

ABSTRACT

SHAREK, DAVID JAMES. The Influence of Flow in the Measure of Engagement. (Under the direction of Dr. Eric Wiebe.)

eLearning courses are often perceived by their audiences to not be engaging enough to warrant the time and cognitive resources necessary to complete them. Flow Theory's assessment of optimal experiences (Csikszentmihalyi, 1990) provides insight into understanding user engagement by analyzing the interactions between user skill and task challenge. By designing courses that help users maintain a state of flow through a balance of user skill and task challenge, eLearning courses may better manage the struggle between frustration and boredom and lead to higher levels of engagement. This study investigates a novel technique for measuring task engagement by capturing user behavior data with little-to-no interference with the task. Results indicate that the measurement tool could potentially be used to extrapolate when cognitive overload occurs by helping to identify where in a task a person may reach a point of disengagement, and where they may choose to remain engaged. Implications and future research goals are discussed.

The Influence of Flow in the Measure of Engagement

by
David J. Sharek

A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Master of Science

Psychology

Raleigh, North Carolina

2010

APPROVED BY:

Eric Wiebe, PhD.
Committee Chair

Christopher Mayhorn, PhD.

Anne McLaughlin, PhD.

BIOGRAPHY

I spent my formative years in France, Switzerland, and the United Kingdom. After moving back to the States for university, I studied architecture, art, graphic design, and journalism. Along the way, I taught myself various programming and multimedia development tools, with Flash as my weapon of choice. After graduating, I worked for a number of companies such as IBM and Cisco in various roles including multimedia manager, programmer or designer; mainly in the eLearning sector. During my career I co-authored a book on 3D Flash design, and this experience helped me realize how much I enjoyed researching and writing. After my seventh year of working in the industry, I decided to satisfy my intellectual passions by returning to university to learn and to conduct research in the field of human factors.

ACKNOWLEDGEMENTS

It is my great pleasure to thank my thesis advisor, Dr. Eric Wiebe for his guidance, encouragement, and enthusiasm during my journey towards completing this thesis. I would also like to thank my advisory committee, Dr. Anne McLaughlin, and Dr. Christopher Mayhorn for their time, help, and insights along the way.

Additionally, I would like to thank my family for many reasons, some of which are: my wife, Lisa, for her ideas, unwavering support, encouragement, and ability to always make me smile, my mother for her gift of listening and bouncing ideas back in a way that makes them actually seem worth pursuing, my brother for his wealth of knowledge and willingness to help, and my late father for his inspiration and work ethic.

TABLE OF CONTENTS

LIST OF TABLES	vii
LIST OF FIGURES	viii
Introduction.....	1
The Problem with Traditional eLearning	2
Engagement	5
Prospective Memory.....	7
Flow Theory	9
Choice and Convexities	11
Cognitive Load Theory.....	16
Summary.....	20
Study 1	22
Hypothesis.....	23
Engagement	23
Game-Score Types	23
Study 1 Design.....	24
Independent Variables	24
Feedback conditions.....	24
Engagement Dependent Variables.....	25
Game-Clock Clicks	25
Time	27
Self-Report	27
Engagement.....	27
Game Score	28
Cognitive Load Dependent Variable	28
Affect and Motivation Dependent Variables.....	28
Study 1 Method.....	29
Participants	29
Materials and Apparatus	30

Procedure	30
Study 1 Results	32
Study 1 Summary.....	33
Study 2	33
Hypothesis.....	34
Engagement and Flow	34
Engagement and the Passage of Time	34
Engagement and Cognitive Load	35
Independent Variables	35
Flow State.	35
Engagement Dependent Variables.....	37
Game-Clock Clicks	37
Time	38
Self-Report.....	38
Perceived level of engagement	38
Game Score	38
Cognitive Load Dependent Variable	39
Study 2 Method.....	39
Participants	39
Materials and Apparatus	39
Task	40
Procedure	42
Study 2 Results	44
Design Conditions and Flow States.....	44
Engagement and the Design Conditions.....	48
Total Game-clock Clicks and the Passage of Time	49
Engagement and Cognitive Load	51
Study 2 Discussion.....	57
General Discussion	62
The Game-Clock.....	62

Limitations	63
Future Research	63
REFERENCES	65
APPENDICES	73
Appendix A: Study 1 Screenshots	74
Appendix B: Informed Consent Form	80
Appendix C: Binary Permutation Order Example.....	81
Appendix D: Display Order of all the Correct and Incorrect Warnings.....	82
Appendix E: Post-Training Questionnaire Items.....	83
Appendix F: Study 1 Open-Ended Responses.....	87
Appendix G: Study 2 Flash AS3 Code	90
Appendix H: Block Walk Game.....	121

LIST OF TABLES

Table 1. <i>Study 1 ANOVA Summary</i>	32
Table 2. <i>Individual Game Level M and SD by Condition</i>	45
Table 3. <i>Design Condition Post-hoc Mean Differences</i>	47
Table 4. <i>Game-clock Clicks and Over Time Means and Standard Deviations</i>	50
Table 5. <i>Ratio of Intermission Clicks to Total Game-Play Clicks Mean Differences</i> ...	51
Table 6. <i>TLX Workload Breakdown Descriptives</i>	53
Table 7. <i>NASA-TLX Subscale Post-hoc Mean Differences</i>	55

LIST OF FIGURES

<i>Figure 1.</i> Flow Theory's Interaction between Challenge and Skill.....	10
<i>Figure 2.</i> Example of Multiple Convexities	13
<i>Figure 3.</i> Similarities Between Cognitive Load Theory and Flow Theory	20
<i>Figure 4.</i> Game-Clock Expanded Before Minimum Time had been Reached	26
<i>Figure 5.</i> Game-Clock Expanded After Minimum Time had been Reached	26
<i>Figure 6.</i> Study 2's Three Conditions based on Flow Theory.....	36
<i>Figure 7.</i> Clustered Bar Graph of Individual Game Level <i>M</i> and <i>SD</i>	46

Introduction

According to the American Society for Training and Development, US workplace learning accounted for an estimated \$134.39 billion dollars in 2007 (Paradise, 2008). eLearning accounts for almost one-third of all workplace learning and this trend is continuing to grow as industry educators explore the cost saving benefits of electronic training methods (Young, 2002), such as reduced travel costs for learners and trainers. (Paradise, 2008). Compared to classroom training more people are able to benefit from eLearning because classroom size is no longer a limiting issue and content is becoming more globally accessible as electronic training completes its transition from CD-ROM-based delivery to Web-based delivery. eLearning has also opened up opportunities for universities to offer entire undergraduate and graduate degrees; a trend that is increasingly becoming more popular partly due to the many jobs that have been lost as a result of the current recession (Pawlowski, 2009). In 2006, nearly 3.5 million people were taking at least one eLearning course (Allen & Seaman, 2007), a strong indicator that eLearning will continue to grow in both the education and industry sectors (Paradise, 2008).

Though the numbers presented above seem to indicate that eLearning is an influential training method the definition of eLearning remains somewhat cloudy. Previous literature on eLearning rarely differentiates between eLearning and e-teaching (Prensky, 2003). Prensky explains that the majority of eLearning literature is based on

teaching techniques tailored for electronic deployment rather than on how the end user actually processes and learns the information. For the purposes of this paper, eLearning will be used to describe web-based training (WBT) and computer-based training (CBT) deployments of content specifically tailored to teach new information and train users on new procedures through the uniquely dynamic and adaptive characteristics of electronically delivered information and technologies.

The Problem with Traditional eLearning

A considerable amount of money and time is invested in corporate eLearning courses to train employees on job-specific skills, or company-specific business processes (Paradise, 2008). Multimedia development of eLearning courses can be extremely costly due to the requirements of developing audio, video, and user interactivity all of which is usually custom-designed for each course and audience. Traditionally, eLearning course development requires close communication between subject matter experts (SMEs), instructional designers (IDs), multimedia programmers, and graphic designers. As an added layer of communication complexity, project managers are usually required to act as a liaison between the development team and the clients and project sponsors (Dan, Feldman, & Serpanos, 1998). This diverse blend of expensive developmental roles and responsibilities can shift the focus from perfecting training methodologies to more of a focus on completing projects before the deadline hits.

Traditional eLearning courses are linearly designed and usually adopt a two-dimensional, sequential pedagogy (Robberecht, 2007) which forces users to follow the same path regardless of experience or just-in-time learning needs. Without interactive, content-specific feedback (Robberecht, 2007), the user may be less intrinsically motivated to continue interacting with the course (Chen & Macredie, 2002). This preference for nonlinear learning has been found to be influenced by individual learning styles. For example, Durfresne and Turcotte (1997) found that field-independent users (those who have higher cognitive restructuring skills) are able to better develop mental models of learning environments compared to field-dependent learners (those who prefer a passive learning approach), and therefore favor non-linear eLearning courses. Designing eLearning courses with a linear navigational path provides the potential to alienate users who require more adaptive and flexible navigational schemas.

Over the years, eLearning courses have not strayed far from their traditional design of breaking up content into individual pages with generous sprinklings of assessments at the end of each section. Navigational structures reflect this page-by-page content by adhering to ubiquitous control elements such as back and forward arrows, and topic or module level menus. The greatest flexibility this navigational structure allows is that instructional designers may choose between a forced linearity design, or a design that allows users to jump from topic to topic. Recently, the use of

interactions, animations, and videos and games is becoming more common as instructional designers and developers try to make their courses more palatable by taking note of the success of video games that provide nonlinear game play that increases the immersive experience by more closely resembling real-life decision making options (Krawczyk & Novak, 2006).

In the past, there has been a greater focus on the content of the information, rather than on the methods to motivate people to want to learn the content (Burns & Gentry, 1998; Engelhard & Monsaas, 1988). Loewenstein (1994) suggests this is because educators know less about how to motivate students and are therefore better equipped to educate people who are already motivated or are required to learn the content.

This inattention to motivation is crippling when coupled with the fact that courses aren't always required and that they can take a large amount of time to complete. For example, salesmen often feel that their time could be better spent by making sales calls, and any training that they will require could be learned 'on-the-go' rather than participating in five seat-hours of eLearning.

Instead of focusing on developing an environment that increases intrinsic motivation, companies often choose to offer extrinsic rewards such as certifications or even job security for completing specific courses. Focusing solely on extrinsic

motivators does not guarantee an effective solution since people may be negatively affected by extrinsic motivators. Further, Deci and Ryan (1985) found that external motivators could threaten certain types of people's personal autonomy. With this in mind, effective multimedia eLearning design should incorporate both extrinsic and intrinsic motivators (Jacques, Jenny Preece, & Carey, 1995; Malone, 1980).

Engagement

Intrinsic motivation has been linked to engagement. The psychology literature provides numerous examples of how engaging people in tasks can increase interest, learning retention (Adelson, 1992; Webster & Ho, 1997), pleasure (Charlton & Danforth, 2007) and an overall intrinsic desire to continue participating in a task. One characteristic of engagement in learning is the overall direction and intensity of a person's learning experience; a characteristic defined by Colquitt, LePine, and Noe (2000) as training motivation. These examples contribute to the common belief among industry managers that engaged employees equate to higher company profits (Macey & Schneider, 2008). Training material that is designed to be meaningfully engaging, irrespective of the technological media in which it is presented, encourages effective learning (Kearsley & Shneiderman, 1999) making it important to understand how and why certain multimedia training methods engage users more (Jacques, et al., 1995). A more engaging course should increase the quality of time and the amount of time a user spends on eLearning over and beyond the bare minimum that they are required to

spend. As the level of engagement increases; a more engaging course is more likely to guide the user's attention and help them focus on important content, rather than on content that will increase extraneous cognitive load (Paas, Renkl, & Sweller, 2003). Since engagement is an important factor in motivation (Flowerday & Schraw, 2003); a more engaging course should increase intrinsic motivation because the user will be more likely to feel that they have the ability to choose to participate, and they will do so because they are interested in some aspect of the training (Deci & Ryan, 1985; Deci, Vallerand, Pelletier, & Ryan, 1991).

For the purposes of this paper, engagement is defined using the following nine characteristics: "challenge, positive affect, durability, aesthetic and sensory appeal, attention, feedback, variety/novelty, interactivity, and perceived user control" (O'Brien & Toms, 2008, p. 938). Additionally, the stages of engagement will be referenced thusly: point of engagement, sustained engagement, disengagement, and reengagement (O'Brien & Toms, 2008).

In a review of engagement literature it quickly becomes apparent that there are almost as many definitions of engagement as there are articles on the subject (e.g., O'Brien & Toms, 2008; Paradise, 2008). These variations in definitions of engagement contribute to variations in what was measured; thus making it difficult to compare experimental results. For example, Brown (2005, p. 994) defines engagement as "the degree to which learners are actively involved in learning" (p.994). In terms of

multimedia learning, Jacques, et al. (1995) define engagement as an outcome of being able to hold a person's attention through the provision of intrinsic rewards.

One potential measurable construct of engagement is a person's awareness of the passage of time (McCarthy & Wright, 2004; O'Brien & Toms, 2008). O'Brien and Toms (2008) found evidence of this attribute of engagement and linked such spatiotemporal experiences to a person's self and external awareness. For example, when a person is asked to participate in a task, they may become fully engaged in the task and unaware of how long they have spent on the task. In contrast, a person who is very much aware of the passage of time as indicated by, for example, continual glances at their watch, may be thought of as not engaged in a task, i.e. bored by it. McCarthy and Wright (2004) propose the idea that a person's sense of time can change depending on their level of emotional engagement. They suggest that a person's willingness to continue to engage in a task is directly related to their perception of time and space. Though this construct has not yet been specifically tested in the area of engagement, previous research on prospective memory (Cook, Marsh, & Hicks, 2005; Einstein & McDaniel, 1990) provides some support to warrant further investigation.

