamara, Boonthum et al., 2007; Jackson et al., 2010).

Jennett et al. (2008) Engagement Survey. Engagement and enjoyment within the system were measured with separate subsections of the Jennett et al. (2008) scale, which was developed and used to measure responses to gaming (e.g., Jefferson, Moncur, & Petrie, 2010). As dictated by the scale, five engagement items and four enjoyment items from the overall scale were used as subscales. Scale items were modified to

increase the relevance to the current task. The score was computed based upon positive and negative weights for particular questions in the battery. The questions are on a 5-point likert scale. The engagement questions (see Table 2) focused on emotional involvement and desire to win. The enjoyment questions (see Table 3) focused on overall enjoyment and likeability of the system.

Table 2
Five questions from engagement scale adapted from Jennett et al. (2008)

Items
To what extent did you feel emotionally attached to the game?
To what extent were you interested in seeing how the game's events would progress?
How much did you want to "win" the game?
Were you in suspense about whether or not you would win or lose the game?
At any point did you find yourself become so involved that you wanted to speak to the game directly?

Table 3
Four questions from enjoyment scale adapted from Jennett et al. (2008)

Items
To what extent did you enjoy the graphics and the imagery?
How much would you say you enjoyed playing the game?
When interrupted, were you disappointed that the game was over?
Would you like to play the game again?

Turn Duration. Turn duration was also examined to determine if the practice conditions differed in the average amount of time that they spent to complete a self-explanation. One turn in either system consisted of presenting the text and target sentence

(sentence to be self-explained), formulating, typing, and submitting your self-explanation. All turn duration statistics were reported in seconds.

Results

Analyses

The dependent measures were average iSTART self-explanation score (ranging from 0-3), engagement scale score on the Jennett et al. (2008) survey, enjoyment scale score, and turn duration (text presentation plus time to type). The first analyses were conducted to determine if the specific text or text presentation order affected overall self-explanation quality or turn duration. Second, analyses were conducted to determine if the practice condition (Coached Practice or Showdown) affected the self-explanation quality, engagement, enjoyment, or turn duration (in seconds). Magnitude of variance explained is reported as eta squared (η^2), where η^2 values of .01, .06, and .14 are regarded as small, medium, and large respectively (Graesser, McNamara, & Kulikowich, in preparation) .

Text Effects

Analyses were conducted to determine if the specific text ("Sex Determination" or "Convection and Radiation") affected participants' self-explanation quality or turn duration (reported in seconds). Because the two texts were selected for their similarity on established cohesion measures (see Table 4), the results were expected to be similar across the two texts.

A 2 (text) x 2 (practice condition) factorial ANOVA was conducted with self-explanation quality and turn duration as the dependent variables. There was no interaction between text and practice condition on self-explanation quality, $F(1,34) = 1.619$, $MSE = .169$, $\eta^2 = .045$, $p = .212$, or turn duration, $F(1,34) = 1.344$, $MSE =$

795.893, $\eta^2 = .038$, $p = .254$. There was a large main effect of text on self-explanation quality, $F(1,34) = 5.846$, $MSE = .169$, $\eta^2 = .147$, $p = .021$, but no significant main effect of text on average turn duration, $F(1,34) = .473$, $MSE = 795.893$, $\eta^2 = .014$, $p = .496$. Means and standard errors are displayed in Table 4. Participants spent the same amount of time on each text, but produced higher quality self-explanations for the text "Sex Determination" as compared to the text "Convection and Radiation." The texts were counterbalanced to ensure that any differences would not affect the overall findings; therefore this difference was not considered to be an issue.

Table 4
Self-Explanation Quality and Turn Duration as a Function of Text and Practice Condition

Measure	Practice Condition	Sex Determination		Convection and Radiation	
		M	*SE*	*M*	*SE*
Self-Explanation Quality	Coached Practice	2.49	.10	2.61	.12
	Showdown	1.67	.10	2.03	.12
	Total**	2.08	.07	2.32	.09
Turn Duration	Coached Practice	161.18	8.58	158.04	9.44
	Showdown	71.89	8.58	84.17	9.44
	Total	116.53	6.06	121.11	6.68

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

A further analysis was conducted to determine if there was a text presentation order effect between the first and second text, such that participants performed better or more quickly on the second text. The text presentation order could affect the self-explanation quality, but was unlikely with practice limited to two texts. However, practice may provide more opportunity for the participant to learn how to navigate the system, thus reducing the turn duration.

A 2 (text presentation order) x 2 (practice condition) factorial ANOVA was conducted with self-explanation quality and turn duration as the dependent variables. There was no interaction between text presentation order and practice condition on self-explanation quality, $F(1,34) = .166$, $MSE = .202$, $\eta^2 = .005$, $p = .686$, or turn duration, $F(1,34) = .368$, $MSE = 753.225$, $\eta^2 = .011$, $p = .548$. There was no significant main effect of text presentation order on self-explanation quality, $F(1,34) = .573$, $MSE = .202$, $\eta^2 = .017$, $p = .454$, but there was a marginally significant, medium-sized main effect of text presentation order on turn duration, $F(1,34) = 3.478$, $MSE = 753.225$, $\eta^2 = .093$, $p = .071$. Means and standard errors are displayed in Table 5. As expected, participants produced similar quality self-explanations on the first text and second text, as well as a trend towards lower turn duration during the second text. Thus, participants were unable to develop or alter their self-explanation skills within in a two-text trial, but showed a trend of moving through the system more quickly.

Table 5
Self-Explanation Quality as a Function of Text Presentation Order and Practice Condition

Measure	Practice Condition	1st Text		2nd Text	
		M	*SE*	*M*	*SE*
Self-Explanation Quality	Coached Practice	2.48	.11	2.61	.12
	Showdown	1.83	.11	1.87	.12
	Total	2.16	.08	2.24	.09
Turn Duration	Coached Practice	167.61	9.67	151.62	8.18
	Showdown	82.10	9.67	73.96	8.18
	Total*	124.85	6.83	112.79	5.78

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

Main Analysis

A one-way ANOVA was conducted to determine if practice condition (Coached Practice or Showdown) affected the self-explanation quality, engagement, enjoyment, or turn duration (in seconds). Game-based practice was expected to be more engaging than the non-game-based practice, but it was unclear how the two types of practice would affect self-explanation quality or turn duration. Ideally, the practice conditions would not differ on the two measures, as the game-based practice was intended to recreate the non-game-based practice while only adding in game elements.

There was no significant interaction between text presentation order and condition on self-explanation scores, $F(1,34) = .166$, $MSE = .202$, $\eta^2 = .005$, $p = .686$. There was a significant large-sized main effect of practice condition on overall self-explanation quality, $F(1,34) = 29.744$, $MSE = .147$, $\eta^2 = .467$, $p < .001$, a large effect on first text self-explanation quality, $F(1,34) = 16.407$, $MSE = .235$, $\eta^2 = .325$, $p < .001$, a large effect on second text self-explanation quality: $F(1,34) = 18.863$, $MSE = .262$, $\eta^2 = .357$, $p < .001$), and a marginally significant, medium-sized effect on engagement, $F(1,34) = 3.693$, $\eta^2 = .100$, $p = .064$. There was no significant main effect of practice condition on enjoyment, $F(1,34) = .007$, $\eta^2 = .000$, $p = .933$, but there was a significant, large-sized main effect on turn duration, $F(1,34) = 56.180$, $\eta^2 = .623$, $p < .001$. Means and standard errors are displayed in Table 6. Participants in the Coached Practice condition produced higher quality self-explanations, reported being less engaged, and spent more time per turn interacting with the system than participants in the Showdown condition. However, neither condition's participants enjoyed their gameplay experience. Participants were expected to be more engaged by the game-based practice. However, the self-explanation

results were unexpected. The lower self-explanation scores indicate that participants were not being prompted to create high quality self-explanations in the same way that they were in the original non-game-based practice. Finally, participants spent more time per turn in Coached Practice as opposed to Showdown. This result can be attributed to the differences in text presentation and formative feedback. While Coached Practice presents each new sentence of the text one at a time, Showdown presents all new sentences together. Also, Coached Practice reads each new sentence aloud before continuing to the next sentence, while Showdown does not. These differences account for the significant differences in turn duration.

Table 6
Self-Explanation Quality, Engagement, Enjoyment, and Turn Duration as a Function of Practice Condition

Measure	Coached Practice		Showdown	
	M	*SE*	*M*	*SD*
Overall SE Quality***	2.54	.09	1.85	.09
First text SE quality***	2.49	.11	1.83	.11
Second Text SE Quality***	2.61	.12	1.87	.12
Engagement**	2.43	.23	3.04	.23
Enjoyment	2.25	.23	2.28	.23
Turn Duration (s)***	159.61	7.70	78.03	7.70

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

Summary

These findings indicated that Coached Practice was more effective and less engaging than Showdown. However, the two practice modules were equally enjoyable and participants spent more time in Coached Practice than in Showdown. These effects point to noticeable differences in the two practice conditions. First, the differences in

time spent in Coached Practice as compared to Showdown are likely based upon a feature difference between the two practice conditions. Coached Practice reads each sentence aloud to the participant. Second, Coached Practice requires the participant to wait until the system has completed presenting the text until typing, while Showdown allows the participant to type immediately. Third, participants in Coached Practice may be required to complete a self-explanation more than once, while participants in Showdown are not. And fourth, Coached Practice provides pedagogical feedback while Showdown does not. These results lead to the conclusion that Showdown, while more engaging, lacks pedagogical guidance as compared to Coached Practice. Experiment 2 attempts to bridge the gap in performance between the two modules while still retaining the improvement in engagement.

Experiment 2: Increasing Information Delivery in Showdown

Experiment 1 found that Showdown was more engaging but less effective at producing high quality performance than Coached Practice. The difference in performance may be due to the differences in the amount of pedagogical feedback between the two modules. Previous research indicates that instructional support can aid in game-based learning (Moreno & Mayer, 2005; Rieber, 2005; Shaffer, 2007; Swaak & de Jong, 2001). Based on these results and the findings of Experiment 1, the purpose of Experiment 2 was to increase the instructional support present within Showdown. Therefore, Experiment 2 compares Showdown-FB to both Coached Practice and Showdown. In Showdown, typical messages were purely procedural and designed to progress the game to the next target sentence and self-explanation (see Table 7).

Table 7
Showdown Messages

Feedback
Write your Self-explanation in the box above and click SUBMIT.
SHOWDOWN! Let me look at your self-explanations.
Player 1 wins the point.
Ready for the next sentence? Click the next sentence button.

Showdown-FB incorporates the formative feedback from Coached Practice into Showdown to create a more comparable practice module. Coached Practice feedback was adapted for use within Showdown and displayed at the end of each turn in the dialogue box where all other messages are displayed. The messages in Showdown-FB mirror the feedback responses in Coached Practice. This instructional feedback is designed to help shape subsequent self-explanations (see Table 8). The instructional feedback is based on the original Coached Practice feedback that is automatically generated via the iSTART algorithms. Based on these algorithms, the system provides both length-appropriate and strategy-appropriate feedback. See Appendix C for a complete list of feedback in the two modules. The feedback is presented at the bottom of the final screen for each turn, which contains multiple other gameplay elements.

Table 8
Example Showdown-FB Messages

Feedback
Write your Self-explanation in the box above and click SUBMIT.
SHOWDOWN! Let me look at your self-explanations.
Player 1 wins the point.
Say more next time to earn more stars. Click the next sentence button.

While providing the participant feedback on how to improve scores during gameplay, the feedback also contains motivational and engaging features that encourage competition with an opponent. Showdown-FB was expected to retain engagement benefits found in the original Showdown, but also remediate any potential decrease in self-explanation quality found in Experiment 1 from lack of qualitative feedback that may be present between Coached Practice and Showdown.

Table 9
Experiment 2 Design

Condition	Coached Practice	Showdown	Showdown-FB
Pedagogical Feedback	Yes	No	Yes
Competition	No	Yes	Yes

Method

Participants

This study included 82 students from a Southern United States University who participated in exchange for course credit. The participants included 60 females and 22 males, among which, there were 44 African-Americans, 30 Caucasians, and 8 participants of other ethnic background. These participants were native English speakers and had no prior experience with the iSTART system. Participants were randomly assigned to Coached Practice, Showdown, or Showdown-FB.

Previous reading strategy training studies investigating self-explanation quality demonstrated average effect sizes of $\eta^2 = .15$ ($\eta^2 = .05$, O'Reilly et al., 2004; $\eta^2 = .24$, McNamara et al., 2006). The sample in Experiment 2 includes 82 participants distributed

over three groups. A power analysis reveals that this sample size yields the power to reliably detect an effect size of $\eta^2 = .15$ ($a = .05$) with a power of $1 - b = .90$. Hence, this study has sufficient power to detect effect sizes observed in previous studies.

Design

Experiment 2 is a between-subjects design with participants in one of the three practice conditions (Coached Practice, Showdown, or Showdown-FB). The dependent measures were self-explanation quality, engagement, enjoyment, turn duration, and average feedback duration.

Procedure

The procedure in Experiment 2 was the same as in Experiment 1 with the addition of a demographics survey and the addition of Showdown-FB as a separate condition. The participants in Experiment 2 completed the abbreviated iSTART introduction module followed by Coached Practice, Showdown or Showdown-FB, and then the Jennett et al. (2008) engagement questionnaire.

Materials

The materials were the same as used in Experiment 1. However, Experiment 2 added a demographics questionnaire (Appendix E) and an additional Showdown condition, Showdown-FB. Showdown-FB is the same as the original Showdown with the addition of pedagogical feedback aimed at improving self-explanations.

Demographics. Participants in Experiment 2 completed a demographics questionnaire that assessed their attitudes toward areas such as games, computers, reading, and the current study. For a full list of demographic questions, see Appendix E.