Prospective Memory

Research in prospective memory focuses on how people remember their time-based or event-based intentions to complete future tasks (Cook, et al., 2005; Einstein & McDaniel, 1990). Event-based intentions are tasks that need to be carried out when a

certain event will occur in the future. For example, when a person meets a friend (the event), they may be reminded to tell their friend about a book they read (the task).

Time-based intentions, on the other hand, are tasks that need to be carried out at certain points, or ranges, in time. For example, a person may want to go for a jog (the task) at some point during the next day (the range in time). The link between time-based prospective memory research and research in engagement mainly lies in the similarities of how a person monitors their perceived passage of time (Cook, et al., 2005) while performing a task. Time-based prospective memory cannot rely on environmental cues to indicate when a task should be initiated. Similarly, when a person is engaged, they may spend the majority of their attentional resources on the task leaving little room to attend to environmental cues because remembering a future intention requires a degree of cognitive capacity (Smith, 2003).

The predominant theory used to measure how time-based intentions are carried out is the test-wait-test-exit model (TWTE), previously known as the test-operate-test-exit (TOTE) unit (Miller, Galanter, & Pribram, 1960). The TWTE model is based on the mechanics of the feedback loop similar to that of a servomechanism. In terms of behavior, the TWTE model can be used to explain how a person constantly tests current conditions against expected outcomes. When a condition matches an outcome, a person will automatically react (carry out their intentions); otherwise they will continue to wait and check conditions. In terms of a person's awareness of the passage

of time, the TWTE model has been used to design experiments that monitor how often a person checks a clock when they are told that they must perform a task at a future time. When participants were told to press certain keys on a computer keyboard (the task) when they reach a specific stage in the experiment, they were less likely to check the computer's clock compared to participants who were given no context association (Cook, et al., 2005).

Flow Theory

Flow is described as an optimal experience that includes feelings of exhilaration and deep enjoyment (Csikszentmihalyi, 1990) where being in an optimal experience is similar to being fully engaged. Csikszentmihalyi proposed that one of the most powerful experiences in flow occurs when a person is faced with difficult obstacles that they deem to be worthwhile to overcome. For example, including a scoring system in video games can help a player stay in their flow by providing feedback on uncertain outcomes such as whether or not they will receive the highest score as they progress through the game. Malone (1980) refers to this as a *metagoal* and explains that though the main goal for the game may be to finish a level, the inclusion of a scoring system can also motivate players to score as high as possible thus creating more of an interest in the game.

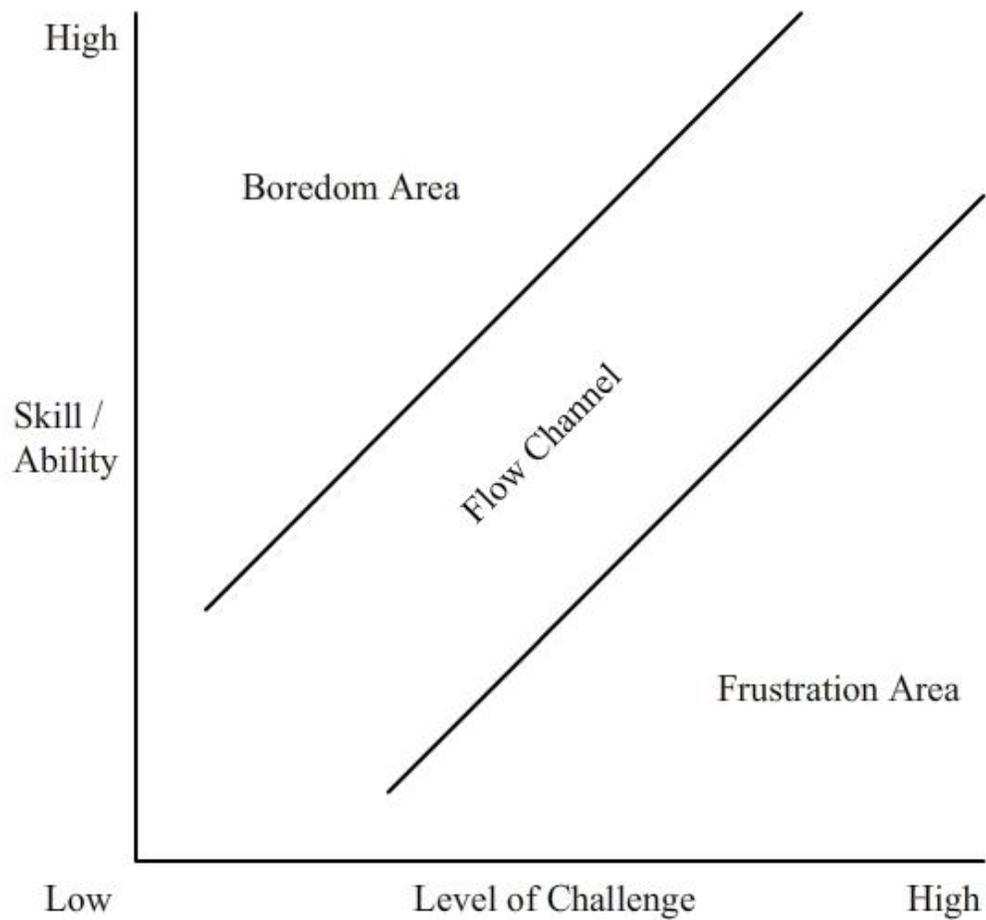


Figure 1. Flow Theory's Interaction between Challenge and Skill - Adopted from Csikszentmihalyi (1990)

Figure 1 shows the Flow Channel. A person can fall into the Frustration Area if their skill level is not matched up with a comparable difficulty level while playing a game or participating in a task. People usually begin a task with a low set of skills and their task should match their skill level with an appropriately low set of challenges.

According to Flow theory, as a person progresses through a task, their flow will more likely be maintained if their task difficulty manageably increases.

One way to influence the flow of a video game is by introducing cut-scenes or animations to break up potentially monotonous parts of a game. If done correctly this should increase the game flow, however, flow can be decreased by overusing cut scenes, or by using them at inappropriate points in the game (Krawczyk & Novak, 2006).

In a similar vein to Flow Theory, Loewenstein (1994) provides a model of curiosity which is based on the idea that people have the desire to fill the manageable gaps that they identify in their existing declarative or procedural knowledge structure. Gaps that are too great can stimulate learned helplessness (Frustration Area) and gaps that are too little can cause apathy (Boredom Area) (Loewenstein, 1994). This has implications for eLearning since it highlights that it is not only the balance between challenge and acquired skill that determines a person's placement in the flow channel; the intrinsic desire to simply gain knowledge can also motivate people to continue participating in a learning task.

Choice and Convexities

Video game designers have adopted design patterns that clearly reflect Flow theory's suggestion to actively balance the challenges provided by the game with the user's personal skills and abilities. One theory that stems from motivation and

engagement research is the idea of the importance of play during learning (Jacques, et al., 1995; Webster & Ho, 1997).

In Rabin's introduction to game design book, he explains that games with a linear increase in difficulty can become boring and predictable (Rabin, 2005). Rabin uses Flow Theory to introduce a game design pattern he calls a Convexity (see *Figure 2*). *Convexities* are a series of non-linear, multi-path navigational design approaches and choices that provide a practical architecture to enhance flow in game-play. Convexities provide players with tasks that are interconnected and directly related to the overall goal. At the beginning of the game, a player may only have one choice, but as the convexity widens and they progress throughout the game, more choices and paths are revealed. The number of choices decreases as the player reaches the end of a level. Games that include difficult sections in-between easier sections can build excitement and increase feeling of exhilaration (Rabin, 2005). These feelings of pleasure may lead to higher levels of engagement when considering the nine characteristics of engagement proposed by (O'Brien & Toms, 2008)

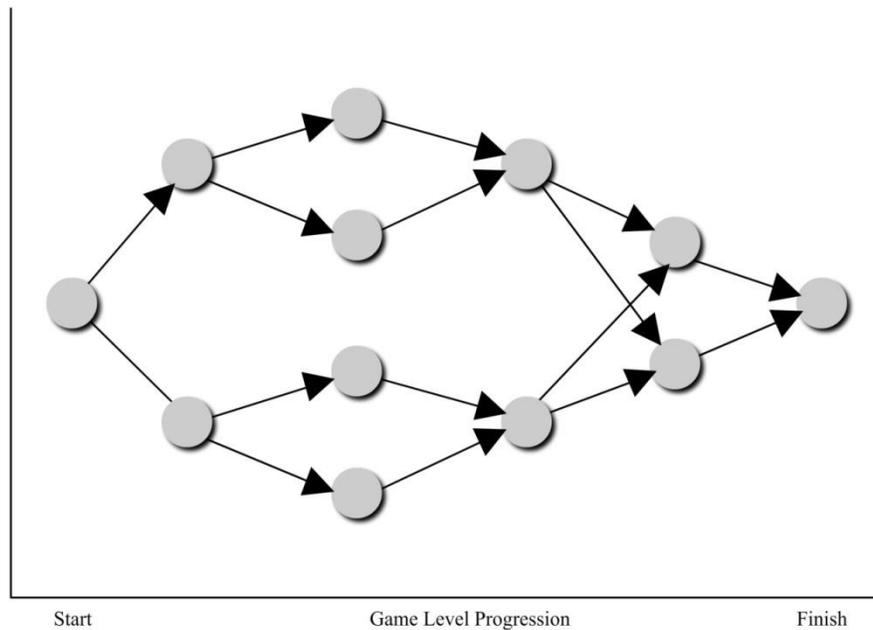


Figure 2. Example of Multiple Convexities – Adopted from Rabin (2005)

Flowerday and Schraw (2000) interviewed teachers regarding choice and found that teachers believed that choice can increase intrinsic motivation by giving students control over learning what interests them. The teachers also believed that this can lead to developing interest in subjects that the students weren't initially interested in learning. Through observation, teachers, found that providing learning choices promoted student involvement, interest and engagement, producing feelings of positive affect. These observations are supported by Cordova and Lepper (1996), who found that introducing choice increased intrinsic motivation and learning engagement.

Using convexities to design experiences that accommodate and even reward a user's choice of which challenge to tackle next can help users feel a sense of control and increase their motivation to stay involved in the game or computer task (Garris, Ahlers, & Driskell, 2002; Malone, 1980; Wideman, et al., 2007).

Though integrating user choice in eLearning courses can increase intrinsic motivation, it is important to note that not all users welcome the opportunity to make choices. Some students respond negatively to choice because they don't know how to choose. Desire for control literature (Burger, 1985; Burger & Cooper, 1979; E. Thompson, Chaiken, & Hazlewood, 1993) suggests that a low desire for control can negatively impact intrinsic motivation if that person exhibits a low desire for control.

One challenge that introducing video games into educational systems may bring is the student's initial reaction of not understanding how games will help them learn. Squire (2005) found that 25% of the students in his class elected to stop playing a video game that he introduced because they didn't see how the game related to their education. This reaction may have been due to the type of game Squire used since the game was primarily intended for entertainment and not for educational purposes. It is useful to extract the purely entertaining elements in video games which can be imported to eLearning courses. Researchers have begun to focus on these elements in hopes of identifying which aspects video game designs can be extracted to increase

engagement in eLearning courses (Malone, 1980; McGinnis, Bustard, Black, & Charles, 2008; Squire, 2005, 2007; Wideman, et al., 2007).

A game also needs to provide uncertain outcomes otherwise it will become boring as the user realizes that they are certain to either win or lose (Malone, 1980, 1984). Malone provides several suggestions for integrating uncertainty in game design. For example, varying the difficulty can make the game more challenging and can increase user engagement. This is supported by McGinnis, et al. (2008) findings that a lack of engagement can be attributed to a lack of challenge. Additionally, users have indicated that unchallenging learning material fails to stimulate them making their experience unattractive and discouraging. (Prensky, 2003; Zemsky & Massey, 2004). Malone also suggests providing multiple level goals. In other words, engagement may be increased by providing smaller sub-goals. One way to achieve this is to adopt the convexity design pattern and allow users to choose which sub-goals to complete as they continue towards their main goal.

Though a player may feel certain to accomplish one level in a game - the next level's outcome can still be uncertain. This idea ties in with varying the difficulty of the game. Score keeping or speeded responses can be used as meta-goals.

The learner needs to know how they are doing throughout the game (Malone, 1980, 1984). In video games, this is achieved by building in an interactive feedback

loop that provides instant feedback to the player. (Hunicke, Leblanc, & Zubek, 2004). Using this feedback helps a player know where they have gone wrong so they can go back and correct their mistakes.

Cognitive Load Theory

A learner's ability to engage in higher order cognitive processing during eLearning training is limited (Merrienboer & Sweller, 2005) therefore it is important for a person to maintain an optimum amount of cognitive processing if they wish to remain in their flow channel.

A learner's ability to engage in higher order cognitive processing during eLearning training is limited (Merrienboer & Sweller, 2005). The most common, underlying psychological principle used to analyze how a learner's cognitive processing is affected by multimedia elements in eLearning is Cognitive Load Theory (CLT). Building on the assumptions that the learner has limited working memory, and virtually unlimited long-term memory, CLT can be used to aid the instructional designer in selecting the appropriate multimedia elements to enhance training (Sweller, van Merrienboer, & Paas, 1998). If too much information is directed to the learner at one time, for example, in one animation, or in one viewable page containing text and graphics in an eLearning course, cognitive overload could result. Put another way, cognitive overload occurs when a learner's cognitive processing capacity is less than

the cognitive processing required by the combination of the multimedia elements in the eLearning (Mayer & Moreno, 2003).

Research involving CLT and eLearning focuses on three types of load: intrinsic, extraneous, and germane. CLT assumes that all three loads are additive. For example, if intrinsic load is high, due to teaching complex information, then extraneous load must be kept low to prevent total cognitive overload (Paas, et al., 2003). An interesting point that Pass et al. discuss is that cognitive resources are first allocated to intrinsic load before extraneous and germane load can be processed, however it also seems likely that the resource allocation is governed to some degree by individual factors such as preference, motivation and goals.

Intrinsic load represents the load produced by the amount and type of information that is conveyed in instructional material. This type of load can vary from learner to learner because the number of chunks of information required to understand a given subject have to simultaneously be held in working memory, and that amount depends on how the chunks of information are formed. A learner with previously developed schemata for a given subject may be able to place more information together into one chunk, thus reducing element interactivity (Merrienboer & Sweller, 2005). Since element interactivity depends on the learner's expertise and pre-developed schemata, it is important to remember that the difficulty level in learning new content is variable. Instructional designs that provide specific ways for novice learners to build

supporting schemata and reduce intrinsic load will be more effective than simply considering intrinsic load as a constant and only focusing on ways to reduce extraneous load.

Unlike intrinsic load, extraneous load can be reduced, and indeed, cognitive load researchers have focused much of their time on finding ways to reduce it in instructional materials. Extraneous load is created by the formatting and presentation of information (Sweller, et al., 1998). Though extraneous load is not clearly defined (Schnotz & Kuerschner, 2007) it can generally be thought of as the formatting and implementation of instructional design elements that do not directly aid schema acquisition or schema automation (Sweller, 2005).

For over 30 years CLT has been used extensively to show that, while intrinsic load remains constant, reducing extraneous cognitive load promotes learning and transfer. Germane cognitive load was introduced a little over 10 years ago (Paas & van Merriënboer, 1994) as a means to explain findings that an increase in cognitive load due to variability in instructional presentation actually produced better transfer. Germane load can be thought of as the cognitive effort committed by the learner towards the learning goal. Therefore, it can be suggested that germane load should be increased as much as possible. One way to achieve this is to reduce extraneous load, and increase motivation (Paas, et al., 2003).

Vygotsky's (1963) *Zone of Proximal Development* can be used in conjunction with CLT to demonstrate how Flow Theory may work at the cognitive level. Much as Flow Theory does, the Zone of Proximal Development theorizes the creation of learning contexts that create an optimal matching of a learner's level of expertise with the learning goals. *Figure 3.* shows the zone of proximal development overlaid with the flow channel. In both theories learning and engagement mainly occurs when a person's expertise is aligned with a task's difficulty level. As expertise increases, the task's difficulty will decrease. If a person's expertise exceeds a task's difficulty level, the person may experience a decrease in intrinsic load, resulting in boredom. Similarly, if a task's difficulty exceeds a person's expertise, the persons may experience an increase in intrinsic load, resulting in frustration. In the later case, what may be considered to be intrinsic load (important task information) may not be able to be processed by the person since they haven't developed schemata to manage this increase in element interactivity.

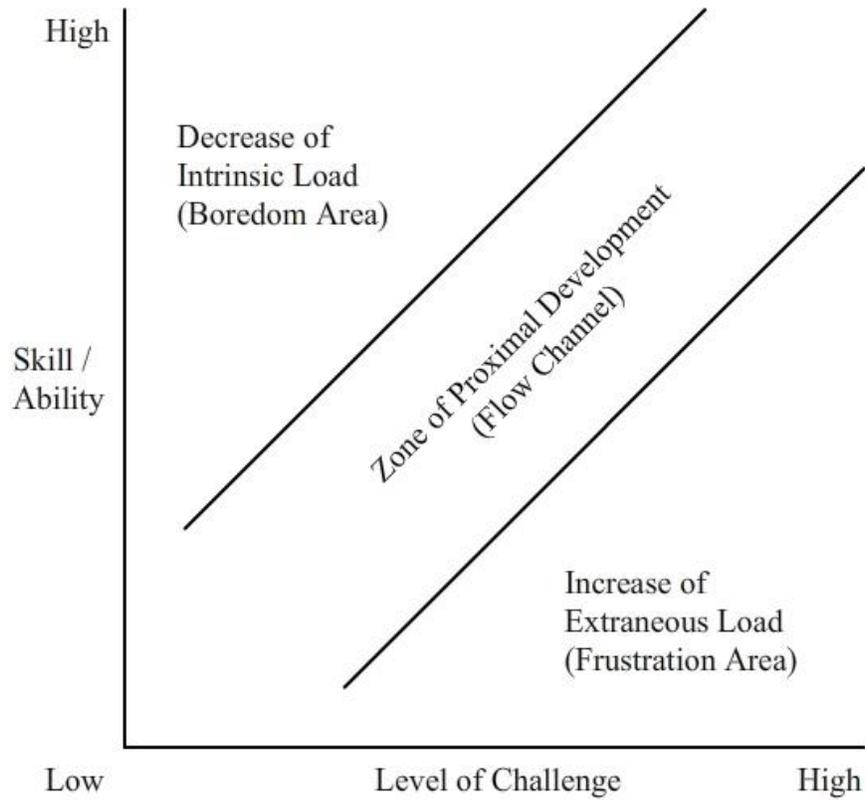


Figure 3. Similarities Between Cognitive Load Theory and Flow Theory – Adopted from Csikszentmihalyi (1990) and Schnotz and Kuerschner (2007)

Summary

Traditional eLearning courses are commonly perceived to be boring, and the navigational linearity and non-adaptive design of their content makes it difficult for users to enter a point of engagement and remain in a sustained engagement state. As

more and more people are required to participate in eLearning courses, it is becoming increasingly important to design courses that intrinsically motivate and captivate the attention of its users. Though the psychological construct of engagement still remains fuzzy to researchers and practitioners alike (Macey & Schneider, 2008), it does seem to offer a promising area of study for eLearning designers to create courses that instill a desire to participate in users.

For the purposes of engagement in eLearning, Flow Theory has shown to be one of the more thorough and practical frameworks from which to base experimental designs. As Flow Theory suggests, there is a constant interplay between boredom and frustration as a person tackles a new task. The goal of eLearning designers should be to help users find and remain in their flow channel while taking a course. By doing so, the user should be able to settle into an engaged state where they are constantly challenged and learning at a manageable rate. Video game design patterns such as convexities, controlled challenges, and feedback loops such as scoring systems have shown to be successful tools in sustaining a user's state of engagement.

Though measuring engagement in a controlled laboratory setting has been largely under-studied (O'Brien & Toms, 2008), prospective memory research introduces a potential mechanism for measuring one of the more observable characteristics of engagement; that is the awareness of the passage of time. When a

person is fully engaged, they should be less aware of the passage of time as their limited cognitive resources will be captured by their current task. When a person becomes disengaged, they may release some of their cognitive resources and become more aware of the passage of time.

Study 1

Study 1 focused on developing and testing an eLearning task for use in multiple engagement experiments. The theoretical rationale used to design the game was based on Flow Theory and video game design patterns such as *convexities*. Research on prospective memory also helped guide the design of a game-clock used to measure a person's awareness of the passage of time, and therefore their level of engagement.

There are many mechanisms in successful video game design patterns that may contribute to engagement. Not all of them may be appropriate for eLearning courses and in order to test these mechanisms, multiple experiments will be required. Study 1 investigated how variations on the user performance feedback loop (Malone, 1980, 1984) in the form of a game score affected engagement. In addition to testing whether variations in the display of a game's score contributed to engagement and performance, Study 1 also investigated the ability for a game-clock to be used as a measure of engagement. The game-clock was implemented by telling participants that they were required to play a game for a certain amount of time. Participants were not told how

much time they were required to spend on the game, only that clicking on the game-clock would reveal whether or not they had reached the minimum amount time or not. The amount of times a participant clicked on the game-clock could be used to indicate their level of engagement since every game-clock click had to be self-initiated, and the only reason for clicking on the clock would be to check if they could exit the game.

Hypothesis

Engagement

The more engaged a user is, the less aware they should be of the passage of time while participating in a task. Similarly, a user who is not engaged will be more aware of the passage of time while participating in a task.

H_{1a}: Engagement will negatively correlate with the number of game-clock clicks. For example, more game-clock clicks indicate low engagement, and fewer clicks indicate higher engagement.

H_{1b}: Engagement will positively correlate with the amount of time over-and-beyond the minimum amount of time to play the game.

H_{1c}: Engagement will positively correlate with the overall game score. For example, the higher the score, the higher the level of engagement.

Game-Score Types

Game score mechanisms were manipulated in the form of a user performance feedback loop and used in this study as independent between-subject variables. Game

scores that instantly display current numerical scores should increase engagement (ENG) more than non-numerical game scores displayed in the form of an analog meter. Both game scoring mechanisms should increase engagement compared to no score. Additionally, overall time spent playing the game (TME), and final scores (SCO) should be higher for participants in the numerical condition followed by those in the meter condition, with participants in the text-only condition spending the least amount of time required and scoring the lowest.

H2: $ENG_{\text{numerical}} > ENG_{\text{meter}} > ENG_{\text{no score}}$

H3: $TME_{\text{numerical}} > TME_{\text{meter}} > TME_{\text{no score}}$

H4: $SCO_{\text{numerical}} > SCO_{\text{meter}} > SCO_{\text{no score}}$

Study 1 Design

Independent Variables

Feedback conditions. The three feedback score conditions (see Appendix A for screenshots) are as follows:

Design Condition 1 (Numerical Scoreboard + Non-supportive text) – eLearning game feedback was presented in the form of a digital scoreboard accompanied by either incorrect or correct, non-supportive feedback. Numerical scoreboard animates by counting up or down as points are either given for correct answers or subtracted for answering questions incorrectly.

Design Condition 2 (Analog Meter Scoreboard + Non-supportive text) –

eLearning game feedback was presented in the form of an analog meter accompanied by either incorrect or correct, non-supportive feedback. When correct answers are made, the analog needle glows green and incrementally rotates clockwise towards the correct side of the meter. Incorrect feedback is indicated by a glowing red analog needle that incrementally rotates counterclockwise towards the incorrect side of the meter.

Design Condition 3 (Non-supportive text) –

eLearning game feedback was presented only in the form of non-supportive feedback such as “Great Job!” or “Sorry, that was incorrect”. Participants were not given any form of a score while playing the game nor after the game had been completed.

Engagement Dependent Variables

Game-Clock Clicks

A computer clock mechanism was used to record every time a participant would click on a button in order to see if the minimum required time to play the game had been reached. Each game-clock click was recorded.



Figure 4. Game-Clock Expanded Before Minimum Time had been Reached – Game-Clock Automatically Slide Off-Screen After Five Seconds.



Figure 5. Game-Clock Expanded After Minimum Time had been Reached – Game-Clock Automatically Remain On-Screen for User Input.

Participants were instructed to click on the game-clock to find out if the minimum time to play the game was up. When the button labeled, "TIME", was clicked the game-clock would slide out and display a text message indicating if the minimum time was up but it gave no indication of how much time was left. Upon clicking the Time button, if the participants had not reached the minimum time the game-clock would slide out (see *Figure 4*) with a red background and the message, "*The minimum time has not yet been reached.*" After three seconds, the game-clock

would automatically slide back off-screen. If the minimum time had been reached, the game-clock would slide out (see *Figure 5*) with a green background and the message, “*The minimum required time to play is up. You may continue playing if you want*” Two buttons would also become visible labeled, “EXIT GAME” and “KEEP PLAYING”. Clicking on the keep playing button would slide the clock off-screen and clicking on the exit button would immediately take the participant to the end of the game.

Time

Time was measured using an internal timer that was integrated into the game. The total length of time that the participants spent playing the game was measured as well as the length of time they spent playing after they had reached the minimum amount of required time. The minimum amount of time that the participants were required to spend playing the game was 10 minutes. Based on pilot research data, it was estimated that participants would have approximately an additional five minutes of game-play time once the minimum time had been reached should they choose to continue playing.

Self-Report

Engagement was measured by asking participants if the game was engaging as well as an open-ended question that asked them to define engagement, and discuss how their definition applied or did not apply to the game.

Game Score

The overall score of how many questions were answered correctly, and how many were answered incorrectly was also captured.

Cognitive Load Dependent Variable

Cognitive Load was measured using the NASA Task Load index (NASA-TLX) (Hart & Staveland, 1988). Cognitive load scores were used to ensure that a minimum amount of load had been reached while playing the game. The scores were also used to better understand whether or not the participants had actively participated in the experiment, and whether they were likely to be in the optimal flow range of challenge vs. ability (see *Figure 1*).

Affect and Motivation Dependent Variables

Subjective Rating Measures were used to capture the participants' *affective reactions* (Thompson, Sebastianelli, & Murray, in press) and level of intrinsic motivation using the *Scale of Intrinsic Motivation Inventory* (Deci, 2009).

Study 1 Method

Participants

A total of 124 people participated in this study. Sixty-four participants were enrolled in a research 1 university's Introduction to Psychology program. Sixty additional people were concurrently recruited through Amazon's Mechanical Turk (Amazon.com, 2009). The Mechanical Turk is a website that connects people with tasks that require human input, known as human intelligence tasks (HIT). Amazon's Mechanical Turk has been successfully used to gather participants for psychology experiments in the past (e.g. Colowick & Pool, 2007; Kaisser, Hearst, & Lowe, 2008; Kittur, Chi, & Suh, 2008) and provides a good representation of the increasingly global employee training landscape (Cascio & Aguinis, 2008; Paradise, 2008).