Results

Analyses

The two principal dependent measures were average iSTART self-explanation score (ranging 0-3) and the engagement subscale score on the Jennett et al. (2008) questionnaire. First, analyses were conducted to determine if the specific text or text presentation order (comparisons between first and second text) affected the self-explanation quality, turn duration, or amount of time spent viewing the screen where feedback is presented in Showdown. Second, a set of preliminary analyses were conducted to determine if any of the three randomly assigned practice condition groups differed in their response to the demographic questions. Any differences were entered as covariates in the main analyses. Third, analyses were conducted to determine if the practice condition (Coached Practice, Showdown, or Showdown-FB) affected the self-explanation quality, engagement, enjoyment, turn duration, or amount of time spent viewing the feedback screen in Showdown.

Text Effects

The order of the texts was counterbalanced. Analyses were conducted to determine if the specific text ("Sex Determination" or "Convection and Radiation") affected participants' self-explanation quality, turn duration (reported in seconds), or amount of time spent viewing the feedback screen in Showdown (reported in seconds). Because the two texts were selected for their similarity on established cohesion measures (see Table 1), the two measures were expected to be similar.

A 2 (text) x 3 (practice condition) factorial ANOVA was conducted with self-explanation quality and turn duration as dependent measures. Means and standard errors

are displayed in Table 10. There was no significant interaction between text and practice condition on self-explanation quality, $F(2,78) = 1.468$, $MSE = .098$, $\eta^2 = .036$, $p = .237$, or turn duration, $F(2,78) = 2.665$, $MSE = 915.343$, $\eta^2 = .064$, $p = .076$. However, as found in Experiment 1, there was a significant, medium-sized main effect of text on self-explanation quality, $F(1,78) = 11.036$, $MSE = .098$, $\eta^2 = .124$, $p = .001$. Participants produced higher quality self-explanations for the text "Sex Determination" than for the text "Convection and Radiation". Text presentation was counterbalanced and therefore this difference is not expected to affect conclusions based on the results. There was not a significant main effect of text on the turn duration, $F(1,78) = .826$, $MSE = 914.343$, $\eta^2 = .010$, $p = .366$. Participants spent similar amounts of time on each text.

Showdown and Showdown-FB were compared to determine if the added feedback affected the amount of time spent viewing the feedback screen. A 2 (text) x 2 (practice condition) factorial ANOVA was conducted with feedback viewing duration as a dependent measure. Means and standard errors are shown in Table 10. There was no significant interaction between text and practice condition on feedback duration, $F(1,51) = .000$, $MSE = 1.533$, $\eta^2 = .000$, $p = .993$. There was not a significant main effect of text on the amount of time spent on the feedback screen, $F(1,51) = .509$, $MSE = 1.533$, $\eta^2 = .010$, $p = .479$, as shown in Table 10. Participants spent similar amounts of time across both conditions on the feedback screen for the text "Sex Determination" and the text "Convection and Radiation."

These results indicate that the two texts varied in their difficulty thus producing different levels of self-explanation quality. However, producing different quality responses did not require different amounts of time (turn duration or feedback duration)

to produce the differing quality. These results were consistent with the findings in Experiment 1 where participants produced higher quality responses for "Convection and Radiation," and were faster per turn on their second text.

Table 10
Self-Explanation Quality, Turn Duration, and Feedback Duration as a Function of Text and Practice Condition

Measure	Practice Condition	Sex Determination		Convection and Radiation	
		M	*SE*	*M*	*SE*
Self-Explanation Quality	Coached Practice	2.62	.09	2.67	.09
	Showdown	1.89	.10	2.16	.10
	Showdown-FB	2.01	.09	2.18	.09
	Total***	2.17	.05	2.34	.05
Turn Duration	Coached Practice	159.64	10.05	145.86	7.52
	Showdown	61.35	10.66	75.12	7.98
	Showdown-FB	64.74	10.07	65.61	7.53
	Total	95.24	5.85	95.53	4.37
Feedback Duration	Showdown	11.22	.39	11.06	.44
	Showdown-FB	11.37	.38	11.20	.43
	Total	11.30	.27	11.13	.30

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

Analyses were also conducted to determine the effect of text presentation order on self-explanation quality, turn duration, and amount of time spent viewing the feedback page in Showdown (reported in seconds). The text presentation order could affect the self-explanation quality, but would most likely not be apparent with completing only two texts. However, the text presentation order may affect the turn duration and amount of time spent viewing feedback in Showdown. While participants may not quickly learn the strategies that would improve their self-explanation quality, participants may be able to

learn the strategies to progress through the game in the same amount of time (i.e., navigating through the system or feedback screen).

A 2 (text presentation order) x 3 (practice condition) factorial ANOVA was conducted with self-explanation quality and turn duration as dependent measures. Means and standard errors are displayed in Table 11. There was not a significant interaction between text presentation order and condition on self-explanation quality, $F(2,78) = .416$, $MSE = .114$, $\eta^2 = .011$, $p = .661$, or turn duration, $F(2,78) = .307$, $MSE = 823.986$, $\eta^2 = .008$, $p = .737$. There was no significant main effect of text presentation order on self-explanation quality, $F(1,78) = .018$, $MSE = .114$, $\eta^2 = .000$, $p = .895$. There was no effect of text order on self-explanation quality and thus there were no effects of text presentation order. Therefore, subsequent analyses included both texts. There was a significant, large main effect of text presentation order on turn duration, $F(1,78) = 12.922$, $MSE = 823.986$, $\eta^2 = .142$, $p = .001$). Participants spent less time per turn on their second text.

Showdown and Showdown-FB were compared to determine if the added feedback affected the amount of time spent viewing the feedback screen. A 2 (text presentation order) x 2 (practice condition) factorial ANOVA was conducted with time spent on the feedback screen as a dependent measure. Means are displayed in Table 11. There was no significant interaction between text presentation order and practice condition on feedback duration, $F(1,51) = .015$, $MSE = 1.757$, $\eta^2 = .000$, $p = .904$. However, there was a significant, large-sized main effect of text presentation order on feedback duration, $F(1,51) = .41.474$, $MSE = 1.757$, $\eta^2 = .448$, $p < .001$. Participants spent more time on their turn overall as well as on the feedback screen when completing the first text as

compared to the second text. These results indicate that participants' self-explanation quality did not improve with the limited practice; however, their duration in progressing through the game interface shortened. These results were consistent with the expectations and findings from Experiment 1, as participants in Experiment 1 spent less time per turn on the second text.

Table 11
Self-Explanation Quality, Turn Duration, and Feedback Duration as a Function of Text Presentation Order and Practice Condition

Measure	Practice Condition	1st Text		2nd Text	
		M	*SE*	*M*	*SE*
Self-Explanation Quality	Coached Practice	2.60	.09	2.69	.10
	Showdown	2.04	.10	2.01	.10
	Showdown-FB	2.08	.09	2.11	.10
	Total	2.24	.05	2.27	.06
Turn Duration	Coached Practice	163.30	10.62	142.20	6.45
	Showdown	75.00	11.27	61.47	6.84
	Showdown-FB	72.05	10.64	58.31	6.46
	Total***	103.45	6.18	87.32	3.75
Feedback Duration	Showdown	11.68	.45	10.49	.35
	Showdown-FB	11.91	.44	10.77	.33
	Total***	11.79	.30	10.63	.24

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

Covariates

Demographic responses were examined to determine if there were any significant differences between conditions. As shown in Tables 12 and 13, there was a significant difference between the practice conditions on the response to the statement "I tend to be competitive", $F(2,79) = 3.275$, $p = .043$. Participants in the Showdown with no feedback condition tended to respond that they were less competitive than participants in the

coached practice condition and the Showdown-FB condition. As a result, participants' self-reported competitiveness was entered as a covariate in the analyses where all three conditions are compared.

As shown in Tables 12 and 13, there was a significant difference between the practice conditions on their response to the statement "I am motivated to participate", $F(2,79) = 3.145$, $p = .049$. Participants in the Showdown-FB condition were more motivated than participants in the Showdown with no feedback condition. As a result, participants' self-reported motivation was entered as a covariate in the analyses where only the two Showdown conditions are being compared since there were no differences involving the Coached Practice condition.

Table 12
Demographic Question Responses as a Function of Practice Condition

Measure	Coached Practice		Showdown with No Feedback		Showdown-FB	
	M	*SD*	*M*	*SD*	*M*	*SD*
I tend to be competitive**	4.64	.99	3.88	1.42	4.68	1.39
I am motivated to participate**	4.64	.87	4.42	1.33	5.11	.83

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

Table 13
Frequency of Demographic Question Responses by Category as a Function of Practice Condition

	Strongly Disagree	2	3	4	5	Strongly Agree
I tend to be competitive						
Coached Practice	0	0	3	11	7	7
Showdown No Feedback	2	1	8	6	5	4
Showdown Feedback	0	3	2	8	3	12
I am motivated to participate						
Coached Practice	0	0	2	11	10	5
Showdown No Feedback	1	1	4	6	8	6
Showdown Feedback	0	0	0	8	9	11

Main Analysis

A one-way ANCOVA with competitiveness as a covariate was conducted to determine if practice condition (Coached Practice, Showdown with no feedback or Showdown-FB) affected the self-explanation quality, engagement, enjoyment, turn duration, or amount of time spent viewing the feedback screen in Showdown. Based on the results of Experiment 1, Coached Practice was expected to be less engaging but produce higher quality self-explanations than Showdown with no Feedback. Showdown-FB is also expected to be more engaging than Coached Practice as well as expected to produce higher quality self-explanations than Showdown with no feedback. Finally, the two Showdown versions were expected to differ on the amount of time that participants spend viewing the feedback screen. Because Showdown-FB contains more pedagogical information than Showdown with no feedback, participants were expected to spend more time viewing extra information.

A 2 (text presentation order) x 3 (practice condition) factorial ANCOVA was conducted with competitiveness as a covariate and self-explanation quality as a dependent measure. Means and standard errors are displayed in Table 14. There was not a significant interaction between text presentation order and practice condition on self-explanation quality, $F(2,78) = .416$, $MSE = .114$, $\eta^2 = .011$, $p = .661$. As shown in Table 14, there was a significant, large main effect of practice condition on self-explanation quality overall averaging across texts, $F(2,78) = 16.808$, $MSE = .184$, $\eta^2 = .301$, $p < .001$, and a large-sized main effect for both the first text completed, $F(2,78) = 11.429$, $MSE = .231$, $\eta^2 = .227$, $p < .001$, and the second text completed, $F(2,78) = 14.335$, $MSE = .250$, $\eta^2 = .269$, $p < .001$. Participants in the Coached Practice condition produced higher quality self-explanations than participants in either Showdown condition. This finding was contrary to the predictions that adding pedagogical feedback to Showdown would improve self-explanation quality as compared to Showdown with no feedback.

Table 14
Self-Explanation Quality, Engagement, Enjoyment, and Feedback Duration as a Function of Practice Condition

Measure	Coached Practice		Showdown with No Feedback		Showdown-FB	
	M	*SE*	*M*	*SE*	*M*	*SE*
Total SE Quality***	2.64	.08	2.03	.09	2.10	.08
1st Text SE Quality***	2.60	.09	2.04	.10	2.08	.09
2nd Text SE Quality***	2.69	.10	2.01	.10	2.11	.10
Engagement*	2.82	.16	3.29	.17	3.12	.16
Enjoyment	2.36	.17	2.61	.19	2.47	.17
Turn Duration (s)***	152.75	7.89	68.23	8.37	65.18	7.91
Average Feedback Duration (s)			11.14	.45	11.28	.37
1st Text Feedback Duration (s)			11.66	.34	11.93	.44
2nd Text Feedback Duration (s)			10.62	.38	10.64	.33

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

A one-way ANCOVA with competitiveness as a covariate was used to test for differences in engagement and enjoyment among three practice conditions (Coached Practice, Showdown, and Showdown-FB). Means and standard errors are displayed in Table 14. There was no main effect of practice condition on engagement between the three conditions, $F(2,78) = 1.992$, $MSE = .738$, $\eta^2 = .049$, $p = .143$. Further analyses were conducted to determine if the results from Experiment 1 were replicated. The further investigation indicated that there was a marginally significant, medium-sized difference between Coached Practice and the original Showdown on engagement, $F(1,51) = 3.588$, $MSE = .733$, $\eta^2 = .066$, $p = .064$, but there was no difference in engagement between Coached Practice and Showdown-FB, $F(1,53) = 1.471$, $MSE = .863$, $\eta^2 = .027$, $p = .231$.

There was no significant main effect of practice condition on enjoyment, $F(2,78) = .463$, $MSE = .840$, $\eta^2 = .012$, $p = .631$, but there was a significant, large main effect of practice condition on turn duration, $F(2,78) = 39.105$, $MSE = 1724.888$, $\eta^2 = .501$, $p < .001$. There was a trend such that participants were more engaged in the Showdown condition than the Coached Practice condition, but no difference in engagement between Coached Practice and Showdown-FB. Participants showed no differences in enjoyment, but spent more time in each Coached Practice turn than in either Showdown condition turn. These results were consistent with the expectation that the results from Experiment 1 would be replicated, but were inconsistent with the expectation that the Showdown-FB would remain more engaging than Coached Practice.