Four participants produced data that were outliers and so were removed from the analysis. Two of them made an inordinate number of clicks on the game-clock; well above 3 standard deviations while the other two scored below 3 standard deviations on the NASA-TLX. One participant ended the experiment prematurely and their data were lost. Of the remaining 119 participants, 58% were male and 42% were female (mean age = 25.57, $SD = 9.96$). 86.6% were from the United States. Conditions one and two had 39 participants each and condition three had 41 participants.

Materials and Apparatus

The experiment was hosted at www.playgraph.com, an experimental psychology Web site maintained by the author that hosts Adobe Flash psychology experiments. The Web site uses a MySQL database and a PHP server-side scripting language to store participant responses. The experiment could be accessed from any computer with Internet access. The computer requirements included a minimum computer monitor resolution of 1024x768 and an installed version of the Adobe Flash player v.9 or greater.

Procedure

The experiment was conducted over an Internet connection. Once participants read, and accepted the informed consent (see Appendix B), they were asked to enter their email address so it could be used to generate a secure 32-digit hexadecimal unique user ID via a MD5 cryptographic hash function. Once participants entered their email address, they were randomly assigned one of three conditions (numerical score, meter score, and no score) and given instructions to read. After reading the instructions, participants were asked to perform a short tutorial to ensure that they understood the game mechanics. After completing the tutorial the experiment started.

Participants were asked to view different Microsoft Windows operating system warnings and determine if they were legitimate or not. Three different warning types

were used with five visual elements manipulated per warning (Sharek, Swofford, & Wogalter, 2008): exit/maximize/minimize buttons, OK/cancel button, background, text/icon content, and the border. Each element could be displayed for the user in one of two states, correct or incorrect (represented by a 1 or a 0). During game play, participants were individually shown one of the three warnings with a combination of correctly or incorrectly displayed visual elements. For a single warning with five binary displayed visual elements, 32 possible combinations of correctly or incorrectly displayed elements exist. Binary permutation functions (Blake, Cohen, & Deza, 1979; Ouahada, Swart, Ferreira, & Cheng, 2008; Yeong-Taeg, Arce, & Grabowski, 1995) were written to calculate the total number of correct/incorrect combinations (see Appendix C) for each warning type. After the total number of binary permutations was calculated, the total number per warning type was divided by three (rounded up) to generate the number of correct warnings to display. The display order of all the correct and incorrect warnings was then randomized. Appendix D provides an example order.

When players began the game, they were presented with warning types with all five visual elements incorrectly displayed. This large number of incorrect elements should make it easier for the participant to recognize the warning as being illegitimate. As the game progressed, fewer and fewer elements were incorrectly displayed, until only one element would be incorrect.

After completing the game, participants were asked to complete an integrated custom Flash version of the NASA-TLX that was followed by a series of subjective and demographic questions (Appendix E). Finally, an open-ended question asked participants to define engagement, and use their definition to describe how engaging the game was. When the questionnaire was completed, participants were taken to a final screen where they were debriefed and thanked. An 80 cent payment was then sent to their Amazon account.

Study 1 Results

Table 1.

Study 1 ANOVA Summary

	<i>F</i>	<i>df</i>	<i>Sig.</i>	<i>Partial Eta Squared</i>
Game-Clock Clicks	1.50	2	.23	.02
NASATLX	.50	2	.61	.01
Percent Correct	.59	2	.55	.01
Total Answers	1.95	2	.15	.03
Total Time	3.04	2	.05	.05
Engaging	.06	2	.95	.00

Note: (*n*=82)

Study 1 Summary

As can be seen in Table 1, results revealed a floor effect where the majority of participants in all three conditions described their experience with the game as boring and monotonous (see sample responses in Appendix F). According to Flow Theory, the participants gained skill but they perceived that their new abilities were not matched by more difficult challenges; they were essentially prevented from entering the flow channel.

The preliminary results also revealed that there was no significant interaction between the number of times the game-clock was clicked and the three conditions, though the results were trending in support of the hypothesis that the numerical score condition would be the most engaging, followed by the meter score, and then the text only/no score condition.

Study 2

The goal of Study 2 is to validate the game-clock used in Study 1 as a valuable and reliable measure of engagement. The game-clock mechanism will be similarly implemented with one exception. In Study 1, the game-clock did not automatically slide out when the minimum time was up, so participants could theoretically play the entire game without ever noticing the game-clock's text message. This made it difficult

to compare the amount of time a participant played over-and-beyond the required minimum amount of time.

The floor effect of engagement experienced in Study 1 will be mitigated by designing three conditions that reflect three distinct user experience states using Flow Theory (Csikszentmihalyi, 1990) as a framework. Pilot studies will also be used to ensure accurate implementations for each flow state.

Hypothesis

Engagement and Flow

Flow Theory was used to design three, between-subject variables: Frustration, Flow, and Boredom (see *Figure 6*). Participants in the Flow condition should be more engaged (ENG) than participants in the Frustration or Boredom conditions.

H1: $ENG_{Flow} > ENG_{Boredom}$ and that, $ENG_{Flow} > ENG_{Frustration}$

Engagement and the Passage of Time

The more engaged a user is, the less aware they should be of the passage of time while participating in a task. Similarly, a user who is not engaged will be more aware of the passage of time while participating in a task.

Following from the hypothesis that the Flow condition represents the greatest level of engagement, engagement will negatively correlate with the number of game-clock clicks (GC). For example, more game-clock clicks indicate low engagement, and fewer clicks indicate higher engagement. Additionally, engagement will positively correlate with the amount of time over-and-beyond the minimum amount of time to play the game (TME).

$$\begin{aligned} \text{H2a: } & GC_{\text{Flow}} > GC_{\text{Boredom}} \text{ and that, } GC_{\text{Flow}} > ENG_{\text{Frustration}} \\ \text{H2b: } & TME_{\text{Flow}} > TME_{\text{Boredom}} \text{ and that, } TME_{\text{Flow}} > TME_{\text{Frustration}} \end{aligned}$$

Engagement and Cognitive Load

Participants in the Boredom condition should experience little cognitive load (CL), followed by participants in the Flow condition. Participants in the Frustration condition should experience the greatest amount of cognitive load.

$$\text{H3: } CL_{\text{Frustration}} > CL_{\text{Flow}} > CL_{\text{Boredom}}$$

Independent Variables

Flow State. Three flow-state conditions (see *Figure 6*) were derived using Flow Theory (Csikszentmihalyi, 1990). A manipulation check was conducted to ensure that each condition accurately reflects its corresponding flow-state. Specifically, the number of times a participant clicked on the game-clock, the number of times a participant changed the block's direction for each level, the number of times the block

was moved off of the game board and into the water, the number of times the block was moved, and the total length of time participants spent playing each level was analyzed.

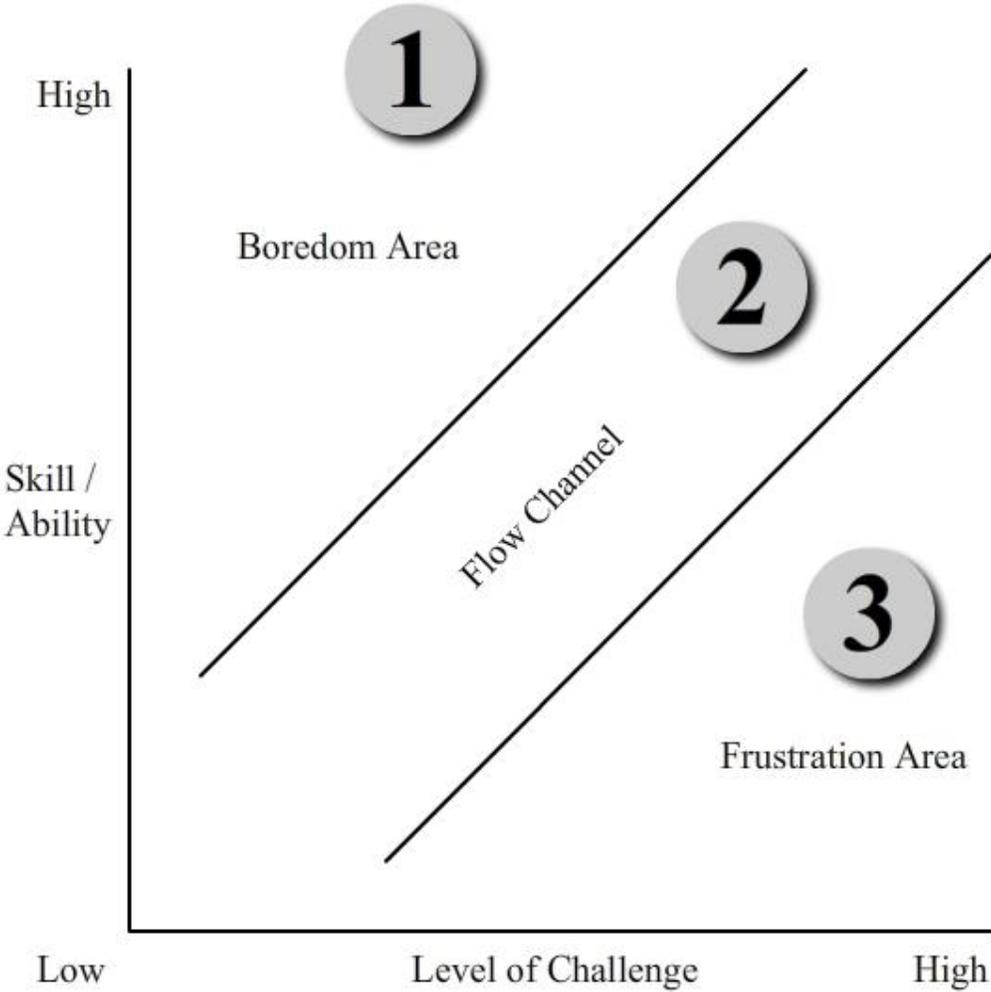


Figure 6. Study 2's Three Conditions based on Flow Theory - Adopted from Csikszentmihalyi (1990)

Design Condition 1 (Boredom: High Skill, Low Difficulty) – Video game will begin and stay at a low difficulty level. According to Flow Theory, the user will quickly become bored and apathetic while playing because their skill will quickly accommodate and exceed the game’s difficulty.

Design Condition 2 (Flow: Skill Matched with Difficulty) – Video game will begin at a low difficulty level and incrementally become more difficult as the user progresses through the game. According to Flow Theory, the user will be able to gain the skills necessary to accommodate the game’s difficulty level. By creating an experience where skill and difficulty are managed and appropriately matched, the user should remain in a flow channel.

Design Condition 3 (Frustration: High Difficulty, Low Skill) – Video game will begin and stay at a high difficulty level. According to Flow Theory, the user will quickly become frustrated while playing because their skill will not be able to reach the game’s level of difficulty.

Engagement Dependent Variables

Game-Clock Clicks

A computer clock mechanism was used to record every time a participant clicks on a button in order to see if the minimum required time to play the game has been reached. Each game-clock click was recorded (see descriptions from Study 1).

Time

Time will be measured using an internal timer integrated into the game. The length of time that the participants spend playing the game will be measured as well as the length of time they spend playing after they had reached the minimum amount of required time.

Self-Report

Perceived level of engagement was measured by asking participants to rate their level of engagement during the game. Specifically, participants were asked to rate their level of agreement with the statement, “I found this game to be engaging” on a five point Likert-type scale (Strongly Disagree to Strongly Agree). An open-ended question was also used ask them to define engagement, and discuss how their definition applied or did not apply to the game. Both of these measures were developed by the author for this study.

Game Score

The overall number of levels completed and the number of moves for each level were captured as a performance measure.

Cognitive Load *Dependent Variable*

Cognitive Load was measured using the NASA Task Load index (NASA-TLX) (Hart & Staveland, 1988). Cognitive load scores are used to ensure that a minimum amount of load has been reached while playing the game. The scores are also used to indicate whether or not the participants have actively participated in the experiment, and whether they are likely to be in the optimal flow range of challenge vs. ability (see *Figure 6*).

Study 2 Method

Participants

A total of 169 people were recruited through Amazon's Mechanical Turk (Amazon.com, 2009). Thirteen participants indicated that they had trouble loading some of the game levels (most likely due to poor Internet connections) during the experiment and so were removed from the analysis. Of the remaining 156 participants, 58% were female and 42% were male (mean age = 30.79, $SD = 10.22$). Seventy-eight percent were from the United States. Condition one (Boredom) had 48 participants, condition two (Flow) had 53 participants, and condition three (Frustration) had 55 participants. Thirty-three percent indicated that they had previous experience with a similar game but results from a one-way analysis of variance (ANOVA) revealed no significant main effect between past experience and condition, $F(2,153) = .45, p = .64$.

Materials and Apparatus

The experiment is hosted at www.playgraph.com, an experimental psychology Web site maintained by the author that hosts Adobe Flash psychology experiments. The Web site uses a MySQL database and a PHP server-side scripting language to provide the storage of participant responses. The experiment is accessible from any computer with Internet access. The computer requirements include a minimum computer monitor resolution of 1024x768 and an installed version of the Adobe Flash player v.10 or greater.