Further analysis was conducted to determine if participants attended to the feedback screen differently between the two Showdown practice conditions. Participants were expected to spend more time viewing the feedback screen in the Showdown-FB condition than the Showdown with no feedback condition because of the added information on the screen. A one-way ANCOVA with participants' self-report motivation as a covariate was used to assess differences between the two practice conditions (Showdown and Showdown-FB). A 2 (text presentation order) x 2 (practice condition) factorial ANCOVA was conducted with time spent on the feedback screen as a dependent measure. Means and standard errors are displayed in Table 14. There was no significant interaction between text presentation order and practice condition on feedback duration, $F(1,51) = .015$, $MSE = 1.757$, $\eta^2 = .000$, $p = .904$. As shown in Table 14, there was no significant main effect of practice condition on overall time per turn spent on the feedback screen, $F(1,51) = .071$, $MSE = 3.578$, $\eta^2 = .001$, $p = .791$, or for either the first

text completed, $F(1,51) = .173$, $MSE = 5.100$, $\eta^2 = .003$, $p = .679$, or the second text completed, $F(1,51) = .002$, $MSE = 2.816$, $\eta^2 = .000$, $p = .968$. These results indicate that the added information on the feedback screen was not used in a significantly different manner, but was enough to slightly alter the engagement within the game. This was contrary to the prediction that the feedback would be attended to more, would produce higher quality self-explanations, and would not alter the engagement.

Summary

The results of Experiment 2 build on the results of Experiment 1. First, the results of Experiment 1 were essentially replicated. Participants produced higher quality self-explanations in Coached Practice as compared to the original version of Showdown with no feedback. Also, Showdown with no feedback was marginally more engaging than Coached Practice. This difference was also found in Experiment 1. The expectations of creating a version of Showdown with pedagogical feedback were that the pedagogical feedback would help mitigate the achievement deficit between Coached Practice and Showdown with no feedback while still maintaining the engagement benefits. However, the inclusion of pedagogical feedback not only produced self-explanation scores similar to Showdown, but including the pedagogical feedback resulted in Showdown-FB no longer being more engaging than Coached Practice. Furthermore, the amount of time that a participant spent viewing feedback in Showdown leads to the conclusion that when feedback was available, the participants likely did not attend to it, and when they did, they paid less attention to the feedback screen from the first text to the second text. In conclusion, adding pedagogical information to the "game" may not have been beneficial to the gameplay. The feedback also could have become counterproductive and unhelpful,

resulting in the participant moving more quickly through the feedback screens as their games progressed. Further study can benefit from investigating if other factors (i.e., individual differences or opponent difficulty) may contribute to the performance in the tasks to determine if these factors can be manipulated or harnessed.

Experiment 3: Determining Effect of Challenge within Gamer Type

Experiments 1 and 2 were conducted with the assumption that the presentation style and amount of feedback may affect the self-explanation quality and engagement. Experiment 3 was designed to assess the extent to which individual differences, in particular, gamer type, interacts with gameplay challenges. Experiment 3 determines the participants' gamer type (Bartle, 1996, 2004) and then presents the participants with either an easy or difficult opponent to assess whether different types of gamers produce different quality self-explanations. Experiment 3 also assessed whether participants are more or less engaged when presented with a challenging or non-challenging opponent within an online educational game.

Individual Differences: Gamer Type

Bartle (1996, 2004) separated video game players along individual characteristics related to their preferred actions during games. The Bartle gamer type scale (see Appendix D) is a questionnaire that classifies a game player (gamer) as one of four types: Achiever, Explorer, Killer, and Socializer. These four gamer types reflect the players' attention to the characteristics of the game stimuli using thirty dichotomous forced-choice questions (see Figure 3 for examples). The Bartle gamer type questionnaire was administered through a prescreening measure and scored prior to participation in the study. The gamer type was returned as percentages of each gamer type. Experiment 3

only considered the participants that had a distinctly higher score for one gamer type, above the other types. Participants with the highest distinction in each gamer type were invited to the study. Participants who had equal level responses in more than one gamer type were not used in the study.

Stem	Option 1	Option 2
Would you rather:	Become a hero faster than your friends	Know more secrets than your friends
Would you rather:	Know where to find things	Know how to get things
Is it better to be:	Feared	Loved
What's worse:	To be without friends	To be without power

Figure 3. Bartle Gamer Type Example Questions

Method

Participants

Experiment 3 included 121 participants. Due to errors in the Showdown logging system, 25 of those participants' data were unable to be used. Therefore, this study includes the remaining 96 students from a Southern United States University who participated in exchange for course credit. The final sample consisted of 59 female and 37 male participants. There were 31 African-American, 59 Caucasian, and 6 participants of other ethnicity. The participants were native English speakers and had no prior experience with the iSTART system. Approximately 25 undergraduates per gamer type were randomly assigned to either a challenging opponent or non-challenging opponent condition within the Showdown-FB module. The sample consisted of 24 Achievers, 26 Explorers, 26 Socializers, and 20 Killers. The number of Killers in the current study is lower than the other three groups because of low response rate (or low frequency) within the overall population.

Previous reading strategy training studies investigating self-explanation quality demonstrated average effect sizes of $\eta^2 = .15$ ($\eta^2 = .05$, O'Reilly et al., 2004; $\eta^2 = .24$, McNamara et al., 2006). A power analysis revealed that this sample size yielded the power to reliably detect an effect size of $\eta^2 = .15$ ($a = .05$) with a power of $1 - b = .81$. Hence, this study has sufficient power to detect effect sizes observed in previous studies.

Design

Experiment 3 is a 2 (opponent difficulty) x 4 (gamer type) between-subjects design with 4 different types of gamers (Achiever, Explorer, Socializer, and Killer) assigned to one of two conditions (easy opponent or difficult opponent). All participants completed the abbreviated iSTART introduction module, Showdown-FB with either an easy or difficult opponent, and an engagement measure. The game usually returns a randomly selected self-explanation as an opponent response. Within the easy condition, opponent self-explanations were selected based on if they had a score of 0 or 1. The difficult opponents only returned a self-explanation that had a score of 2 or 3. The dependent measures for experiment 3 were self-explanation quality, engagement, enjoyment, and feedback duration.

Procedure

Participants completed the Bartle gamer type questionnaire as part of a system-wide prescreening measure. After completing the prescreening measure, participants were invited to the study as needed depending upon their gamer type.

The participants in Experiment 3 completed the abbreviated iSTART introduction module followed by Showdown-FB (with either a challenging opponent or an unchallenging opponent), and then the engagement questionnaire.

The procedure was the same as Experiments 1 and 2 apart from the experimental conditions used for training and the additional individual differences questionnaire.

Materials

The materials were the same as in Experiment 1 and 2, except for the addition of the Bartle gamer type questionnaire prescreening measure (see Appendix D).

Results

Analyses

The dependent measures in the main analysis were iSTART self-explanation quality, responses to the Jennett et al. (2008) engagement and enjoyment questionnaire, and average time (in seconds) for each turn. First, a set of preliminary analyses were conducted to determine if either of the randomly assigned opponent difficulty conditions differed in response to the demographic questions. Any differences were then entered as covariates in the subsequent analyses. Second, analyses were conducted to determine if the specific text or order of text presentation affected self-explanation quality and average turn duration. Third, the main analyses were conducted to determine if participants' self-explanation quality, engagement, enjoyment, or turn duration vary as a function of the type of opponent (Easy or Difficult) and gamer type (Achiever, Explorer, Socializer, or Killer). Finally, separate analyses for each gamer type were conducted to further assess if the type of opponent (Easy or Difficult) affected any of the specific gamer types.

Covariates

Demographic responses were examined to determine if there were any significant differences between conditions. As shown in Tables 15, 16, and 17, there was a significant difference between the opponent difficulty groups on the response to the

statement "Computers frustrate me", $F(1,96) = 11.329$, $\eta^2 = .12$, $p = .001$, and "How often do you play games that help you learn?", $F(1,96) = 4.014$, $\eta^2 = .04$, $p = .048$. Participants with a difficult opponent responded via demographics that they were more frustrated by computers than participants with an easy opponent. Participants with an easy opponent responded via demographics that they played games that help them learn more frequently than participants with a difficult opponent. As a result, participants' self-reported frustration with computers and frequency of interaction with learning games were entered as covariates in the analyses where opponent difficulty was a factor.

Table 15
Demographic Question Responses as a Function of Opponent Difficulty

Measure	Easy Opponent		Difficult Opponent	
	M	*SD*	*M*	*SD*
Computers frustrate me***	2.08	1.00	2.92	1.43
How often do you play games that help you learn?**	1.88	1.50	1.29	1.43

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

Table 16
Responses to "Computers frustrate me" by Category as a Function of Opponent Difficulty

	Strongly Disagree	2	3	4	5	Strongly Agree
Easy Opponent	15	21	8	4	1	0
Difficult Opponent	6	20	6	8	7	2

Table 17
Responses to "How often do you play games that help you learn?" by Category as a Function of Opponent Difficulty

	Never	At least once per year	At least once per semester	At least once per month	At least once per week	At least once per day
Easy Opponent	10	13	11	5	8	2
Difficult Opponent	20	12	6	6	4	1

Text Effects

Analyses were conducted to determine if the specific text ("Sex Determination" or "Convection and Radiation") affected participants' self-explanation quality. Because the two texts were selected for their similarity on established cohesion measures (see Table 1), the self-explanation quality was expected to be similar. A 2 (text) x 2 (opponent difficulty) x 4 (gamer type) ANCOVA with frustration with computers and educational game exposure as covariates was conducted with self-explanation quality as a dependent measure. Means and standard errors are displayed in Table 18. There was not a significant interaction between text, gamer type, and opponent difficulty on self-explanation quality, $F(3,86) = .576$, $MSE = .090$, $\eta^2 = .020$, $p = .632$. There was also not a significant interaction between text and opponent type on self-explanation quality, $F(1,86) = .070$, $MSE = .090$, $\eta^2 = .001$, $p = .791$, or a significant interaction between text and gamer type on self-explanation quality, $F(3,86) = 1.017$, $MSE = .090$, $\eta^2 = .034$, $p = .389$. However, as found in Experiments 1 and 2, there was a significant, medium-sized main effect of text on self-explanation quality, $F(1,86) = 10.643$, $MSE = .090$, $\eta^2 = .110$, $p = .002$.

A similar 2 (text) x 2 (opponent difficulty) x 4 (gamer type) factorial ANCOVA with frustration with computers and educational game exposure as covariates was conducted with turn duration as a dependent measure. Means and standard errors are displayed in Table 18. Due to database errors, turn duration data was unavailable for 13 participants. The remaining participants were included within the following time-based analyses. There was not a significant interaction between text, gamer type, and opponent difficulty on turn duration, $F(3,73) = .879$, $MSE = 247.772$, $\eta^2 = .035$, $p = .456$. There was also not a significant interaction between text and opponent type on turn duration, $F(1,73) = .034$, $MSE = 247.772$, $\eta^2 = .000$, $p = .855$, or between text and gamer type on turn duration, $F(3,73) = 1.155$, $MSE = 247.772$, $\eta^2 = .045$, $p = .333$. As found in Experiments 1 and 2, there was not a significant main effect of text on turn duration, $F(1,73) = .001$, $MSE = 247.772$, $\eta^2 = .000$, $p = .972$. Participants produced higher quality self-explanations with the text "Sex Determination" than with the text "Convection and Radiation", although they did not take more time to produce the higher quality self-explanations.

Table 18
Self-Explanation Quality and Turn Duration as a Function of Text, Gamer Type, and Opponent Difficulty

			Sex Determination			Convection and Radiation		
Measure	Gamer Type	Opponent	*N*	*M*	*SE*	*N*	*M*	*SE*
SE	Achiever	Easy	12	2.08	.14	12	2.23	.14
		Difficult	12	2.48	.14	12	2.43	.14
		Total	24	2.28	.10	24	2.33	.10
	Explorer	Easy	13	2.35	.13	13	2.43	.14
		Difficult	13	2.44	.13	13	2.56	.13
		Total	26	2.40	.09	26	2.50	.10
	Socializer	Easy	12	1.97	.14	12	2.23	.14
		Difficult	14	2.41	.13	14	2.63	.13
		Total	26	2.19	.09	26	2.43	.09
	Killer	Easy	11	2.28	.14	11	2.41	.15
		Difficult	9	2.42	.16	9	2.66	.16
		Total	20	2.35	.11	20	2.54	.11
	Total***		96	2.31	.05	96	2.45	.05
Turn Duration	Achiever	Easy	12	62.83	7.45	12	63.19	6.43
		Difficult	10	70.91	8.18	10	62.27	7.06
		Total	22	66.87	5.36	22	62.73	4.63
	Explorer	Easy	11	65.89	7.72	11	68.06	6.66
		Difficult	11	70.13	7.61	11	83.13	6.57
		Total	22	68.01	5.41	22	75.59	4.67
	Socializer	Easy	11	52.79	7.57	11	54.48	6.53
		Difficult	13	69.53	6.98	13	64.38	6.02
		Total	24	61.16	5.13	24	59.43	4.43
	Killer	Easy	7	59.53	9.54	7	56.92	8.23
		Difficult	8	78.09	9.17	8	76.55	7.92
		Total	15	68.80	6.56	15	66.74	5.66
	Total		83	66.21	2.80	83	66.12	2.42

Note. Database errors account for lower N in turn duration statistics; ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

A further analysis was conducted to determine the effect of text presentation order on turn duration. While participants may not quickly learn the strategies that would improve their self-explanation quality, participants may be able to learn the strategies to progress through the game.

A 2 (text presentation order) x 2 (opponent difficulty) x 4 (gamer type) factorial ANCOVA with frustration with computers and educational game exposure as covariates was conducted with self-explanation quality as a dependent measure. Means and standard errors are displayed in Table 19. There was not a significant interaction between text presentation order, gamer type, and opponent difficulty on self-explanation quality, $F(3,86) = 2.101$, $MSE = .097$, $\eta^2 = .068$, $p = .106$. There was also no significant interaction between text presentation order and opponent difficulty on self-explanation quality, $F(1,86) = 1.386$, $MSE = .097$, $\eta^2 = .016$, $p = .245$, or between text presentation order and gamer type on self-explanation quality, $F(3,86) = .365$, $MSE = .097$, $\eta^2 = .013$, $p = .779$. There was no significant main effect of order on self-explanation quality, $F(1,86) = .920$, $MSE = .097$, $\eta^2 = .011$, $p = .340$. There were no effects of text presentation order on self-explanation quality.

A similar 2 (text presentation order) x 2 (opponent difficulty) x 4 (gamer type) factorial ANCOVA with frustration with computers and educational game exposure as covariates was conducted with turn duration as a dependent measure. Means and standard errors are displayed in Table 19. Again, due to software errors, 13 participants were omitted from the following time-based analyses. There was not a significant interaction between text presentation order, gamer type, and opponent difficulty on turn duration, $F(3,73) = .131$, $MSE = 141.248$, $\eta^2 = .005$, $p = .947$. There was no significant interaction between text presentation order and opponent type on turn duration, $F(1,73) = .451$, $MSE = 141.248$, $\eta^2 = .006$, $p = .504$. There was a significant, large interaction between text presentation order and gamer type on turn duration, $F(3,73) = 4.094$, $MSE = 141.248$, $\eta^2 = .144$, $p = .010$. There were significant, large main effects of text presentation order on

turn duration for Achievers, $F(1,18) = 12.684$, $MSE = 158.535$, $\eta^2 = .413$, $p = .002$, and Socializers, $F(1,20) = 4.633$, $MSE = 94.069$, $\eta^2 = .188$, $p = .044$, but not for Explorers, $F(1,18) = .030$, $MSE = 113.501$, $\eta^2 = .002$, $p = .864$, or Killers, $F(1,11) = 2.025$, $MSE = 216.473$, $\eta^2 = .155$, $p = .182$. There was a significant, large-sized main effect of text presentation order on turn duration, $F(1,73) = 46.455$, $MSE = 141.248$, $\eta^2 = .389$, $p < .001$. Similar to Experiments 1 and 2, participants spent less time per turn playing Showdown during their second text. This result was in the expected direction, as the replicated findings from experiments 1 and 2. Participants did not improve their self-explanation skills within two texts, however they were likely able to learn the game mechanics and game strategies that allowed them to progress through the system more quickly in those two texts.

Table 19
Self-Explanation Quality and Turn Duration as a Function of Text Presentation Order, Gamer Type, and Opponent Difficulty

			1st Text			2nd Text		
Measure	Gamer Type	Opponent	*N*	*M*	*SE*	*N*	*M*	*SE*
SE	Achiever	Easy	12	2.15	.14	12	2.16	.15
		Difficult	12	2.50	.14	12	2.42	.15
		Total	24	1.32	.09	24	2.29	.10
	Explorer	Easy	13	2.36	.13	13	2.42	.14
		Difficult	13	2.48	.13	13	2.52	.14
		Total	26	2.42	.09	26	2.47	.10
	Socializer	Easy	12	2.09	.13	12	2.11	.14
		Difficult	14	2.44	.12	14	2.60	.13
		Total	26	2.27	.09	26	2.35	.10
	Killer	Easy	11	2.18	.14	11	2.51	.15
		Difficult	9	2.63	.16	9	2.45	.17
		Total	20	2.41	.11	20	2.48	.11
	Total		96	2.35	.05	96	2.40	.05
Turn Duration	Achiever	Easy	12	73.80	7.03	12	52.22	6.16
		Difficult	10	79.72	7.72	10	53.47	6.77
		Total***	22	76.76	5.06	22	52.84	4.44
	Explorer	Easy	11	71.33	7.28	11	62.61	6.39
		Difficult	11	81.53	7.18	11	71.72	6.29
		Total	22	76.43	5.14	22	67.17	4.47
	Socializer	Easy	11	57.41	49.87	11	49.87	6.26
		Difficult	13	73.34	6.58	13	60.57	5.77
		Total**	24	65.38	4.84	24	55.22	4.24
	Killer	Easy	7	62.25	9.00	7	54.21	7.89
		Difficult	8	81.24	8.66	8	73.37	7.59
		Total	15	71.75	6.19	15	63.79	5.43
	Total***		83	72.58	2.65	83	59.76	2.32

Note. Database errors account for lower N in turn duration statistics; ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

Main Analysis

A 2 (text presentation order) x 2 (opponent difficulty) x 4 (gamer type) factorial ANCOVA with frustration with computers and educational gameplay frequency as covariates was conducted with opponent difficulty and gamer type as between-subjects

variables and self-explanation quality, engagement, enjoyment, and turn duration as dependent measures. Means and standard errors are displayed in Table 20.

Table 20

Means with Standard Error for Self-explanation Quality, Engagement, Enjoyment, and Turn Duration as a Function of Gamer Type and Opponent Difficulty

		Easy Opponent		Difficult Opponent	
		M	*SE*	*M*	*SE*
Total SE Quality	Achievers	2.09	.13	2.45	.14
	Explorers	2.32	.13	2.36	.13
	Socializers**	2.08	.15	2.49	.12
	Killers	2.29	.17	2.46	.19
		Easy Opponent		Difficult Opponent	
		M	*SE*	*M*	*SE*
1st Text SE Quality	Achievers	2.07	.13	2.52	.14
	Explorers	2.33	.14	2.42	.13
	Socializers	2.06	.15	2.42	.12
	Killers	2.10	.17	2.56	.19
		Easy Opponent		Difficult Opponent	
		M	*SE*	*M*	*SE*
2nd Text SE Quality	Achievers	2.11	.16	2.39	.18
	Explorers	2.32	.17	2.31	.17
	Socializers**	2.10	.18	2.57	.15
	Killers	2.48	.21	2.36	.23
		Easy Opponent		Difficult Opponent	
		M	*SE*	*M*	*SE*
Engagement	Achievers	2.76	.25	2.83	.28
	Explorers**	2.14	.27	2.99	.26
	Socializers**	2.44	.28	3.20	.24
	Killers	3.05	.34	2.95	.36
		Easy Opponent		Difficult Opponent	
		M	*SE*	*M*	*SE*
Enjoyment	Achievers	2.56	.23	2.41	.26
	Explorers**	2.09	.25	2.92	.24
	Socializers	2.48	.27	2.45	.22
	Killers	2.67	.31	2.62	.34
		Easy Opponent		Difficult Opponent	
		M	*SE*	*M*	*SE*
Turn Duration (s)	Achievers	60.08	5.89	62.35	6.70
	Explorers	59.76	5.46	69.53	6.29
	Socializers	53.66	6.83	67.57	5.70
	Killers	57.09	8.07	77.10	8.68

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

Main effects of opponent difficulty and gamer type were expected on all dependent variables within the study (self-explanation quality, engagement, enjoyment, and turn duration). Means and standard errors are presented in Tables 20, 21, and 23. All participants were expected to produce higher quality responses and be more engaged by difficult opponents due to the opportunity to model high quality responses from difficult opponents. Modeling high quality responses would likely require the participant to be more engaged than if producing a low quality response. Achievers were not expected to differ in their response to opponent difficulty. Explorers were expected to spend longer in the game than other players because they were expected to spend more time exploring and testing the features of the game and testing their limits of the system. Socializers were expected to be more engaged and glean more enjoyment from the game than other gamer types based on the perceived interaction with another player. And finally, Killers were expected to produce higher quality self-explanations than all other gamer types.

There was not a significant interaction between text presentation order, gamer type, and opponent difficulty on self-explanation quality, $F(3,86) = 2.101$, $MSE = .097$, $\eta^2 = .068$, $p = .106$. There was not a significant interaction between gamer type and opponent difficulty on self-explanation quality, $F(3,86) = .631$, $MSE = .361$, $\eta^2 = .022$, $p = .597$. There was also not a significant interaction between text presentation order and opponent difficulty on self-explanation quality, $F(1,86) = 1.368$, $MSE = .097$, $\eta^2 = .016$, $p = .245$, or between text presentation order and gamer type on self-explanation quality, $F(1,86) = .365$, $MSE = .097$, $\eta^2 = .013$, $p = .779$. There was not a significant interaction between gamer type and opponent difficulty on engagement, $F(3,87) = 1.122$, $MSE = .811$, $\eta^2 = .037$, $p = .344$. There was not an interaction between gamer type and opponent

difficulty on enjoyment, $F(3,87) = 1.340$, $MSE = .660$, $\eta^2 = .044$, $p = .267$. There was not an interaction between gamer type and opponent difficulty on turn duration, $F(3,73) = .450$, $MSE = 423.012$, $\eta^2 = .018$, $p = .718$.

Analyses were conducted to determine if there was a main effect of type of opponent (easy or difficult) on all dependent variables within the study (self-explanation quality, engagement, enjoyment, and turn duration). Means and standard errors are displayed in Table 21. Difficult opponents were expected to produce a more challenging task during the game. Participants were expected to respond to this challenging task with higher quality self-explanation scores, higher engagement, and increased turn duration. These results were expected because a more difficult opponent would potentially increase the probability that the participant would produce higher quality self-explanations to compete with the computer opponent (research indicates that players model the most recent opponent response; Fudenberg & Levine, 1999). Producing higher quality self-explanations was expected to require the participant to be more engaged and take longer to produce the better self-explanations.

Table 21
Self-Explanation Quality, Engagement, Enjoyment, and Turn Duration as a Function of Opponent Difficulty

	Easy Opponent		Difficult Opponent	
	M	*SE*	*M*	*SE*
Overall SE Quality***	2.19	.07	2.44	.08
First text SE quality***	2.14	.07	2.48	.08
Second Text SE Quality*	2.25	.09	2.41	.09
Engagement**	2.60	.15	3.00	.15
Enjoyment	2.45	.14	2.60	.14
Turn Duration (s)**	57.65	3.48	69.14	3.53

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

There were significant medium main effects of opponent type on self-explanation quality overall, $F(1,86) = 7.203$, $MSE = .180$, $\eta^2 = .077$, $p = .009$, and self-explanation quality for the first text completed, $F(1,86) = 9.197$, $MSE = .212$, $\eta^2 = .097$, $p = .003$, and a marginally significant small main effect for the second text completed $F(1,86) = 3.176$, $MSE = .245$, $\eta^2 = .036$, $p = .078$. There was a significant, medium-sized main effect of opponent type on engagement, $F(1,87) = 6.141$, $MSE = .811$, $\eta^2 = .066$, $p = .015$. The main effect of opponent difficulty on enjoyment was not significant, $F(1,87) = 2.769$, $MSE = .660$, $\eta^2 = .031$, $p = .100$. There was a significant, medium-sized main effect of opponent difficulty on turn duration while playing Showdown, $F(1,73) = 5.350$, $MSE = 423.012$, $\eta^2 = .068$, $p = .024$. When presented with a difficult opponent, participants produced higher quality self-explanations, were generally more engaged, and spent more time playing the game than when playing against an easy opponent. Participants reported similar levels of enjoyment regardless of opponent difficulty. These results were consistent with the predictions that more skilled opponents would prompt participants to produce higher quality self-explanations, either through competitive desire or through modeling (Fudenburg & Levine, 1999). Participants were also expected to be more engaged in the gameplay experience when playing against a more skilled opponent. This result combined with the result that participants spent more time per turn when playing a difficult opponent, indicates that participants were more careful in their gameplay while playing against a difficult opponent.

The participants' response to difficult opponents is likely either a modeling response (Fudenburg & Levine, 1999), or a competitive response. To investigate this possibility, participants' self-report competitiveness was separated into more- and less-

competitive categories via a median split. Two potential hypotheses motivate the analyses. First, the increased performance and engagement associated with difficult opponents could be due to competitive players wanting to keep up with a difficult opponent. If competitiveness was responsible for the effect, then difficult opponents would only elicit high quality responses from competitive participants. Second, the increased performance and engagement associated with difficult opponents could be due to participants modeling their response after the most recent opponent response (Fudenburg & Levine, 1999). If opponents are modeling, then their self-explanation quality will depend on their opponent's ability. Instead, there will likely be an increase in engagement for less-competitive participants who are attempting to simply recall and copy the previous opponent response instead of putting forth competitive effort in the game.

A 2 (text presentation order) x 2 (competitiveness) x 2 (opponent difficulty) factorial ANCOVA was conducted on self-explanation quality. Means and standard errors are displayed in Table 22. There was not a significant three-way interaction between text presentation order, competitiveness, and opponent difficulty, $F(3,77) = .072$, $MSE = .104$, $\eta^2 = .009$, $p = .407$. There was not a significant two-way interaction between competitiveness and opponent difficulty for self-explanation quality, $F(1,77) = .225$, $MSE = .191$, $\eta^2 = .003$, $p = .636$. There was not a significant main effect of competitiveness on self-explanation quality, $F(1,77) = 1.553$, $MSE = .191$, $\eta^2 = .020$, $p = .216$. Competitive participants did not respond any differently to a difficult opponent than less-competitive participants. This result indicates that competitiveness is likely not the critical factor in the increased performance associated with difficult opponents.