Task

Participants played an online Flash-based strategy game (See Appendix G for source code) called Block Walk (Sharek, 2009). The game mechanics are based on Bloxorz, a game developed by Damien Clarke (Clarke, 2007). As Appendix H shows, the goal of the isometric tile-based game is to move a rectangular block, made up of two differently colored cubes, towards a goal point so that it is standing up on top of the goal. In more difficult levels, the goal will only accept the end of the block that is of the same color as the goal. The movement of the block depends on the starting position of the block on each tile. If the block is standing up on a tile, it will fall down and occupy two tiles in the direction that the user moves it; thus successive movements in this direction will increment the block by two tiles. If the block is on its side, it can

either be tilted upward for a two-tile move or it can be rolled sideways for a one-tile move. This makes it difficult to predict the block's future position a few moves from its starting point. There are certain sequences of moves that can be learned to position the block more accurately; learning these sequences are usually only possible through experimentation and practice over time.

Participants in the *high skill, low difficulty* (Boredom) condition were introduced to the game by playing easy game levels similar to those played by participants in the *skill matched difficulty* condition. However, as players progress through levels, the game difficulty does not increase.

Participants in the *skill matched with difficulty* (Flow) condition were introduced to the game through easy levels where only a few simple moves were required to position the block over the goal. As the player solves each level, the number of required moves and the complexity of the moves were increased. As the player progresses through the easier levels it is assumed that they have, to some degree, mastered the game mechanics and are ready for more difficult levels where strategic thinking becomes increasingly critical.

Participants in the *high difficulty, low skill* (Frustration) condition were presented with game levels where many combinations of the two types of moves are required to correctly position the block over the goal. The number of moves can easily

reach into the hundreds. The difficulty level was also enhanced by requiring a specifically colored end of the block to connect with the goal. In many cases the level may seem impossible to solve. The participants in this condition were not given an opportunity to learn the idiosyncrasies of the block's movements by scaffolding through simpler levels.

Procedure

The experiment will be conducted over an Internet connection. Once participants read, and accept the informed consent (see Appendix A), they will be asked to enter their email address so it can be used to generate a secure 32-digit hexadecimal unique user ID using via a MD5 cryptographic hash function. Once participants entered their email address, they will be randomly assigned to one of three conditions. They will then be told about the game-clock and asked to interact with the Time button (thus assuring they are acquainted with how the game-clock functions) before proceeding to the general game instructions that identify the game's goal and key game mechanics. The experiment will begin after the instructions have been read.

Before the game begins, participants will be instructed to click on a button labeled, "TIME", located at the bottom of the game's screen. Clicking on the button will cause the game-clock to slide out and display a text message indicating if the minimum time of 10 minutes is up without giving an indication of how much time is

left. If a participant has not reached the minimum time when the TIME button is clicked, the game-clock will slide out with a red background and the message, *“The minimum time has not yet been reached.”* After three seconds, the game-clock will automatically slide back off-screen. When the minimum time has been reached, the game-clock will automatically slide out with a green background and the message, *“The minimum required time to play is up. You may continue playing if you want”* Two buttons will also become visible labeled, “EXIT GAME” and “KEEP PLAYING”. Clicking on the keep playing button will slide the clock off-screen and clicking on the exit button will immediately end the game.

After completing the game, participants were asked to complete a Flash version of the NASA-TLX and a series of subjective and demographic questions (see Appendix E). The final question asked participants to define engagement, and use their definition to describe how engaging the game was. When the questionnaire was completed, participants were taken to a final screen where they were debriefed and thanked. On this page, participants were given an experimental completion code which they used to paste into their Mechanical Turk user page to indicate that they have completed the experiment and required payment.

Study 2 Results

Overall and level-specific performance, self-report engagement, and self-report subjective workload measures for the NASA-TLX are presented in this section. An alpha level of .05 was used for all analyses.

Two databases were used to collect data. Database One contained 156 rows of overall individual participant-level results collapsed across all game levels. This included items such as overall time spent on the game, total times the game-clock was clicked and all post-experimental answers. Database Two contained 3107 rows of game-level data. These data include total time spent on each level, the number of times the game-clock was clicked for each level, and the number of moves (how many times the arrow keys were pressed to move the block), errors (directing the block to fall off the game board) and directions (number of directional changes) made for each level.

Design Conditions and Flow States

A manipulation check was conducted to determine if the three design conditions (Boredom, Flow, and Frustration) accurately reflected their corresponding flow-states. Descriptive statistics on performance data for all three design conditions can be found in Table 2.

Table 2.

Individual Game Level M and SD by Condition

Condition		<i>M</i>	<i>SD</i>
Boredom	Directions	4.98	8.06
	Errors	.28	.89
	Moves	12.76	16.46
	Time per Level (s)	16.33	17.96
Flow	Directions	20.67	27.62
	Errors	1.47	3.12
	Moves	41.23	52.32
	Time per Level (s)	48.01	58.27
Frustration	Directions	46.44	64.93
	Errors	4.54	9.27
	Moves	105.42	148.27
	Time per Level (s)	117.42	146.26

Note: (n=3107)

Results from four one-way analysis of variances (ANOVA) indicated that there were significant main effects between all three design conditions and:

- Directions - the number of times a participant changed the block's direction for each level, $F(2,3104) = 397.22, p < .001,$
- Errors - the number of times the block was moved off of the game board and into the water, $F(2,3104) = 219.11, p < .001,$

- Moves - the number of times the block was moved, $F(2,3104) = 399.93, p < .001,$
- Time per Level - the total length of time participants spent playing each level, $F(2,3104) = 450.25, p < .001.$

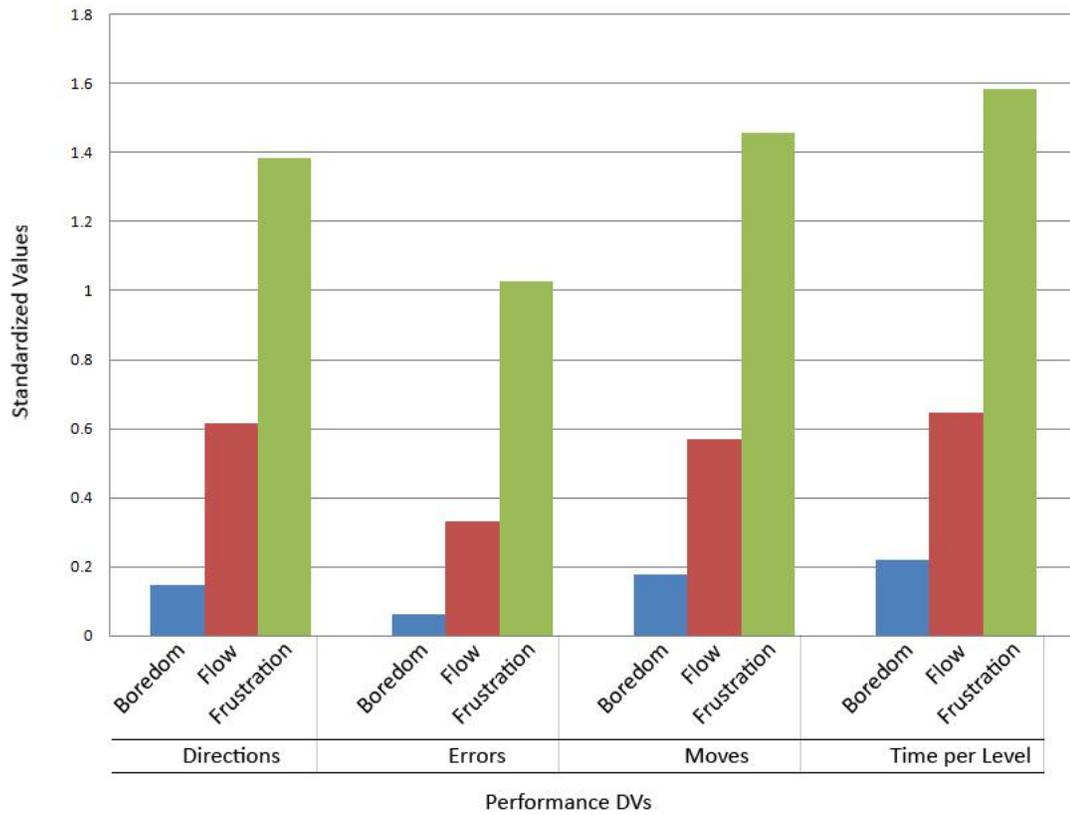


Figure 7. Clustered Bar Graph of Individual Game Level M and SD

Table 3.

Design Condition Post-hoc Mean Differences

IV	Groups	Boredom	Flow
Total Game-clock Clicks	Boredom	--	--
	Flow	.16***	--
	Frustration	.40***	.24***
Directions	Boredom	--	--
	Flow	15.70***	--
	Frustration	41.47***	25.77***
Errors	Boredom	--	--
	Flow	1.19***	--
	Frustration	4.25***	3.07***
Moves	Boredom	--	--
	Flow	28.47***	--
	Frustration	92.66***	64.19***
Time per Level (s)	Boredom	--	--
	Flow	31.68***	--
	Frustration	101.10***	69.41***

Note: $n=3106$, *** $p<.001$

A Games-Howell post-hoc test was conducted because Levine's homogeneity of variance test was significant. Table 3 shows the results from the post-hoc test where

significant interactions were found for all conditions and IVs. Participants in the boredom condition ($M=.08$) clicked on the game-clock the least per level followed by those in the flow condition ($M=.24$). Those in the frustration condition ($M=.48$) clicked on the game-clock the greatest number of times per level. Following this trend, participants in the boredom condition ($M=4.98$) changed the block's direction the least number of times per level followed by those in the flow condition ($M=20.67$), and those in the frustration condition ($M=46.44$) changed the block's direction the greatest number of times per level. Participants in the boredom condition ($M=.28$) made the least number of errors followed by those in the flow condition ($M=1.47$), and then those in the frustration condition ($M=4.54$). Participants in the boredom condition ($M=12.76$) moved the block the least number of times per level followed by those in the flow condition ($M=41.23$), and then those in the frustration condition ($M=105.42$). Finally, participants in the boredom condition ($M=16.33$) spent the least amount of time per level (measured in seconds) followed by those in the flow condition ($M=48.01$), and then those in the frustration condition ($M=117.42$).

Engagement and the Design Conditions

A one-way ANOVA was conducted to investigate self-report engagement data between the three design conditions (H_1). Results indicated a significant main effect of engagement, $F(2,153) = 7.26, p < .001$. Levine's homogeneity of variance test was non-significant, $F(2,153) = 1.90, p = .15$ so a Bonferroni post-hoc was conducted.

Results from the post-hoc test indicated a significant interaction ($p=.001$) between the Boredom condition and the Flow condition with participants in the Flow condition rating the game as more engaging ($M=3.74$) compared to those in the Boredom condition ($M=2.90$). No other significant interactions were found.

Total Game-clock Clicks and the Passage of Time

Performance data measuring the number of game-clock clicks (H_{2a}) and the amount of time spent over and beyond the minimum amount of time to play the game (H_{2b}) were analyzed across the three design conditions using a multivariate analysis of variance (MANOVA). Results from this analysis revealed no significant main effect for the design conditions, $F(2,153) = .77, p = .54, \eta^2 = .01$. Table 4 shows the means and standard deviations for both dependent variables.

Table 4.

Game-clock Clicks and Over Time Means and Standard Deviations

	Condition	<i>N</i>	<i>M</i>	<i>SD</i>
Total Game-clock Clicks	Boredom	48	4.23	3.75
	Flow	53	4.40	3.42
	Frustration	55	3.98	3.04
Game-clock Clicks During Game Play	Boredom	48	3.54	2.74
	Flow	53	3.60	3.05
	Frustration	55	1.96	2.33
Game-clock Clicks During Intermissions	Boredom	48	.69	2.62
	Flow	53	.79	1.03
	Frustration	55	2.02	2.41
Over Time (s)	Boredom	48	131.79	213.86
	Flow	53	150.32	373.89
	Frustration	55	78.91	174.96

Table 4 also shows the mean number of game-clock clicks during game play and during intermissions (an approximately 5 second transition period between levels). A one-way ANOVA was conducted to investigate the differences between the three design conditions and the ratio of game-clock clicks during the intermission compared

to total game-clock clicks. The ratio was calculated using the following formula: game-clock clicks during intermission / total number of game-clock clicks. A significant main effect was found, $F(2,153) = 13.71, p < .001$, and a Games-Howell post-hoc test was conducted because Levine's homogeneity of variance test was significant. As can be seen in Table 5, post-hoc results indicated that those in the Frustration condition clicked on the game-clock during intermissions significantly more times compared to those in the Boredom and Flow conditions.

Table 5.

Ratio of Intermission Clicks to Total Game-Play Clicks Mean Differences

IV	Groups	Boredom	Flow
Game-clock Intermission Clicks (Ratio)	Boredom	--	--
	Flow	.00	--
	Frustration	.29***	.28***

Note: $n=155$, *** $p < .001$

Engagement and Cognitive Load

A one-way ANOVA was conducted to investigate cognitive load differences between the three design conditions based on participant ratings using the NASA-TLX (H3). A significant main effect was found, $F(2,153) = 16.65, p < .001$. Levine's homogeneity of variance test was non-significant, $F(2,153) = 1.17, p = .32$, so a Bonferroni post-hoc test was conducted to determine which design conditions were

significantly different for the cognitive load dependent variable. Post-hoc results indicated that those in the Boredom condition experienced significantly lower levels of cognitive load ($M=36.82$) compared to those in the Flow condition ($M=47.92$) and those in the Frustration condition ($M=50.76$). There were no significant interactions between the Flow and Frustration conditions.