Table 22

Engagement and Enjoyment as a Function of Competitiveness and Opponent Difficulty

		Easy Opponent		Difficult Opponent	
		M	*SE*	*M*	*SE*
Engagement	Less Competitive**	2.24	.20	3.23	.22
	More Competitive	2.76	.17	2.90	.16
Enjoyment	Less Competitive**	2.06	.19	2.81	.20
	More Competitive	2.46	.16	2.43	.16
Turn Duration	Less Competitive***	57.60	4.99	89.99	6.17
	More Competitive	63.19	4.24	65.69	3.87

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

There was a significant, medium-sized two-way interaction between participants' competitiveness and opponent difficulty on engagement, $F(1,79) = 5.366$, $MSE = .727$, $\eta^2 = .064$, $p = .023$. Less competitive participants were more engaged by difficult opponents, $F(1,32) = 9.955$, $MSE = .830$, $\eta^2 = .237$, $p = .003$, while more competitive participants were not, $F(1,39) = .315$, $MSE = .643$, $\eta^2 = .007$, $p = .577$. There was not a significant main effect of competitiveness on engagement, $F(1,79) = .290$, $MSE = .727$, $\eta^2 = .004$, $p = .592$. There was a significant, small-sized two-way interaction between participants' competitiveness and opponent difficulty on enjoyment, $F(1,79) = 4.927$, $MSE = .652$, $\eta^2 = .059$, $p = .029$. Less competitive participants enjoyed difficult opponents more than easy opponents, $F(1,32) = 6.600$, $MSE = .623$, $\eta^2 = .171$, $p = .015$, while more competitive participants did not, $F(1,45) = .002$, $MSE = .682$, $\eta^2 = .000$, $p = .964$. There was not a significant main effect of competitiveness on enjoyment, $F(1,79) = .003$, $MSE = .652$, $\eta^2 = .000$, $p = .960$.

There was a significant, medium-sized two-way interaction between participants' competitiveness and opponent difficulty on turn duration, $F(1,65) = 9.457$, $MSE =$

368.311, η^2 = .127, p = .003. Less competitive participants enjoyed difficult opponents more than easy opponents, F(1,25) = 10.357, MSE = 525.420, η^2 = .293, p = .004, while more competitive participants did not, F(1,38) = .452, MSE = 276.437, η^2 = .012, p = .506. There was a marginally significant, small-sized main effect of competitiveness on turn duration, F(1,65) = 3.753, MSE = 386.311, η^2 = .055, p = .057. There was a trend that less competitive participants took longer per turn than more competitive participants. These results indicate that less competitive participants were more engaged, enjoyed their experience more, and took longer per turn when presented with a difficult opponent as opposed to an easy opponent, while more-competitive participants did not. The differences in results based on competitiveness is an indication that less-competitive participants are likely modeling their responses after the most recent opponent response. In this situation, modeling a high quality self-explanation would likely require the participant to be more engaged and spend more time per turn to produce a self-explanation.

There were also no main effects of gamer type on self-explanation quality, F(3, 86) = .828, MSE = .180, η^2 = .028, p = .482, first text, F(3,86) = .602, MSE = .212, η^2 = .021, p = .616, second text, F(3,86) = .841, MSE = .245, η^2 = 028, p = .475, engagement, F(3,87) = .352, MSE = .811, η^2 = .012, p = .787, enjoyment, F(3,87) = .247, MSE = 660, η^2 = .008, p = .863, or turn duration (reported in seconds), F(3,73) = 1.243, MSE = 423.012, η^2 = .049, p = .300. Based on these results, the predicted relations were not significant. The gamer types exhibited no differences in self-explanation quality, engagement, enjoyment, and amount of time spent on each turn, nor did the gamer types significantly interact with opponent difficulty on any of the dependent measures.

Analyses by Gamer Type

Because the expectations of this interaction involved specific expectations for each gamer, further analysis is separated by the gamer types in the following sections. Although the main effect of gamer type was not significant, there were expected results involving specific gamer types as well as potential interactions between gamer type and opponent difficulty. Thus, further analyses were conducted to fully explore these predictions. Means and standard errors are displayed in Table 23.

Table 23
Means and Standard Error for Self-Explanation Quality, Engagement, Enjoyment, and Turn Duration as a Function of Gamer Type

Measure	Achievers		Explorers		Socializers		Killers	
	M	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Total SE Quality	2.27	.09	2.34	.10	2.29	.10	2.38	.13
1st Text SE Quality	2.29	.09	2.37	.10	2.24	.09	2.33	.13
2nd Text SE Quality	2.25	.12	2.31	.12	2.33	.12	2.42	.16
Engagement	2.80	.18	2.57	.19	2.82	.18	3.00	.24
Enjoyment	2.49	.17	2.51	.18	2.47	.17	2.65	.23
Turn Duration (s)	61.21	4.39	64.65	4.50	60.62	4.43	67.09	5.87

Note. ***$p < .01$. **$p < .05$. *$p < .10$. Comparing means across rows

Achievers. Achievers are characterized by their desire to gain status icons that do not necessarily have any relation to the game goals. Achievers often have their own goals or agendas. Because of these characteristics, Achievers were not expected to be affected by opponent type.

There was no interaction between text presentation order and opponent difficulty on self-explanation quality, $F(1,20) = 2.880$, $MSE = .182$, $\eta^2 = .126$, $p = .105$. There was no significant effect of opponent difficulty for Achievers on self-explanation quality

overall averaging across texts, $F(1,20) = .964$, $MSE = .209$, $\eta^2 = .046$, $p = .338$, first text self-explanation quality, $F(1,20) = 2.405$, $MSE = .274$, $\eta^2 = .107$, $p = .137$, second text self-explanation quality, $F(1,20) = .032$, $MSE = .236$, $\eta^2 = .002$, $p = .860$, engagement, $F(1,20) = .253$, $MSE = .944$, $\eta^2 = .012$, $p = .620$, enjoyment, $F(1,20) = .043$, $MSE = .928$, $\eta^2 = .002$, $p = .837$, or turn duration, $F(1,18) = .151$, $MSE = 302.959$, $\eta^2 = .008$, $p = .702$. These results were consistent with the prediction that Achievers would not respond to changes in opponent difficulty.

Explorers. Explorers are characterized by their ability to exploit tips and tricks of the game. Explorers are likely to be more observant about the action of the game and quickly determine if there are strategies in the game that would help them pass to the next challenge. Because of this characteristic, Explorers are likely to be aided by playing a challenging opponent because a challenging opponent would provide opportunity for the Explorer to learn the tips and tricks of high quality performance (self-explanations). Whether this benefit manifests in self-explanation quality or winning the game is inconsequential to their engagement and enjoyment. However, Explorers are likely to be more engaged and glean more enjoyment out of learning those tips and tricks.

There was no interaction between text presentation order and opponent difficulty on self-explanation quality, $F(1,22) = .132$, $MSE = .109$, $\eta^2 = .006$, $p = .720$. There was no significant effect of opponent difficulty for Explorers on overall self-explanation quality across texts, $F(1,22) = .313$, $MSE = .147$, $\eta^2 = .014$, $p = .581$, or on self-explanation quality on the first text, $F(1,22) = .140$, $MSE = .171$, $\eta^2 = .006$, $p = .712$, or second text, $F(1,22) = .424$, $MSE = .178$, $\eta^2 = .019$, $p = .522$. Explorers were not expected to display meaningful differences in their self-explanation quality scores.

There were significant, large main effects of opponent difficulty for Explorers on engagement, $F(1,23) = 6.696$, $MSE = .834$, $\eta^2 = .225$, $p = .016$, and enjoyment, $F(1,23) = 5.144$, $MSE = .836$, $\eta^2 = .183$, $p = .033$. There was no significant effect of opponent difficulty on turn duration, $F(1,18) = 1.259$, $MSE = 339.445$, $\eta^2 = .065$, $p = .277$. Explorers who played Showdown-FB with a difficult opponent were more engaged and enjoyed their experience more than Explorers who played Showdown with an easy opponent. These results were in the predicted direction that Explorers would be more engaged when given the ability to model their self-explanations after higher-quality self-explanations.

Socializers. According to Bartle (1996, 2004), Socializers enjoy interacting with other players in the game and tend to shy away from adversarial relationships. Socializers would likely match their self-explanation quality to their opponents' level. However, matching self-explanation quality to opponent type may be difficult in certain situations. For example, attempting to match a difficult opponent may be difficult but would likely require constant attention and be very engaging. Conversely, matching self-explanation quality to an easy opponent would be a simple task and would likely be disengaging.

There was no interaction between text presentation order and opponent difficulty on self-explanation quality, $F(1,22) = .846$, $MSE = .223$, $\eta^2 = .037$, $p = .368$. There was a significant large-sized main effect of opponent difficulty for Socializers on overall self-explanation quality averaged across texts, $F(1,22) = 5.944$, $MSE = .210$, $\eta^2 = .213$, $p = .023$, but not self-explanation quality for first text completed, $F(1,22) = 3.040$, $MSE = .267$, $\eta^2 = .121$, $p = .095$. There was a significant large main effect of self-explanation quality for second text completed, $F(1,22) = 6.718$, $MSE = .266$, $\eta^2 = .234$, $p = .017$,

Socializers generally produced higher quality self-explanations when playing against a difficult opponent. These results were consistent with the predicted main effects of opponent difficulty that any player would be expected to produce higher quality self-explanations when playing against a difficult opponent.

There was a significant large main effect of opponent type for Socializers on engagement, $F(1,22) = 4.352$, $MSE = .844$, $\eta^2 = .165$, $p = .049$, but no significant effect of opponent type for Socializers on enjoyment, $F(1,22) = .009$, $MSE = .380$, $\eta^2 = .000$, $p = .925$. There was no effect of opponent difficulty on turn duration, $F(1,20) = 1.519$, $MSE = 547.697$, $\eta^2 = .071$, $p = .232$. Socializers were more engaged when playing against a difficult opponent. These results were consistent with the prediction that Socializers would be more engaged when trying to match their self-explanation quality to the performance of a high quality opponent.

Killers. Bartle (1996, 2004) states that Killers are dominant players. Killers can be expected to be engaged and get enjoyment out of dominating other players. However, Killers are characterized by their dominant nature no matter what the opponent may be. There would likely be no differences in performance between opponent types, as Killers tend to produce high impact responses against all opponents.

There was no interaction between text presentation order and opponent difficulty on self-explanation quality, $F(1,16) = 3.236$, $MSE = .206$, $\eta^2 = .168$, $p = .091$. As shown in Table 20, there was no significant effect of opponent difficulty for Killers on self-explanation quality overall averaging across texts, $F(1,16) = .748$, $MSE = .123$, $\eta^2 = .045$, $p = .400$, first text self-explanation quality, $F(1,16) = 3.456$, $MSE = .147$, $\eta^2 = .178$, $p = .082$, second text self-explanation quality, $F(1,16) = .054$, $MSE = .203$, $\eta^2 = .003$, $p =$

.819, engagement, $F(1,16) = .029$, $MSE = .469$, $\eta^2 = .002$, $p = .867$, enjoyment, $F(1,16) = .749$, $MSE = .389$, $\eta^2 = .045$, $p = .400$, or turn duration, $F(1,11) = 3.717$, $MSE = 496.613$. $\eta^2 = .253$, $p = .080$. The self-explanation quality results were consistent with the characteristics of Killers because of Killers' natural inclination to produce high quality responses against all types of opponents. However, Killers were expected to experience lower engagement when playing a more difficult opponent but did not.

Summary

The analyses indicate that difficult opponents produce higher self-explanation scores as well as a more engaging gameplay experience for all users (except Killers), likely due to the ability to model responses after high quality opponents' responses. These findings are interesting and useful for serious game developers tailoring the gameplay to specific skill levels. The results indicate that tailoring gameplay based on skill level may not be required to create an effective and engaging program. Instead, the results indicate that instead, the developer may be able to set the bar for competition at a challenging level and leave it there to allow low-skill players to model their performance after the high-skilled opponent.

There was no overall effect of gamer type. However, analyses were conducted to further explore *a priori* predictions about how the different gamer types were expected to respond to challenging situations. First, the results indicate that Killers were no more engaged than other gamer types when they could simply dominate a situation with little effort. One of the main hypotheses was that Killers would have noticeable differences in their engagement based on opponent type. Killers were not more engaged by easy opponents as expected.

Second, Socializers matched their response quality to the opponent quality. Specifically, Socializers produced lower quality responses for easy opponents and higher quality responses for difficult opponents. Socializers were expected to display more cooperative social behavior during gameplay. More specifically, Socializers' performance and engagement scores were expected to be closely related to the type of opponent that they are matched against. Socializers were expected to try to match their performance to their opponent. Matching scores with a difficult opponent was expected to be more engaging. The results indicated that this alignment occurred for Socializers. Based on the original Bartle gamer type theory (Bartle 1996; 2006), Socializers tend to be socially cooperative. This cooperation tends to require effort on the part of the Socializer.

Third, Explorers were more engaged by difficult opponents. Explorers were expected to respond to differences in opponent difficulty because of their desire to learn the tips and tricks that would help them further explore the system. Explorers were expected to be more engaged by difficult opponents because a difficult opponent would produce more chances to learn these tips and tricks. This expectation was confirmed by the results. However, Explorers' performance was not expected to be affected by the specific opponent difficulty, rather they would be more interested in the types of responses that they could make the system provide (e.g., receiving different numbers of stars, getting different feedback from the system). These characteristics make the opponent secondary to the Explorer's performance. The results indicate that, although Explorers showed no response to opponent type, neither did the majority of gamer types. The only gamer type that varied across opponent difficulty was Socializers.

Last, Achievers showed no response to opponent difficulty. Achievers were not expected to be affected by their opponent because of their inclination to set their own goals for gameplay. These gameplay goals often do not match the goals for performing well in the game as set by the designers. This expectation was confirmed by the results, as Achievers showed no differences in their performance or engagement across opponent difficulty.

Conclusion

In conclusion, the objective of the current dissertation was to assess the validity of the claim that there is an observable relation between game-like elements, individual differences in gameplay, and engagement within a task. To investigate this claim, this dissertation had three main goals. The first goal was to establish a baseline for performance and engagement between a practice module in an ITS and a game-based version of the same practice. The result, in this case, was that while the game-based version of the original practice module was more engaging, the original practice module was more effective in generating higher quality responses. This result is likely because the game-based version included more opportunities for modeling the higher quality responses.

The second goal was to attempt to mitigate the deficits in performance for participants who would rather play the game-based module, while maintaining the more engaging nature of the game. To accomplish this goal, a second version of the game-based practice incorporating pedagogical feedback was developed. The goal of adding feedback was to create a new game that was more effective in generating high quality self-explanations while being just as engaging as the original game-based practice.

However, as a result of adding the pedagogical feedback, the game-based practice may no longer be seen as a "fun" task because of a more consistent focus on the educational task. The participants no longer found the game-based practice to be more engaging than the original practice module, and it was still ineffective at generating high quality self-explanations. The instructive nature of the feedback may have counteracted the benefits of the original game-like elements, thus reducing engagement.

The third goal of the current work was to determine if there are other factors that contribute to the performance and engagement within the system. Participants were assigned to either an easy or difficult opponent to determine if individual gamer type affected responses to an opponent's difficulty. If the gamer types provided specific patterns of behavior, then serious game developers could consider the ramifications of a participant's gamer type when designing a game. The participants' overall performance was mainly affected by the type of opponent that they competed against within the game, regardless of gamer type. Specifically, when participants played against difficult opponents, they generated higher quality self-explanations and were more engaged than if they played against an easy opponent. When gamer type is taken into account, the participants' gamer types had marginal bearing on serious game performance. For example, Killers enjoy winning easily and Socializers are engaged by difficult opponents. One caveat for the current study is that there is no established metric of difficulty for the opponent. The opponent was certainly "more difficult" than the easy opponent, but may not have been truly difficult. If the opponent were unbeatable, then players could either become disengaged by an insurmountable task, or further engaged by the most challenging task possible.

One major limitation of the current study is the brevity of the iSTART training used. The training in the current study is an abbreviated version of the original iSTART training. The original iSTART training contains multiple examples of how to use each strategy, demonstrates the strategies as they are applied to an example text, and then allows participants to make multiple attempts at using the strategies. The current abbreviated version only has one example of each strategy and requires the participant to use the strategies immediately. Participants may not have mastered the strategies when they were required to implement them within the practice environments. Instead, if they were allowed to train with the full version, participants might have learned the strategies more fully before attempting to use them with Coached Practice or Showdown. In the current study, the participants are using the practice environments as introductory learning tools, when they are primarily intended to supplement the learning that takes place in the demonstration and extended practice modules. Consequently, the differences between how participants were introduced to the reading strategies in the current study as compared to previous iSTART studies (e.g., O'Reilly et al., 2004; McNamara et al., 2006) may affect the ability to generalize the self-explanation quality results to the ITS domain. However, engagement should be relatively unaffected by this difference in training.

The current study has implications for multiple research areas, including serious game designers, ITS developers, and classroom educators. First, serious game developers can use the current findings to steer game development away from tailoring gameplay to specific gamer types as a primary goal. The findings of the current study indicate that as a potential individual difference measure, gamer types have little influence on the overall

performance in the game. Instead, performance is drawn from characteristics within the game that allow the player to model successful behavior. Instead of assessing the players' characteristics and tailoring the game around their preferences (as suggested by Bartle, 1996, 2004), the game developers might benefit more from including game characteristics that allow players to learn from and model their own success and performance after previous players/opponents.

Second, ITS researchers can benefit from the current study by developing serious games for their own curriculum. While previous studies have shown that strategy-based tutoring systems need time to work (Jackson et al., 2010), these systems can become tedious to the user. Developing games for the system may be one way to combat the tedium. The current study shows that game-based practice is more engaging than the strict practice module in iSTART. However, the decreased performance cannot be overlooked. ITS developers have the option to decide whether high quality performance in their system is more important than highly engaged users. Short-term high performance is possible (as shown in the current study) but may not lead to sustained learning. Instead, having a highly engaged user would likely lead to more meaningful long-term results. The current findings suggest that the non-game-based system is an effective learning tool that is not engaging to users. Including the game-based system as an intervention after initially learning the strategies from the non-game-based system would likely result in long-term engagement.

Third, educators can benefit from the results of this study by allowing more serious games into the classroom. As shown in the current study, games are an excellent way to engage students in educational tasks, but educators must decide how to balance

the increased engagement with the lower performance. Putting too much emphasis on the learning task may be detrimental to the overall engagement. Even if educators are allowing serious games in the classroom that are not completely focused on educational goals, the gameplay and entertainment goals would likely be enough to produce sustained and engaged time on task for students to merit inclusion in a curriculum. Although games may detract from the short-term performance goals, the benefits of games as supplemental material for disengaged students would likely help overall performance when the learning goals are actively reinforced during class time as part of the normal curriculum. When discussing the goals during class time, students are even likely to ask questions that are driven by the desire to perform in the game.

The current study leads to potential areas for follow-up study. Future studies should determine how long a game player will persist when presented with a challenge. The current study found that game players produce higher quality responses and are more engaged by a difficult opponent. However, the results do not indicate whether or not the engagement or increased performance will persist indefinitely. Future studies could present a player with either an easy or a challenging opponent and determine at what point the game is no longer engaging by employing either a continuous measure of engagement or varying the length of gameplay between users.

Follow-up studies could also determine if there is a limit to modeling higher quality responses. In the current study, participants likely modeled their responses from the difficult opponent responses but not the easy opponent responses. However, there could be a limit to the modeling behavior. Specifically, modeling a high quality response may be too challenging for participants with low prior knowledge or prior skill. A

follow-up study could investigate what would be too challenging for low-ability participants by assessing the prior knowledge and ability in the relevant area before determining whether high- or low-ability participants are able to both model the responses of increasingly high-ability opponents. Combined with the current results, these experiments would provide researchers and game developers with guidelines for producing challenging games. These guidelines are necessary, because producing games with difficult opponents, while effective, could be too difficult or too defeating to certain players. Further studies could also provide feedback cues for intentionally modeling higher quality responses.

Despite the limitations, the current study provides a clearer picture for serious game designers. The current study demonstrates that the individual differences in gameplay for each serious game player are not the most important factor for increasing performance and engagement. Instead, the results demonstrate that increasing opponent difficulty is an immediate option for creating an engaging serious game that produces high quality performance.

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Appendices

Appendix A – Sex Determination Text

Sex Determination
Recall that in humans the diploid number of chromosomes is 46, or 23 pairs.
There are 22 pairs of matching homologous chromosomes called autosomes.
Homologous autosomes look exactly alike.
The 23rd pair of chromosomes differs in males and females.
These two chromosomes, which determine the sex of an individual, are called sex chromosomes.
In humans, the chromosomes that control the inheritance of sex characteristics are indicated by the letters X and Y.
If you are a human female, XX, your 23rd pair of chromosomes are homologous and look alike.
However, if you are a male, XY, your 23rd pair of chromosomes look different.
Males, which have one X and one Y chromosome, produce two kinds of gametes, X and Y, by meiosis.
Females have two X chromosomes, so they produce only X gametes.
Sex-linked inheritance: Drosophila, commonly know as fruit flies, inherit sex chromosomes in the same way as humans do.
Traits controlled by genes located on sex chromosomes are called sex-linked traits.
The alleles for sex-linked traits are written as superscripts of the X or Y chromosome.
Because the X and Y chromosomes are not homologous, the Y chromosome has no corresponding allele to one on the X chromosome and no superscript is used.
Also remember that any allele on the X chromosome of a male will not be marked by a corresponding allele on the Y chromosome.
In 1910, Thomas Hunt Morgan discovered traits linked to sex chromosomes.
Morgan noticed one day that one male fly had white eyes rather than the usual red eyes.
He crossed the white-eyed male with a homozygous red-eyed female.
All of the F1 offspring had red eyes, indicating that the white-eyed trait is recessive.
Then Morgan allowed the F1 flies to mate among themselves.
According to simple Mendelian inheritance, if the trait were recessive, the offspring in the F2 generation would show a 3:1 ratio of red-eyed to white-eyed flies.
That is what Morgan observed.
However, he also noticed that the trait of white eyes appeared only in male flies.
Morgan hypothesized that the red-eye allele was dominant and the white-eye allele was recessive.
He also reasoned that the gene for eye color was located on the X chromosome and was not present on the Y chromosome.
In males however, a single recessive allele is expressed as a white-eyed phenotype.
When Morgan crossed a heterozygous red-eyed female with a white-eyed male, half of all the males and half of all the females inherited white eyes.
The only explanation of these results is Morgan's hypothesis.
The allele for eye color is carried on the X chromosome and the Y chromosome has no allele for eye color.
Traits dependent on genes that follow the inheritance pattern of a sex chromosome are called sex-linked traits.
Eye color in fruit flies is an example of an X-linked trait.
Y-linked traits are passed only from male to male.

Appendix B – Convection and Radiation Text

Convection and Radiation
What is convection?
Have you ever warmed up your hands by putting them over an open flame?
You can do this because the air right above the flame heats up and expands.
Because expanded air is less dense, it rises, bringing the heat to your hand.
This heat transfer process is called convection.
Unlike conduction, which occurs mostly in solids, convection occurs only in liquids and gasses.
Convection comes from a Latin word meaning to carry together.
Convection can occur in all fluids, whether liquids or gases.
Convection occurs because warmer fluids are less dense, and rise.
Cooler fluids are more dense, and sink.
This motion of fluids causes currents.
Convection causes the weather patterns on Earth.
The currents caused by convection occur constantly in our atmosphere and are responsible for much of our weather.
On a global scale, hot air near the equator rises and is forced toward the poles.
The sinking air forces cold air at the poles toward the equator.
Combined with forces due to the rotation of the Earth, convection and unequal heating are the primary causes of weather.
Radiation: What is electromagnetic radiation?
One form of heat transfer due to radiation comes from electromagnetic radiation such as light, untraviolet rays, X rays, and infrared rays.
You know that conduction and convection require matter to transfer heat.
However, as you learned previously, electromagnetic waves can travel through a vacuum.
This is fortunate because the Earth receives most of its heat in the form of electromagnetic radiation from the sun.
Since space is a vacuum, radiation is the primary way we can receive heat from the sun.
What types of radiation do objects emit?
All objects emit radiation due to their thermal properties, or because they have some internal thermal energy.
Some objects emit mostly visible light, some untraviolet, and some infrared.
The type of radiation an object emits depends on its temperature.
Hotter objects have more energy per molecule than cold objects.
Thus hot objects emit light with a higher frequency than cold objects.
Untraviolet photons have more energy than visible light.
Visible light has more energy than infrared light.
You learned previously how the colors of the rainbow, Red, Orange, Yellow, Green, Blue, And Violet are related to the energy of the visible light.
What is infrared radiation?
Infrared radiation has lower energy than visible light.
While human eyes cannot detect infrared radiation, certain species of snakes can.
You may have seen popular spy movies where the hero uses an infrared viewer to see people in the dark.
In addition, firefighters use infrared equipment to find people in smoke-filled rooms.
Color-temperature relationships: You may have noticed that when a light bulb on a dimmer is turned on slowly, the bulb will begin to heat up, then glow in the red, then orange, and then yellow areas of the electromagnetic spectrum.
This is because different temperatures cause the filament in the light bulb to glow at different colors.

Appendix C – Coached Practice/Showdown Feedback

Category	CP_Response	Showdown_Response
MetaUnderstand	Can you write about what you understand in the sentence?	Write more about what you understand in the sentence to earn more stars.
	Please go ahead and explain what you understand in the sentence.	
	Can you give some details about what you understand in the sentence?	Give more details about what you understand in the sentence to earn more stars.
	Please explain the sentence a little more fully.	
	Can you tell me more about what you understand in this sentence?	
	Try to explain how this sentence is related to previous sentences.	Explain how the sentence is related to the previous sentence to earn more stars.
	Please describe how the information in this sentence is related to other things you already know or read.	Explain how the information in the sentence is related to other things you already know or read to earn more stars.
MetaNotUnderstand	Please try to make a guess about what this means.	
	Try making a guess about what this means.	Try making a guess about what this means to earn more stars.
	Think about what you do understand in the sentence, and explain what it means.	Think about what you understand in the sentence, and explain what it means to earn more stars.
	Can you try to use one of the reading strategies? Maybe that will help your understanding.	

Category	CP_Response	Showdown_Response
MetaNotUnderstand	Think about what you do understand in the sentence, and how it relates to a previous sentence.	Write more about what you do understand in the sentence, and how it relates to a previous sentence to earn more stars.
	Please try to make a guess about what this means using what you've already read.	Write more about what the sentence means using what you have already read to earn more stars.
	Try making a guess about what this means based on what you have already read.	Make a guess about what this means using what you've already read to earn more stars.
	Try to connect something in this sentence to something in an earlier sentence.	Connect something in the sentence to something in an earlier sentence to earn more stars.
MetaPredict	Explain a little more about what you think this paragraph is about.	Explain more about what you think the paragraph is about to earn more stars.
	Explain more about what you think is coming up.	Explain more about what you think is coming up to earn more stars.
	Try to explain how this sentence is related to previous sentences.	Explain how this sentence is related to previous sentences to earn more stars.
MetaError	Can you explain what you understand now?	Explain what you understand to earn more stars.
	Please explain what you understand now.	
MetaConf	Can you explain what you were right about?	Explain what you were right about to earn more stars.
	Can you explain how this connects to the sentence where you made your Prediction? Please try to say more about how you were right.	
MetaBoredom	Please try to explain this sentence.	Explain the sentence to earn more stars.