Leveraging the inherent diagnosticity of the NASA-TLX, each of the six subscales that measure self-report workload demand were analyzed using one-way ANOVAs. Descriptive statistics for all six subscales can be found in Table 6.

Table 6.

TLX Workload Breakdown Descriptives

TLX Scales	Conditions	<i>N</i>	<i>M</i>	<i>SD</i>
Mental	Boredom	48	36.15	25.563
	Flow	53	65.00	16.899
	Frustration	55	71.09	20.292
Physical	Boredom	48	16.15	20.323
	Flow	53	16.70	17.622
	Frustration	55	22.36	22.066
Temporal	Boredom	48	20.31	18.720
	Flow	53	26.04	20.484
	Frustration	55	30.36	22.399
Performance	Boredom	48	82.40	18.878
	Flow	53	68.96	18.328
	Frustration	55	43.91	29.118
Effort	Boredom	48	39.58	29.658
	Flow	53	61.42	17.469
	Frustration	55	66.64	20.482
Frustration	Boredom	48	26.35	23.218
	Flow	53	49.43	27.151
	Frustration	55	70.18	26.246

Results from the ANOVAs revealed significant main effects for Mental demand ($F(2,153) = 39.42, p < .001$), Temporal demand ($F(2,153) = 3.04, p = .05$), Performance ($F(2,153) = 38.00, p < .001$), Effort ($F(2,153) = 19.80, p < .001$), and Frustration ($F(2,153) = 37.34, p < .001$). Physical demand was not found to be significant, $F(2,153) = 1.56, p = .21$.

Table 7.

NASA-TLX Subscale Post-hoc Mean Differences

Subscale	Groups	Boredom	Flow
Mental Demand	Boredom	--	--
	Flow	28.85***	--
	Frustration	34.95***	6.09
Temporal Demand	Boredom	--	--
	Flow	5.73	--
	Frustration	10.05*	4.33
Performance	Boredom	--	--
	Flow	-13.43**	--
	Frustration	-38.49***	-25.05***
Effort	Boredom	--	--
	Flow	21.83***	--
	Frustration	27.05***	5.22
Frustration	Boredom	--	--
	Flow	23.08***	--
	Frustration	43.83***	20.75***

Note: $n=155$, * $p<.05$, ** $p<.01$, *** $p<.001$

A Games-Howell post-hoc test was conducted because Levine's homogeneity of variance test was significant. Table 7 shows the results from the post-hoc test. Participants in the Boredom condition ($M=36.15$) reported significantly lower *mental demands* than those in the Flow ($M=65$) and Frustration ($M=71.10$) conditions. Participants in the Boredom condition ($M=20.31$) reported significantly lower *temporal demands* than those in the Frustration condition ($M=30.36$). Participants in the Boredom condition ($M=82.40$) reported significantly higher *performance demands* than those in the Flow ($M=68.96$) and Frustration ($M=43.91$) conditions. Additionally, participants in the Flow condition reported significantly lower *performance demands* than those in the Frustration condition. Participants in the Boredom condition ($M=39.58$) reported significantly lower *effort demands* than those in the Flow ($M=61.42$) and Frustration ($M=66.64$) conditions. Participants in the Boredom condition ($M=26.35$) reported significantly lower *frustration levels* than those in the Flow ($M=49.43$) and Frustration ($M=70.18$) conditions. Additionally, participants in the Flow condition reported significantly lower *frustration levels* than those in the Frustration condition.

Study 2 Discussion

Results from Study 2 support, in part, the original hypothesis that people in the Flow condition will be more engaged than people in the Boredom or Frustration conditions. Though a complete agreement with the hypotheses was not found, the results are encouraging and provide insight into how future studies on user engagement might be designed.

The primary goal set for Study 2 was to investigate the efficacy of the game-clock as a measure of engagement. In order to interpret the results in terms of this goal it is imperative to first ensure that the three conditions were successfully designed to reflect the three desired engagement states: Boredom, Flow, and Frustration. The results from analyzing the individual game-level, user-behavior data strongly supported this expectation and provided confidence that what was intended to be measured was indeed measured.

After ensuring that the conditions were successfully designed, the number of game-clock clicks, self report level of engagement, and time spent over the minimum required time was analyzed. It was expected that those in the Flow condition would:

1. click on the game-clock the least compared to the other two conditions,
2. report the highest level of engagement compared to the other two conditions,

3. play the game over and beyond the minimum required time longer than those in the other two conditions.

When analyzed in aggregate, the first expectation did not appear to be met; the number of game-clock clicks was not significantly different between the three conditions. This finding may be because the amount of cognitive demand required to play in the Flow and Frustration conditions was too similar. In support of this, results indicate that those in the Boredom condition reported significantly lower levels of cognitive load than those in the Flow and Frustration conditions. Additionally, those in the Frustration condition did not experience significantly higher levels of cognitive load compared to those in the Flow condition as was expected, though results were trending in this direction. Though agreement with the hypothesis was not found, significant differences were uncovered when investigating the number of game-clock clicks during game-play compared to during intermissions.

Further investigation into why those in the Frustration condition did not click on the game-clock as much as expected revealed a rather unexpected finding comparing the number of times the game-clock was clicked during game play and between game play (intermissions). A five second intermission followed the completion of each level. The purpose of the intermission was to provide generic feedback such as “Great Job!” while also allowing the next level to load. The results

showed that participants in the Frustration condition clicked on the game-clock significantly more times during intermissions than those in the Boredom and Flow condition. Those in the Boredom and Flow conditions may have clicked on the game-clock during game-play more because they did not experience the same degree of cognitive load compared to those in the Frustration condition, and therefore retained a sufficient amount of cognitive resources available to attend to both the game and the game-clock.

The six subscales measured using the NASA-TLX shed additional insight into the perceived differences between the three conditions. Analyzing each subscale individually reveals a trend that, although the user-behavior data for the Flow and Frustration conditions were significantly different, they may have not been different enough to create environments where cognitive load and engagement differences could be found. The *performance* and the *frustration* subscales were the only two measurements that produced significant differences between the Flow and Frustration conditions. As would be expected, the Frustration condition was perceived to be more frustrating than the Flow condition, but whether the high levels in frustration contributed to the lower levels of perceived performance in the Frustration condition is unclear. Additional research into the direction of influence between these two factors could provide insight into how feelings of frustration affect performance.

The second expectation (self-report engagement) was partially met. Self-report data on level of engagement was expected to show that people would rate their level of engagement significantly higher for the Flow condition compared to the other two conditions. Results indicate that, though a main effect of engagement was found, it was limited to only between the Boredom condition and the Flow condition with those in the Flow condition rating the game as more engaging than those in the Boredom condition. One explanation for why no significant difference between the Frustration condition and the Flow condition was found may be that the Flow and Frustration conditions were too closely related in terms of level design thus creating a ceiling effect of engagement.

The third expectation of time was also not met. Results indicate that time spent over and beyond the minimum amount of time was not significantly different between the three conditions. The results trend in the predicted direction with people in the Flow condition spending more time than those in the Boredom or Frustration conditions, but a large amount of variance was reported which most likely contributed to the lack of significant findings. Additionally the NASA-TLX results revealed that the Flow and Frustration conditions may have been too similarly designed. For example, it was found that mental demand was significantly higher for those in the Flow and Frustration condition compared to the Boredom condition. This is expected because the boredom condition was designed to keep the players wanting more

challenging game levels. It was expected that the Frustration condition would reveal significantly higher levels of mental demand compared to the Flow condition but this was not found; a trend that analysis of the six subscales revealed.

The original hypotheses focused more on the cognitive and behavioral differences as a whole between the three conditions and did not delve into when these differences occurred. Strictly looking at the number of game-clock clicks, it appears that those in the Frustration condition did not exhibit a substantially different game-clock clicking behavior compared to those in the other two conditions, but further inspection of when game-clock clicks were made tells a different story. Internal disengagement (O'Brien & Toms, 2008) refers to the point in time when a person makes the conscious choice to remove themselves from participating in a task. It is likely that those in the Frustration condition experienced high levels of frustration while playing each game level and therefore they did not have the available cognitive resources required to internally disengage. As soon as a level was completed, however, they would choose to disengage from the task and seek an exit, i.e., they would click on the game-clock. In contrast, those in the Boredom and Flow conditions may have had enough cognitive resources available to allow them to choose to disengage while playing the game.

General Discussion

The Game-Clock

The data suggests that the game-clock offers a useful measurement of user-behavior tracking due to the nature of its real-time performance monitoring. The advantage of the game-clock's real-time monitoring system over the retrospective self-report method used in the NASA-TLX and similar self-report instruments is that the game-clock provides an increased level of sensitivity. Workload sensitivity can be thought of as the degree to which a workload measure is able to discriminate between task-related workload differences (Eggemeier, Shingledecker, & Crabtree, 1985). Specifically, the game-clock collects time-based performance data that can potentially be used to extrapolate when cognitive overload occurs. Additionally, the game-clock decreases measurement intrusiveness, which is described as a measurement tool's level of interference with a task which can potentially lead to degraded performance (Eggemeier, et al., 1985). For example, for the NASA-TLX to provide a more precise workload measurement of a user's workload during specific stages in a task, it would have to be administered during the task which, in turn, could introduce a potential point of disengagement. The game-clock's capability to capture data behind-the-scenes should prevent the opportunity for the measurement tool to impair performance.

Limitations

An intrinsic limitation to using a measurement of engagement such as the game-clock is that it can only be implemented during electronic-based tasks. Additionally, a game-clock may not be appropriate for tasks that require constant interaction with little time for intermissions. For example, if the game in Study 2 was similar to Pac-Man, there would be little chance for the player to stop moving the hero away from the ghosts and click on the game-clock; doing so could result in losing the game. However, even during games like Pac-Man, intermissions do exist and perhaps the game-clock could still prove to provide useful user-behavior data. This is not to say that the game-clock could not be useful, but it is important to conduct future research to investigate the appropriate use of such a measurement tool.

Future Research

The results found in both studies are encouraging, but reveal that measuring engagement without interfering with a task is a complex undertaking both from a technical implementation point-of-view, and from a psychological measurement standpoint. More detailed research will need to be conducted to determine when and how such a measurement tool could be effectively used.

Results from Study 2 may indicate that the amount of cognitive load required to essentially pause participation in the task and click on the game-clock could influence a

person's ability to click on the clock. Traditional task-switching literature might provide insight into how further research could be conducted in this regard. That is, the more cognitive resources available, the more likely a person may be to click on the clock. Future research will need to be conducted to identify if this is the case.

A measurement tool such as the game-clock could be used in adaptive task management. Rather than change aspects of a task after performance has degraded, a form of the game-clock could potentially be used to support a person's engagement and keep them in the task flow. For example, considering the possibility that the game-clock can be used to predict when a person is beginning to reach the point of disengagement; aspects of the task could be changed to reduce frustration and cognitive overload. Understanding and measuring engagement is still a young area of research and therefore a focused, methodical approach to experimental design will need to be maintained in order to develop a solid framework of engagement.

REFERENCES

- Adelson, B. (1992). *Evocative Agents and Multi-Media Interface Design*. Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.
- Allen, I. E., & Seaman, J. (2007). *Online Nation: Five Years of Growth in Online Learning*: Babson Survey Research Group.
- Amazon.com (2009). Mechanical Turk Retrieved May 2, 2009, from <https://www.mturk.com/mturk/welcome>
- Blake, I. F., Cohen, G., & Deza, M. (1979). Coding with Permutations. *Information and Control*, 43(1), 1-19.
- Brown, K. G. (2005). An Examination of the Structure and Nomological Network of Trainee Reactions: A Closer Look at 'Smile Sheets'. *Journal of Applied Psychology*, 90(5), 991-1001.
- Burger, J. M. (1985). Desire for Control and Achievement-Related Behaviors. *Journal of Personality and Social Psychology*, 48(6), 1520-1533.
- Burger, J. M., & Cooper, H. M. (1979). The Desirability of Control. *Motivation and Emotion*, 3(4), 381-393.
- Burns, A. C., & Gentry, J. W. (1998). Motivating Students to Engage in Experiential Learning: A Tension-To-Learn Theory. *Simulation Gaming*, 29(2), 133-151.
- Cascio, F., & Aguinis, H. (2008). Staffing Twenty-First-Century Organizations. *Academy of Management Annals*, 2(1), 133-165.

- Charlton, J. P., & Danforth, I. D. W. (2007). Distinguishing Addiction and High Engagement in the Context of Online Game Playing. *Computers in Human Behavior*, 23(3), 1531-1548.
- Chen, S., & Macredie, R. (2002). Cognitive Styles and Hypermedia Navigation: Development of a Learning Model. *Journal of the American Society for Information Science and Technology*, 53(1), 3-15.
- Clarke, D. (2007). Bloxorz: DX Interactive.
- Colowick, S. M., & Pool, J. (2007). *Disambiguating for the Web: A Test of Two Methods*. Paper presented at the Proceedings of the 4th international conference on Knowledge capture.
- Colquitt, J. A., LePine, J. A., & Noe, R. A. (2000). Toward an Integrative Theory of Training Motivation: A Meta-Analytic Path Analysis of 20 Years of Research. *Journal of Applied Psychology*, 85(5), 678-707.
- Cook, G., Marsh, R., & Hicks, J. (2005). Associating a Time-Based Prospective Memory Task with an Expected Context Can Improve or Impair Intention Completion. *Applied Cognitive Psychology*, 19(3), 345-360.
- Cordova, D. I., & Lepper, M. R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology*, 88(4), 715-730.
- Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. New York: Harper and Row.
- Dan, A., Feldman, S., & Serpanos, D. (1998). Evolution and challenges in multimedia. *IBM Journal of Research and Development*, 42(2), 177-184.