Category	CP_Response	Showdown_Response
IRR	Please try to add information that is related to the sentence.	Explain what the sentence means and how it relates to what you already know to earn more stars.
	Explain what the sentence means and how it relates to what you already know.	
	Try to write more about the topic.	Write more about the topic to earn more stars.
	I think you should include more information related to the text.	Include more information related to the text to earn more stars.
	Try again, and be sure to include more information related to the paragraph.	Include more information related to the paragraph to earn more stars.
	Your answer could relate more to the text. Try to add more relevant information.	Include more relevant information to earn more stars.
	Could you include more information about the topic?	Include more information about the topic to earn more stars.
	Let's see if you can add more information that relates to the paragraph.	
	Try again. This time try to add a little more about the text.	
	Try to explain what you understand in this sentence.	Explain what you understand in the sentence to earn more stars.
SH	Well, your explanation is kind of short. Could you expand your answer? I like details.	Your explanation is too short. Write more to earn more stars.
	Could you add to your explanation? Try to explain how it relates to something you already know.	Your explanation is short. Explain how it relates to something you already know to earn more stars.
	Can you tell me more about what you understand in this sentence?	
	Please explain the sentence a little more fully.	Your explanation is short. Explain the sentence more fully to earn more stars.

Category	CP_Response	Showdown_Response
SH	I'd like to read a little more. Could you add to your self-explanation?	
	You should say more in your explanation. Try to include your own related ideas.	You should say more in your explanation. Try to include your own related ideas to earn more stars.
	Could you add some information to your explanation? It seems a little short.	
	Try again, and add a little more information to your self-explanation.	
	Can you add to your explanation and include more of your own ideas?	
	See if you can add in more information and incorporate your own ideas.	
	That's a little short. Please add some more information to explain how this sentence relates to previous sentences.	That's a little short. Please add some more information to explain how this sentence relates to previous sentences to earn more stars.
SIM1	Try adding some more information that explains what the sentence means.	Add more information that explains what the sentence means to earn more stars.
	Try to explain this text further and include your own ideas.	Explain the text further while including your own ideas to earn more stars.
	Let's do it again, and this time try to include more about what the text means.	
	Use more information from the previous sentences to help your explanation?	Include more information from the previous sentences to earn more stars.
	Can you add more information to explain what the text means?	Add more information explaining what the text means to earn more stars.

Category	CP_Response	Showdown_Response
SIM1	If you add more information, you will better understand the text.	
	Good. Now can you try to explain the text using your own words and ideas?	
	Hmm, this sounds familiar. Try to add in more information that helps explain the text.	
	Please explain the sentence a little more fully.	
SIM2	That's a good start. Can you add to that?	Add more information to earn more stars.
	Can you add more to your explanation using your own knowledge?	Add more from your own knowledge to earn more stars.
	I like what you have so far, but can you add to it and include more explanation?	
	This is a good start, but you should try to include more information related to the topic.	Include more information related to the topic to earn more stars.
	Try to improve your explanation and include information from different parts of the text.	Include information from different parts of the text to earn more stars.
	Remember, a good self-explanation could include your own ideas or different ideas from the text.	
	Let’s see if you can make this better by including more related information.	
	It looks like you've reworded the sentence. Now, can you explain it by thinking about what else you know?	
	Try explaining more about how this sentence relates to previous sentences.	Explain how the sentence relates to previous sentences to earn more stars.

Category	CP_Response	Showdown_Response
OK1a	Ok, but try to explain the sentence a little more fully next time.	Try to explain the sentence more fully next time to earn more stars.
	Ok, but for the next sentence, explain more about how it is related to other sentences or ideas.	Explain how the sentence is related to other sentences or ideas to earn more stars.
	Let's try the next one.	
	Ok, but try saying even more next time.	Say more next time to earn more stars.
	For the next sentence, think about what you understand in the sentence, and how it relates to a previous sentence.	Write more about what you understand and how it relates to a previous sentence to earn more stars.
	For the next sentence, try to relate it to previous sentences.	Relate the sentence to previous sentences to earn more stars.
OK1b	Try to explain the sentence a little more fully next time.	Try to explain the sentence more fully next time to earn more stars.
	For the next sentence, explain more about how it is related to other sentences or ideas.	
	Let's try the next one.	
	Try saying even more next time.	Say more next time to earn more stars.
	For the next sentence, think about what you understand in the sentence, and how it relates to a previous sentence.	Write more about what you understand and how it relates to a previous sentence to earn more stars.
	For the next sentence, try to relate it to previous sentences.	Relate the sentence to previous sentences to earn more stars.
OK1	O.K.	
	O.K. If you add a little more next time, it will be even better.	Add more to your explanation to earn more stars.
	Good. Next time try to say a little more.	Say more next time to earn more stars.
	Alright, let’s keep going.	

Category	CP_Response	Showdown_Response
OK2	Good job.	That was almost a perfect explanation.
	That's fine.	Good job, but you could still do better.
	Nicely done.	Nice job, try for a perfect explanation next time.
	Good.	
	Sure, that sounds fine.	
	Looks good to me.	Looks good to me, but you could do better next time.
	That's pretty good.	
OK3	Superb!	Superb!
	That's really great!	That's really great!
	Excellent!	Excellent!
	Wonderful!	Wonderful!
	Your self-explanation is great!	Your self-explanation is great!
	Very good!	Very good!
	Nice work!	Nice work!
	I'm impressed!	I'm impressed!
	You're doing a great job!	You're doing a great job!

Appendix D – Bartle Gamer Type Quiz

1. When playing an online game, which would you rather do?
    a. Get to a certain experience level faster than anyone else
    b. Solve a riddle no one else has gotten
2. In an online game, would you rather be known as:
    a. Someone who can run from any two points in the world, and really knows their way around.
    b. The person with the best, most unique equipment in the game.
3. Would you rather:
    a. Know more secrets than your friends?
    b. Become a hero faster than your friends?
4. Would you rather:
    a. Know how to get things?
    b. Know where to get things?
5. In an online game, a new area opens up. Which do you look forward to more?
    a. Exploring the new area, and finding out its history.
    b. Being the first to get new equipment from the area.
6. Which is more exciting?
    a. A deadly battle
    b. A well-roleplayed scenario
7. Is it better to be:
    a. Loved
    b. Feared
8. What's worse?
    a. To be without power
    b. To be without friends
9. In an online game, which would you enjoy more?
    a. Winning a duel with another player
    b. Getting accepted by a guild/clan
10. Would you rather:
    a. Hear what someone has to say
    b. Show them the sharp blade of your axe
11. Which do you enjoy more in an online game?
    a. Getting a new item
    b. Getting the latest gossip
12. Which do you enjoy more in an online game?
    a. Getting involved in the storyline
    b. Getting rewards at the end
13. Are you more comfortable, as a player in an online game
    a. Out hunting by yourself for experience
    b. Talking with friends
14. Which is more enjoyable to you?
    a. Killing a big monster
    b. Bragging about it to your friends
15. Which would you rather be noticed for in an online game?

a. Your personality
b. Your equipment

16. When playing a video game, is it more fun to:
    a. Have the highest score on the list
    b. Beat your best friend one-on-one
17. When playing an online game, would you rather have?
    a. A spell that increases the rate at which you gain experience points
    b. A spell to damage other players
18. In an online game, would you be more prone to brag about:
    a. How many players you've killed
    b. Your equipment
19. In an online game, would you rather have as a quest reward:
    a. Experience points
    b. A wand with 3 charges of a spell that lets you control other players against their will
20. In an online game, would you rather have:
    a. Two levels of experience
    b. An amulet that increases the damage you do against other players by 10%
21. Which would you enjoy more as an online game player?
    a. Running your own tavern
    b. Making your own maps of the world, then selling them
22. In an online game, you're about to go into an unknown dungeon. You have your choice of one more person to go with you. Who would you choose?
    a. A good friend, who's great for entertaining you and your friends
    b. Someone to identify the items that you find there
23. You are being chased by a monster in an online game. Do you:
    a. Ask a friend for help killing it
    b. Hide somewhere you know the monster won't follow
24. What's more important in an online game to you?
    a. The number of people
    b. The number of areas to explore
25. You want to fight a really tough dragon. How would you approach this problem?
    a. Try a variety of weapons and magic against it, until you find a weakness
    b. Get a big group of players to kill it
26. Would you rather be known for:
    a. Knowledge
    b. Power
27. In an online game, you learn another player is planning your demise. Do you:
    a. Attack him before he attacks you
    b. Go to an area your opponent is unfamiliar with and prepare there
28. If you're alone in an area of an online game, do you think:
    a. It's safe to explore
    b. You'll have to look elsewhere for prey
29. In an online game, would you rather join a clan/guild of:
    a. Scholars
    b. Assassins

30. Would you rather:
    a. Defeat an enemy
    b. Explore a new area

Appendix E – Demographics Questionnaire

1. Please type in your Name
2. Please type in your Log-in ID
3. What is your sex?
    a. Male
    b. Female
4. What is your age?
5. What is your year in school?
    a. Undergrad – 1st
    b. Undergrad – 2nd
    c. Undergrad – 3rd
    d. Undergrad – 4th
    e. Undergrad – 5th
    f. Undergrad – 6th
    g. Undergrad – 6th +
    h. Graduate
6. What is your ethnicity?
    a. African American
    b. Caucasian
    c. Hispanic (Latin American)
    d. Asian
    e. Other
7. I tend to be competitive

a. 1 - Strongly Disagree

b. 2

c. 3

d. 4

e. 5

f. 6 – Strongly Agree

8. Do you have a computer at home?

    a. Yes

    b. No

9. Do you use a computer at school?

    a. Yes

    b. No

10. How many hours per day do you play video games (home and school combined)?

    a. None

    b. Less than 1 hour

    c. 1-2 hours

    d. 3-4 hours

    e. 5 or more hours

11. How many hours per day do you use a computer (for homework, games, internet, etc.)?

    a. None

    b. Less than 1 hour

    c. 1-2 hours

d. 3-4 hours

e. 5 or more hours

12. Computers can help me learn difficult course concepts.

a. 1 - Strongly Disagree

b. 2

c. 3

d. 4

e. 5

f. 6 – Strongly Agree

13. Do you expect computer systems to be helpful?

a. Yes

b. No

14. Computers frustrate me.

a. 1 - Strongly Disagree

b. 2

c. 3

d. 4

e. 5

f. 6 – Strongly Agree

15. How often do you play games that help you learn?

a. Never

b. At least once per year

c. At least once per semester

d. At least once per month

e. At least once per week

f. At least once per day

16. I enjoy playing games

a. 1 - Strongly Disagree

b. 2

c. 3

d. 4

e. 5

f. 6 – Strongly Agree

17. I enjoy reading

a. 1 - Strongly Disagree

b. 2

c. 3

d. 4

e. 5

f. 6 – Strongly Agree

18. How many hours per week do you read material that is not required by your teachers/instructors?

a. None

b. Less than 1 hour

c. 1-2 hours

d. 3-4 hours

e. 5 or more hours

19. I am motivated to participate

a. 1 - Strongly Disagree

b. 2

c. 3

d. 4

e. 5

f. 6 – Strongly Agree

20. I am excited to participate

a. 1 - Strongly Disagree

b. 2

c. 3

d. 4

e. 5

f. 6 – Strongly Agree

21. I expect to enjoy this learning system

a. 1 - Strongly Disagree

b. 2

c. 3

d. 4

e. 5

f. 6 – Strongly Agree

Appendix F – IRB Approval

THE UNIVERSITY OF MEMPHIS

Institutional Review Board

To: Danielle McNamara
Psychology

From: Chair, Institutional Review Board
for the Protection of Human Subjects

Subject: **iSTART: Interactive Strategy Training for Active Reading and Thinking (H04-79-06)**

Approval Date: **April 1, 2010**

This is to notify you of the board approval of the above referenced protocol. This project was reviewed in accordance with all applicable statutes and regulations as well as ethical principles.

Approval of this project is given with the following obligations:

1. At the end of one year from the approval date an approved renewal must be in effect to continue the project. If approval is not obtained, the human consent form is no longer valid and accrual of new subjects must stop.
2. When the project is finished or terminated, the attached form must be completed and sent to the board.
3. No change may be made in the approved protocol without board approval, except where necessary to eliminate apparent immediate hazards or threats to subjects. Such changes must be reported promptly to the board to obtain approval.
4. The stamped, approved human subjects consent form must be used. Photocopies of the form may be made.

This approval expires one year from the date above, and must be renewed prior to that date if the study is ongoing.

Brian Schilling
Approved

THE UNIVERSITY OF MEMPHIS

Notice of Human Subject Project Completion

To: Chair, Institutional Review Board
for the Protection of Human Subjects
Administration Building, Room 315

From: Danielle McNamara
Psychology

Subject: iSTART: Interactive Strategy Training for Active Reading and Thinking (H04-79-06)

Date:

This is to notify the Board that the above research project is no longer active.

1. The number of subjects finally enrolled in the research;

2. A description of any adverse events or unanticipated problems involving risks to subjects or complaints about the research;

3. A summary of any recent literature findings, or other relevant information associated with the research;

4. Any publications generated from the research project.

_____
Danielle McNamara, Investigator

_____
Date

Appendix 2a. Letter and non-consent form to be given to the parents of high-school students

Date

Dear Parents/Guardians:

My colleagues and I at the University of Memphis are currently conducting a study at your child's high school regarding reading comprehension. We are researching reading strategies that improve students' comprehension of school textbooks. This is a very important study that has been provided funding from the National Science Foundation, and is expected to contribute greatly to our ability to help students better understand difficult texts. Your child's science teacher has graciously volunteered to participate in our project. We are writing to assure you that this study was reviewed and approved by the University of Memphis human subjects research committee. All of the activities in which your child may participate will be normal educational activities similar to those your child encounters in his or her classroom. Moreover, it is expected that your child will benefit from participating in our research; they will be taught strategies for reading science textbooks effectively, which, in turn, may improve their understanding of science. We also assure you that all information regarding your child will be kept confidential.

More information regarding this study is provided on back of this letter. If you have any further questions, please contact me or your child's teacher. If you do not wish for your child to participate in the study, please sign and return this form. If you agree that your child may participate in activities related to the study, please keep this form for your future reference (you do not need to return the form if you agree that your child may participate).

Sincerely,

Dr. Danielle S. McNamara
Assistant Professor

University of Memphis
Institute for Intelligent Systems
FedEx Institute of Technology, Room 436
Memphis, TN 38152
Email: dsmcnamara1@gmail.com
Phone: 901-678-3803

University of Memphis IRB # H04-79-06
Approval of this form expires 3/31/11

Non-consent form for parents

TITLE OF THE RESEARCH: iSTART: Interactive Strategy Training for Active Reading and Thinking

INVITATION TO PARTICIPATE
You are invited to permit your child to participate in this study concerning children's ability to understand and learn from written material.

BASIS FOR SELECTION
Children in the eighth through twelfth grades have been invited to participate in this study.

PURPOSE OF THE STUDY
The purpose of the study is to assess the effects of a reading strategy program on students' ability to (a) self-explain science texts and (b) comprehend science passages.

EXPLANATION OF PROCEDURE
If you agree to participate, your child will complete a series of brief tasks assessing reading, thinking, and memory skills in a classroom-teaching setting. They will also take part in reading training that is administered via a computer program. It is anticipated that there will be approximately 14 assessment sessions over the academic year, each lasting approximately 50 minutes.

POTENTIAL BENEFITS
The information gathered in this project will be used to assess the usefulness of computer software designed to help students' understand science textbooks, and whether it can be successfully integrated into high schools.

POTENTIAL RISKS
Children will be at minimal risk of psychological or physical discomfort or harm during the completion of this research. All students will be asked to complete a series of tasks at their school. An adult will be present at all times. Participation in this study will not impact the services or education your child receives at school. As required by the university review board, note that The University of Memphis does not have any funds budgeted for compensation for injury, damages, or other expenses.

ASSURANCE OF CONFIDENTIALITY (NON-COMPLIANCE FORM)
All information obtained in this study that could identify you or your child will be kept confidential within the limits allowed by law. The information will be kept in a locked filing cabinet and in secure computer files. The specific results of your child's participation will not be provided to you or to any other persons or institutions. The information obtained in this study may be published in scientific journals or presented at scientific meetings, but your child's name and identity will never be included with this information.

WITHDRAWAL FROM STUDY
Participation in this study is voluntary. If you decide to allow your child to participate, you are free to withdraw your child from the study at any time.

University of Memphis IRB # H04-79-06
Approval of this form expires 3/3/11

OFFER TO ANSWER QUESTIONS

If you have any questions about this project, please do not hesitate to contact the principal investigator, Dr. Danielle S. McNamara at 678-3803. If you have questions concerning your rights or the rights of your child as a research participant, you may contact the Chair of the Committee for the Protection of Human Research Participants at (901) 678-2533. If you do not wish your child to participate in the University of Memphis Reading Study, please return this form to your child's teacher. If you agree that your child may participate, please keep this form for your records. If the form is not returned it is assumed that you are willing for your child to take part.

I do not wish my child to participate

_____ _____

Signature of Parent or Guardian Date

Appendix 2b. Letter and Consent form to be given to the parents of high-school students

Date

Dear Parents/Guardians:

My colleagues and I at the University of Memphis are currently conducting a study with students from your child's high school regarding reading comprehension. We are researching reading strategies that improve students' comprehension of school textbooks. This is a very important study that has been provided funding from the National Science Foundation, and is expected to contribute greatly to our ability to help students better understand difficult texts. We are writing to assure you that this study was reviewed and approved by the University of Memphis human subjects research committee. All of the activities in which your child may participate will be normal educational activities similar to those your child encounters in his or her classroom. Moreover, it is expected that your child will benefit from participating in our research; they will be taught strategies for reading science textbooks effectively, which, in turn, may improve their understanding of science. We also assure you that all information regarding your child will be kept confidential.

More information regarding this study is provided on back of this letter (including monetary compensation). If you have any further questions, please feel free to contact me using the information below. If you agree for your child to participate in the study, please sign this form and contact us using the information on the "Contact Sheet".

Sincerely,

Dr. Danielle S. McNamara
Professor

University of Memphis
Institute for Intelligent Systems
FedEx Institute of Technology, Room 436
Memphis, TN 38152
Email: dsmcnamara1@gmail.com
Phone: 901-678-3803

Consent form for parents

TITLE OF THE RESEARCH: iSTART: Interactive Strategy Training for Active Reading and Thinking

INVITATION TO PARTICIPATE
You are invited to permit your child to participate in this study concerning children's ability to understand and learn from written material.

BASIS FOR SELECTION
Children in the eighth through twelfth grades have been invited to participate in this study. Unfortunately, we are unable to provide transportation services for this study.

PURPOSE OF THE STUDY
The purpose of the study is to assess the effects of a reading strategy program on students' ability to (a) self-explain science texts and (b) comprehend science passages.

EXPLANATION OF PROCEDURE
If you agree to participate, over a period of 14 sessions your child will complete a series of brief tasks assessing reading, thinking, and memory skills. They will also take part in reading training that is administered via a computer program that uses games to help teach and foster engagement. It is anticipated that there will be fourteen assessment sessions over the summer, each lasting approximately 90 minutes.

POTENTIAL BENEFITS
Your child will be compensated for their time at a rate of $8 per hour. An additional amount of $50 will be given upon completion of the 14th session. The information gathered in this project will be used to assess the usefulness of computer software designed to help students' understand science textbooks, and whether it can be successfully integrated into high schools.

POTENTIAL RISKS
Children will be at minimal risk of psychological or physical discomfort or harm during the completion of this research. All students will be asked to complete a series of tasks at the University of Memphis main campus. An adult will be present at all times. As required by the university review board, note that The University of Memphis does not have any funds budgeted for compensation for injury, damages, or other expenses.

ASSURANCE OF CONFIDENTIALITY (NON-COMPLIANCE FORM)
All information obtained in this study that could identify you or your child will be kept confidential within the limits allowed by law. The information will be kept in a locked filing cabinet and in secure computer files. The specific results of your child's participation will not be provided to you or to any other persons or institutions. The information obtained in this study may be published in scientific journals or presented at scientific meetings, but your child's name and identity will never be included with this information.

WITHDRAWAL FROM STUDY
Participation in this study is voluntary. If you decide to allow your child to participate, you are free to withdraw your child from the study at any time.

University of Memphis IRB # _____

Approval of this form expires_____

OFFER TO ANSWER QUESTIONS

If you have any questions about this project, please do not hesitate to contact the principal investigator, Dr. Danielle S. McNamara at 678-3803. If you have questions concerning your rights or the rights of your child as a research participant, you may contact the Chair of the Committee for the Protection of Human Research Participants at (901) 678-2533. If you do not wish your child to participate in the University of Memphis Reading Study, you may discard this form and associated information. If you agree that your child may participate, please sign this form and contact us using the information on the "Contact Sheet". Your child should bring this signed form when they arrive for the first session.

I hereby grant consent for my child to participate.

_____ _____

Signature of Parent or Guardian Date

University of Memphis IRB # H04-79-06
Approval of this form expires 3/31/11

Appendix 3-A. General consent form (for College students)

Investigator: Dr. Danielle McNamara
Department of Psychology
The University of Memphis

Title: iSTART: Interactive Strategy Training for Active Reading and Thinking

I, _____, hereby agree to participate as a volunteer in the above named research project.

The purpose of this study is to investigate the role of reading strategy use in the comprehension of written material, and how the use of reading strategies varies across different kinds of readers (e.g., readers with low and high background knowledge). You will complete a series of tasks assessing reading, thinking, and memory skills. The information gathered in this project will help psychologists to understand reading comprehension processes.

I understand that the information collected in this study will be kept confidential within the limits of the law.

I understand that at any time I am free to refuse to participate or answer any question without prejudice to me, that I am free to withdraw from the experiment at anytime, and that The University of Memphis does not have any funds budgeted to compensate for injury damages, or other expenses.

I understand that this study will last approximately 2 hours and that, for participation, I will receive two hours worth of credit in my psychology course that I am enrolled in this semester.

I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

Signature _____

Student Number _____

Today's Date _____

If you have any questions regarding research participants' rights please contact the Chair of the Committee for the Protection of Human Research Participants at 678-2533. If you would like information about alternative ways of obtaining research credit, please see the subject pool coordinator.

University of Memphis IRB # H04-79-06
Approval of this form expires 3/31/11

Appendix 3-B. General consent form (for high-school students participating in a laboratory-based study)

Investigator: Dr. Danielle McNamara
Department of Psychology
The University of Memphis

Title: iSTART: Interactive Strategy Training for Active Reading and Thinking

I, _____, hereby agree to participate as a volunteer in the above named research project.

The purpose of this study is to investigate the role of reading strategy use in the comprehension of written material, and how the use of reading strategies varies across different kinds of readers (e.g., readers with low and high background knowledge). You will complete a series of tasks assessing reading, thinking, and memory skills. The information gathered in this project will help psychologists to understand reading comprehension processes.

I understand that the information collected in this study will be kept confidential within the limits of the law.

I understand that at any time I am free to refuse to participate or answer any question without prejudice to me, that I am free to withdraw from the experiment at anytime, and that The University of Memphis does not have any funds budgeted to compensate for injury damages, or other expenses.

I understand that this study will last approximately 2 hours, and that I will receive $20 as compensation.

I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

Student's Name _____

Student's signature _____ date:_____

Parent's signature _____date:_____

If you have any questions regarding research participants' rights please contact the Chair of the Committee for the Protection of Human Research Participants at 678-2533. If you would like information about alternative ways of obtaining research credit, please see the subject pool coordinator.

University of Memphis IRB # H04-79-D6
Approval of this form expires 3/31/11

Appendix 3-C. General consent form (for College students participating in a multi-session experiment)

Investigator: Dr. Danielle McNamara
Department of Psychology
The University of Memphis

Title: iSTART: Interactive Strategy Training for Active Reading and Thinking

I, _____, hereby agree to participate as a volunteer in the above named research project.

The purpose of this study is to investigate the role of reading strategy use in the comprehension of written material, and how the use of reading strategies varies across different kinds of readers (e.g., readers with low and high background knowledge). You will complete a series of tasks assessing reading, thinking, and memory skills. The information gathered in this project will help psychologists to understand reading comprehension processes.

I understand that the information collected in this study will be kept confidential within the limits of the law.

I understand that at any time I am free to refuse to participate or answer any question without prejudice to me, that I am free to withdraw from the experiment at anytime, and that The University of Memphis does not have any funds budgeted to compensate for injury damages, or other expenses.

I understand that this study consists of 14 sessions and that each session will last approximately 60-90 minutes. I also understand that I will be compensated for my time at a rate of $8 per hour, with an additional compensation of $50 upon completion of the 14th session.

I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

Signature _____

Student Number _____

Today's Date _____

If you have any questions regarding research participants' rights please contact the Chair of the Committee for the Protection of Human Research Participants at 678-2533. If you would like information about alternative ways of obtaining research credit, please see the subject pool coordinator.

University of Memphis IRB # #104-79-06
Approval of this form expires 3/31/11

Appendix 4. Informed Consent for Teachers

INFORMED CONSENT DOCUMENT
The purposes of this form are to give you information that may affect your decision whether to say YES or NO to participation in this research, and to record the consent of those who say YES.

TITLE OF RESEARCH: iSTART: Interactive Strategy Training for Active Reading and Thinking

RESEARCHERS: Dr. Danielle S. McNamara, Ph.D., Associate Professor, Psychology Department, University of Memphis
Phone: 901-678-3803 Email: dsmcnamara1@gmail.com

DESCRIPTION OF RESEARCH STUDY:
The appropriate description for the study will be outlined for a particular study.
The description include: purpose of the study, times of the year in which testing will be scheduled, duration of the study, number of students to be tested, assignment of students to different conditions within a class, the nature of materials included in the study, etc.

RISKS AND BENEFIT:
RISKS: There are no identified risks for participating in this research. However, as with any research, there is some possibility that you may be subject to risks that have not yet been identified.
BENEFITS: The main benefit to you for participating in this study is that you will contribute significantly to our knowledge of the relationships between teacher's use of strategies and student performance.

CONFIDENTIALITY:
Within the limits of the law, the researchers will take reasonable steps to keep private information, such as performance on test measures and course performance confidential. The researcher will remove identifiers from the information and store information in a locked filing cabinet prior to its processing. The results of this study may be used in reports, presentations, and publications; but the researcher will not identify you. Of course, your records may be subpoenaed by court order or inspected by government bodies with oversight authority.

WITHDRAWAL PRIVILEGE:
It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. Your decision will not affect your relationship with your school, or otherwise cause a loss of benefits to which you might otherwise be entitled. The researchers reserve the right to withdraw your participation in this study, at any time, if they observe potential problems with your continued participation.

COMPENSATION FOR ILLNESS AND INJURY:

If you agree to participate, then your consent in this document does not waive any of your legal rights. However, the University of Memphis does not have funds budgeted for compensation for injury, damages, or other expenses. If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call the Chair of the Committee for the Protection of Human Research Participants at (901) 678-2533.

VOLUNTARY CONSENT:

By signing this form, you are saying several things. You are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them:
Dr. Danielle S. McNamara, 901-678-3803

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call the Chair of the Committee for the Protection of Human Research Participants at (901) 678-2533.

Note Well: By signing below, you are telling the researcher YES, that you agree to participate in this study. The researcher should give you a copy of this form for your records.

Participant's Name Participant's Signature Date

INVESTIGATOR'S STATEMENT:

I certify that I have explained to this subject the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the subject's questions and have encouraged him/her to ask additional questions at any time during the course of this study. I have witnessed the above signature(s) on this consent form.