- Deci, E. (2009). Intrinsic motivation inventory Retrieved March, 30, 2009, from http://www.psych.rochester.edu/SDT/measures/intrins_scl.html
- Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.
- Deci, E., Vallerand, R., Pelletier, L., & Ryan, R. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist*, 26(3), 325-346.
- Durfresne, A., & Turcotte, S. (1997). Cognitive style and its implications for navigation strategies. In B. R. Mizoguchi (Ed.), *Artificial intelligence in education knowledge and media learning system* (pp. 287-293). Kobe, Japan: Amsterdam IOS Press.
- Eggemeier, F. T., Shingledecker, C., & Crabtree, M. (1985). Workload Measurement in System Design and Evaluation. *Human Factors and Ergonomics Society Annual Meeting Proceedings*, 29, 215-219.
- Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16(4), 717-726.
- Engelhard, G., & Monsaas, J. (1988). Grade Level, Gender, and School-Related Curiosity in Urban Elementary Schools. *Journal of Educational Research*, 82(1).
- Flowerday, T., & Schraw, G. (2000). Teacher beliefs about instructional choice: A phenomenological study. *Journal of Educational Psychology*, 92(4), 634-645.
- Flowerday, T., & Schraw, G. (2003). Effect of choice on cognitive and affective engagement. *Journal of Educational Research*, 96(4), 207-215.

- Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, Motivation, and Learning: A Research and Practice Model. *Simulation Gaming*, 33(4), 441-467.
- Hart, S., & Staveland, L. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In P. Hancock & N. Meshkati (Eds.), *Human mental workload* (pp. 139-183). Amsterdam: North Holland.
- Hunicke, R., Leblanc, M., & Zubek, R. (2004). *MDA: A Formal Approach to Game Design and Game Research*. Paper presented at the Challenges in Game AI Workshop, Nineteenth National Conference on Artificial Intelligence, San Jose, California.
- Jacques, J., Jenny Preece, J., & Carey, T. (1995). Engagement as a Design Concept for Multimedia. *Canadian Journal of Educational Communication*, 24(1), 49-59.
- Kaiser, M., Hearst, M., & Lowe, J. (2008). *Improving search results quality by customizing summary lengths*. Paper presented at the Proceedings of ACL/HLT'08.
- Kearsley, G., & Shneiderman, B. (1999). Engagement theory: A framework for technology-based teaching and learning, from <http://home.sprynet.com/~gkearsley/engage.htm>
- Kittur, A., Chi, E., & Suh, B. (2008). *Crowdsourcing user studies with Mechanical Turk*. Paper presented at the Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems.
- Krawczyk, M., & Novak, J. (2006). *Game Development Essentials: Game Story & Character Development*. Clifton Park, NY: Thomson Delmar Learning.
- Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin*, 116(1), 75-98.

- Macey, W., & Schneider, B. (2008). The Meaning of Employee Engagement. *Industrial and Organizational Psychology, 1*(1), 3-30.
- Malone, T. W. (1980). *What makes things fun to learn? heuristics for designing instructional computer games*. Paper presented at the Proceedings of the 3rd ACM SIGSMALL symposium and the first SIGPC symposium on Small systems.
- Malone, T. W. (1984). Heuristics for designing enjoyable user interfaces: lessons from computer games *Human factors in computer systems* (pp. 1-12): Ablex Publishing Corp.
- Mayer, R. E., & Moreno, R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educational Psychologist, 38*(1), 43-52.
- McCarthy, J., & Wright, P. (2004). *Technology as Experience*. Cambridge, Massachusetts: MIT Press.
- McGinnis, T., Bustard, D. W., Black, M., & Charles, D. (2008). *Enhancing E-Learning Engagement Using Design Patterns from Computer Games*.
- Merriënboer, J., & Sweller, J. (2005). Cognitive Load Theory and Complex Learning: Recent Developments and Future Directions. *Educational Psychology Review, 17*(2), 147-177.
- Miller, G., Galanter, E., & Pribram, K. (1960). *Plans and the Structure of Behavior*. New York: Holt, Rhinehart, & Winston.
- O'Brien, H. L., & Toms, E. G. (2008). What is user engagement? A conceptual framework for defining user engagement with technology. *Journal of the American Society for Information Science and Technology, 59*(6), 938-955.

- Ouahada, K., Swart, T., Ferreira, H., & Cheng, L. (2008). Binary permutation sequences as subsets of Levenshtein codes, spectral null codes, run-length limited codes and constant weight codes. *Designs, Codes and Cryptography*, 48(2), 141-154.
- Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive Load Theory and Instructional Design: Recent Developments. *Educational Psychologist*, 38(1), 1-4.
- Paas, F., & van Merriënboer, J. (1994). Variability of worked examples and transfer of geometrical problem-solving skills: A cognitive-load approach. *Journal of Educational Psychology*, 86(1), 122-133.
- Paradise, A. (2008). *State of the Industry Report: ASTD's Annual Review of Trends in Workplace Learning and Performance*. Alexandria, VA.: American Society for Training & Development.
- Pawlowski, A. (2009). Riding out the recession in a virtual classroom Retrieved 18 March 2009, from <http://www.cnn.com/2009/TECH/03/18/economy.online.degrees/index.html>
- Prensky, M. (2003). e-Nough!“e-Learning” is a misnomer—it’s mostly just “e-Teaching.” For any teaching to reliably and consistently produce the results we want, we still have a lot to learn about learning. *On the horizon*, 11(1), 26.
- Rabin, S. (2005). *Introduction to Game Development*. Boston: Charles River Media.
- Robberecht, R. (2007). Interactive Nonlinear Learning Environments. *The Electronic Journal of e-Learning*, 5(1), 59-68.
- Schnotz, W., & Kuerschner, C. (2007). A Reconsideration of Cognitive Load Theory. *Educational Psychology Review*, 19(4), 469-508.
- Sharek, D. (2009). Block Walk.

- Sharek, D., Swofford, C., & Wogalter, M. (2008). *Failure to recognize fake internet popup warning messages*. Paper presented at the Human Factors and Ergonomics Society 52nd Annual Meeting, New York, NY.
- Smith, R. E. (2003). The cost of remembering to remember in event-based prospective memory: Investigating the capacity demands of delayed intention performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 29(3), 347-361.
- Squire, K. (2005). Changing the game: what happens when video games enter the classroom? *Innovate*, 1(6).
- Squire, K. (2007). Open-Ended Video Games: A Model for Developing Learning for the Interactive Age. *The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning*, -, 167-198.
- Sweller, J. (2005). Implications of cognitive load theory for multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 19-30). New York: Cambridge University Press.
- Sweller, J., van Merriënboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. *Educational Psychology Review*, 10(3), 251-296.
- Thompson, E., Chaiken, S., & Hazlewood, J. (1993). Need for Cognition and Desire for Control as Moderators of Extrinsic Reward Effects: A Person x Situation Approach to the Study of Intrinsic Motivation. *Journal of Personality and Social Psychology*, 64(6), 987-999.
- Thompson, L., Sebastianelli, J., & Murray, N. (in press). Monitoring online training behaviors: The awareness of electronic surveillance hinders e-learners. *Journal of Applied Social Psychology*.

- Vygotski, L. (1963). Learning and Mental Development at School Age. In B. Simon & J. Simon (Eds.), *Educational psychology in the U.S.S.R.* (pp. 21-34). London: Routledge & Kegan Paul.
- Webster, J., & Ho, H. (1997). Audience engagement in multimedia presentations. *SIGMIS Database*, 28(2), 63-77.
- Wideman, H. H., Owston, R. D., Brown, C., Kushniruk, A., Ho, F., & Pitts, K. C. (2007). Unpacking the potential of educational gaming: A new tool for gaming research. *Simulation Gaming*, 38(1), 10-30.
- Yeong-Taeg, K., Arce, G. R., & Grabowski, N. (1995). Inverse halftoning using binary permutation filters. *IEEE Transactions on Image Processing*, 4(9), 1296-1311.
- Young, K. (2002). Is e-learning delivering ROI? *Industrial and Commercial Training*, 34(2), 54-61.
- Zemsky, R., & Massey, W. (2004). *Thwarted Innovation. What Happened to elearning and Why.*: Final Report, the Weatherstation Project of the Learning Alliance.

APPENDICES

Appendix A: Study 1 Screenshots

Game Instructions



WARNING
How well can you identify fake computer warning windows?

Goal
For this experiment, you will be playing a game that tests your ability to recognize the legitimacy of computer warning windows.

Game Play

- When a window pops up on the screen, click the **IT'S FAKE** button if you think it is not real.
- If you think the window is a legitimate warning window, click the **IT'S REAL** button.
- When you are happy with your answer, click the **SUBMIT** button to continue the game.
- Game difficulty increases with each level.

Time

- You are required to play this game for a certain minimum period of time.
- You will know when the minimum time is up by clicking on the **TIME** button at the bottom left of the game.
- Once you have played for the minimum amount of time, you may either proceed to the questionnaire, or continue to play the game to the end.

To ensure that you understand the game play, you will play a quick game tutorial next.

Click **Next** to begin the quick tutorial.

NEXT

Game Tutorial

Game Tutorial
Follow the four steps below

1 Decide if the warning displayed below is real or not.

Application Error - Microsoft Internet Explorer

 The instruction at "0x77f41d24" referenced memory at "0x5952a4c". The memory could not be "read".
Click OK to terminate program.

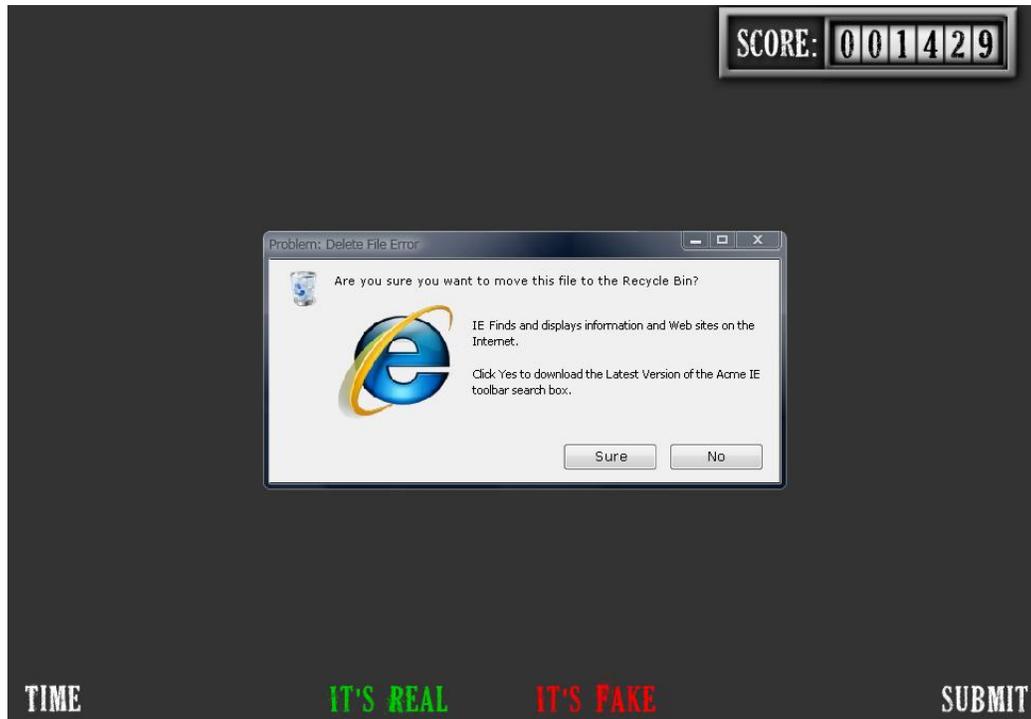
2 Click on the Time button to see if the minimum game-play time is up.
You may do this anytime during the actual game to find out if the minimum time has been met.
Note: The Time button is provided for your benefit, it is not required that you use it during the actual game.

3 Click on either the It's Real or It's Fake button.

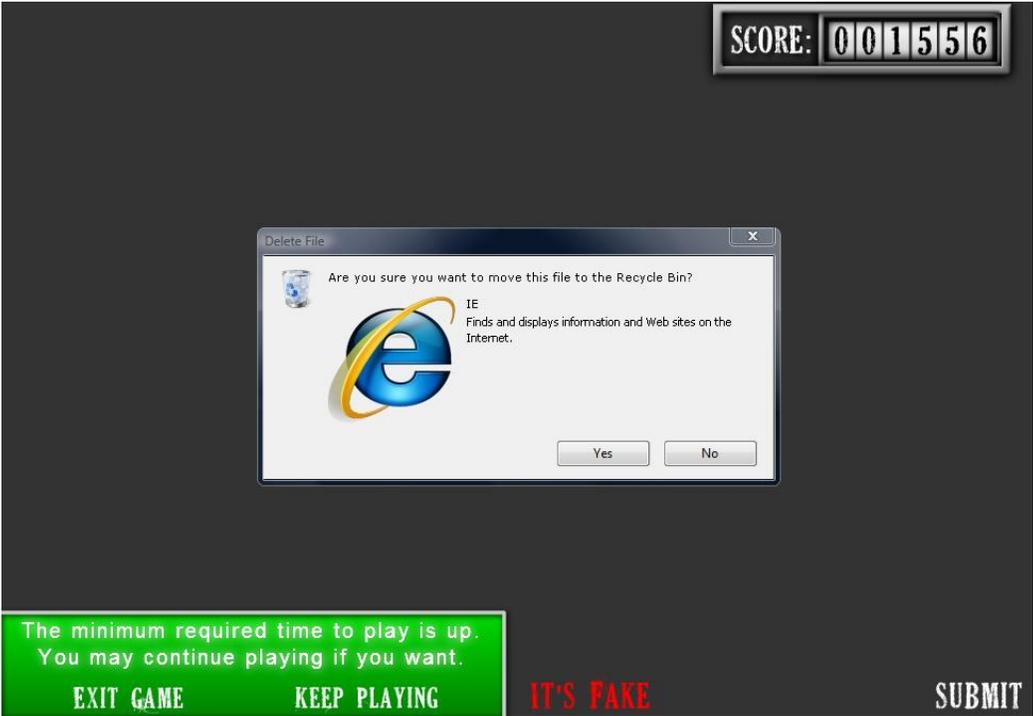
4 Click on the Submit button.

TIME IT'S REAL IT'S FAKE SUBMIT

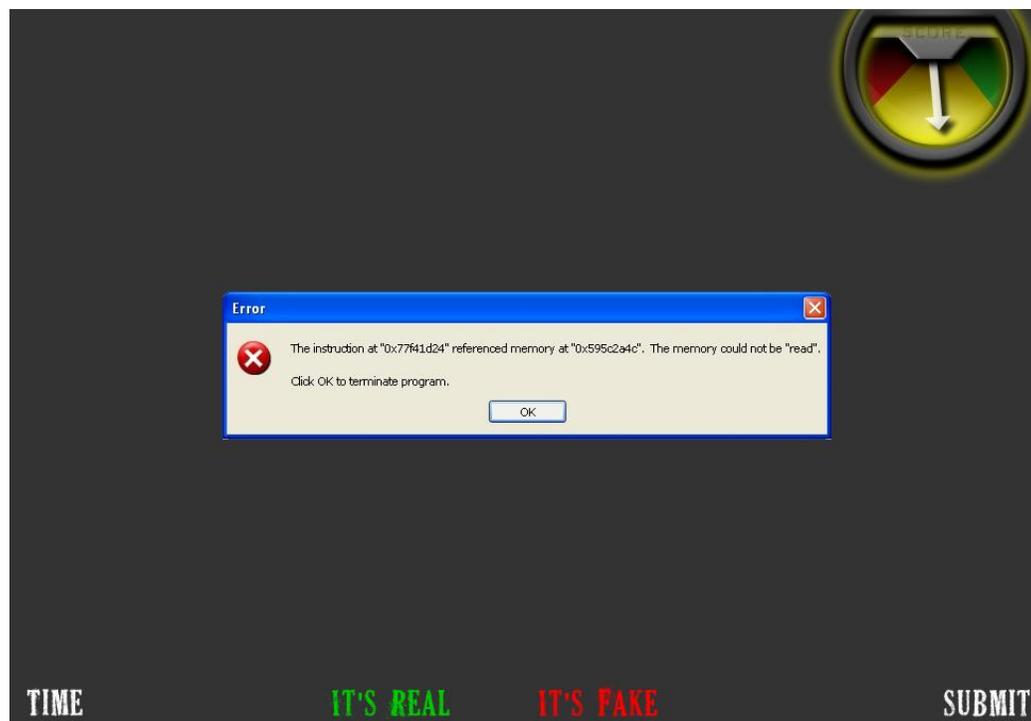
Experimental Condition 1: Scoreboard + Text



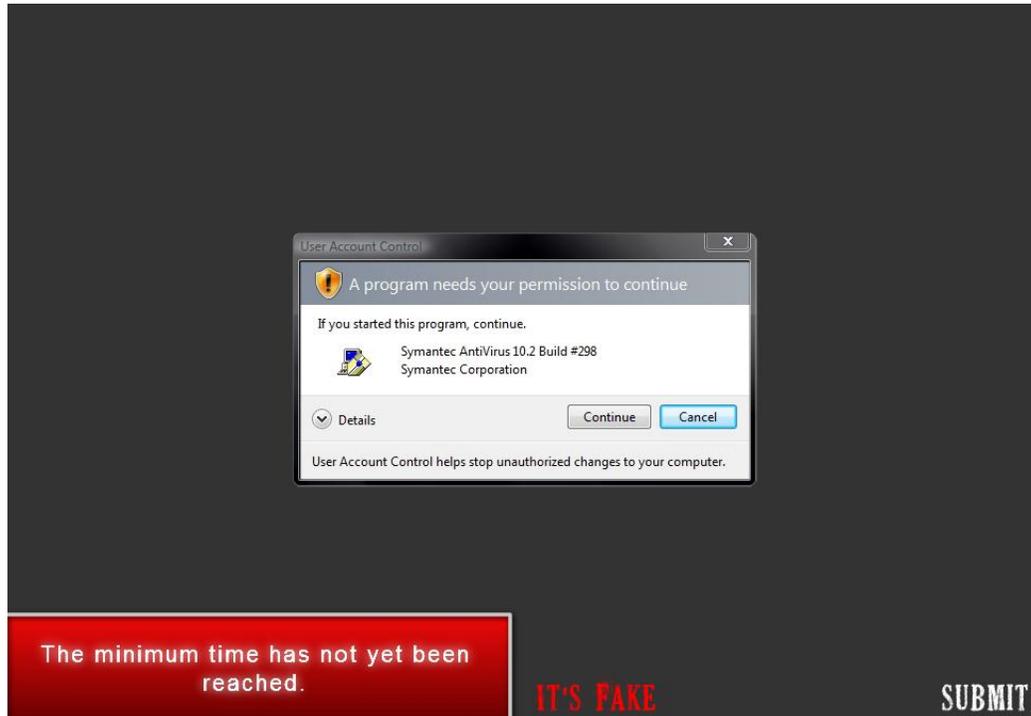
Experimental Condition 1 (Scoreboard + Text): Game-Clock displayed indicating the minimum time had been reached.



Experimental Condition 2 (Game Meter + Text)



Experimental Condition 3 (Text-Only): Game-Clock displayed indicating the minimum time had not yet been reached.



Appendix B: Informed Consent Form

North Carolina State University

INFORMED CONSENT FORM for RESEARCH

Recognizing Fake Warning Windows Study

What are some general things you should know about research studies?

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. You may print this consent form using your Web browser's print option. If at any time you have questions about your participation, do not hesitate to contact the researcher named below.

What is the purpose of this study?

You are invited to participate in a research study. The goal of this study is to investigate if people are able to learn how to recognize fake warning windows.

What will happen if you take part in the study?

If you agree to participate in this study, you will be asked to view some warning windows and decide if they are legitimate or not. Then, you will be asked to fill out a questionnaire regarding varying topics. This study should not take longer than 30 minutes of your time.

Risks

There are no risks or discomforts associated with this study.

Confidentiality

The information and records in the study will be kept strictly confidential. Data will be stored securely in a secured database. No reference will be made in oral or written reports which could link you to the study. You will NOT be asked to enter your name in any study materials so that no one can match your identity to the answers that you provide.

Compensation

If you are an NCSU student you will receive the class credits indicated on the Experimentrix page. If you are an NCSU student and withdraw from the study prior to its completion, you will receive one class credit (other ways to earn the same amount of credit can be found by asking your professor). If you are participating in this experiment through Amazon's Mechanical Turk program, you will receive the compensation described in the HIT page.

What if you have questions about this study?

If you have questions at any time about the study or the procedures, you may contact the researcher, David Sharek, at djsharek@ncsu.edu.

What if you have questions about your rights as a research participant?

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919/515-4514), or Joe Rabiega, IRB Coordinator, Box 7514, NCSU Campus (919/515-7515).

Consent To Participate

By clicking on the "I Consent" button below, you are agreeing with the following statement:

"I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may withdraw at any time."

I Consent I Don't Consent

Appendix C: Binary Permutation Order Example

Level														
1			2			3			4			5		
Base Warning			Base Warning			Base Warning			Base Warning			Base Warning		
1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
11111	11111	00000	00100	01000	10000	00101	11111	11111	01110	11111	11111	11011	11111	10111
00000	00000	11111	11111	11111	00100	11111	00101	00101	10011	01011	10011	11111	10111	01111
			11111	11111	11111	10100	11000	11111	11100	11010	01110	10111	01111	11111
			01000	00100	01000	01010	11111	10001	10101	11001	11100	01111	11011	11101
			00001	00001	00001	00011	00110	11000	01101	11111	11111	11111	11111	11111
			10000	00010	00010	11111	01010	11111	01011	11111	10110	11101	11110	11110
			00010	10000	11111	00110	11111	10100	10110	01101	11001	11110	11101	11011
						10010	00011	01100	11111	10011	11010			
						11111	10100	00011	11001	11100	00111			
						11111	10010	10010	11111	11111	11111			
						11000	01001	11111	11111	00111	11111			
						10001	10001	01010	11010	10110	01011			
						01100	11111	00110	11111	01110	10101			
						01001	01100	01001	00111	10101	01101			

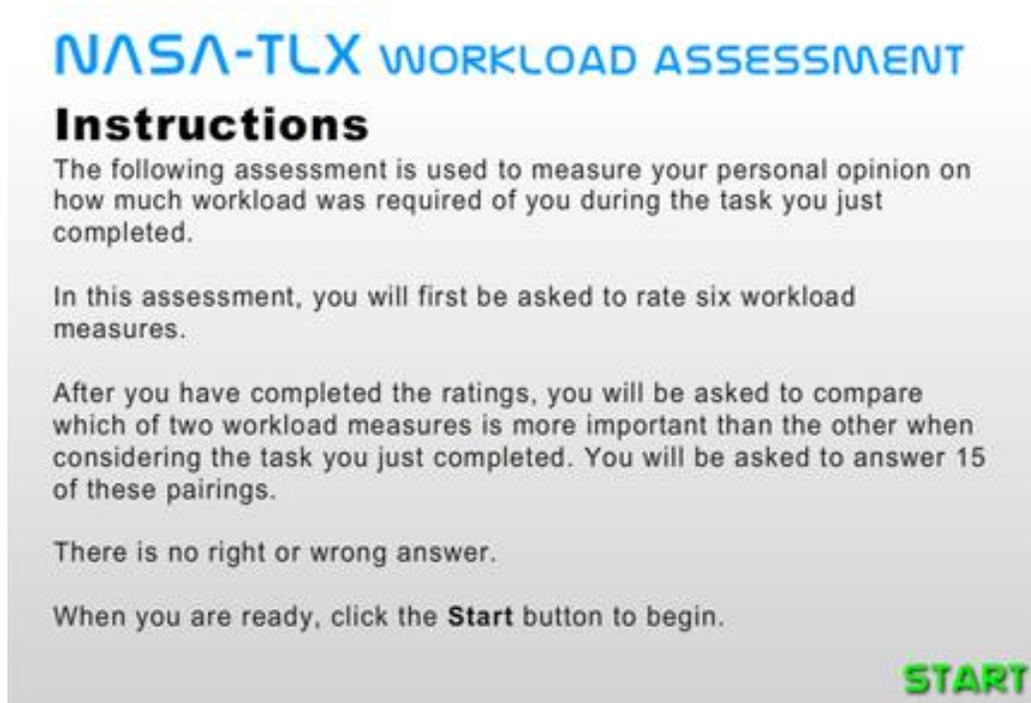
Note: 0 = incorrect element, 1 = correct element i.e., the order, 11111 represents a completely correct warning and the order, 00000 represents a warning with all incorrect elements. Anytime an order contains a 0, the warning is considered to be incorrect because the element represented by the 0 is incorrect.

Appendix D: Display Order of all the Correct and Incorrect Warnings

LEVEL	Base Warning	# of incorrect elements	# of warnings permutations	Difficulty Level
1	1	5	2	*
1	2	5	2	*
1	3	5	2	*
2	1	4	7	**
2	2	4	7	**
2	3	4	7	**
3	1	3	14	***
3	2	3	14	***
3	3	3	14	***
4	1	2	14	****
4	2	2	14	****
4	3	2	14	****
5	1	1	7	*****
5	2	1	7	*****
5	3	1	7	*****

Appendix E: Post-Training Questionnaire Items

NASA-TLX: Workload Measure



NASA-TLX WORKLOAD ASSESSMENT

Instructions

The following assessment is used to measure your personal opinion on how much workload was required of you during the task you just completed.

In this assessment, you will first be asked to rate six workload measures.

After you have completed the ratings, you will be asked to compare which of two workload measures is more important than the other when considering the task you just completed. You will be asked to answer 15 of these pairings.

There is no right or wrong answer.

When you are ready, click the **Start** button to begin.

START

Mental Demand
How much mental and perceptual activity was required (e.g. thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?

Physical Demand
How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Temporal Demand
How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?

Effort
How hard did you have to work (mentally and physically) to accomplish your level of performance?

Performance
How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?

Frustration Level
How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Of the two workload measures below, which one contributed the most to the task you just completed?

Effort

or

Performance

SUBMIT

Mental Demand: How mentally demanding was the task?



Physical Demand: How physically demanding was the task?



Temporal Demand: How hurried or rushed was the pace of the task?



Performance: How successful were you in accomplishing what you were asked to do?



Effort: How hard did you have to work to accomplish your level of performance?



Frustration: How insecure, discouraged, irritated, stressed, and annoyed were you?



INSTRUCTIONS:

Please rate all six workload measures on the left by clicking a point on the scale that best represents your experience with the task you just completed.

Consider each scale individually and select your responses carefully. Mouse over the scale definitions for additional information.

Your ratings will play an important role in the evaluation being conducted. Your active participation is essential to the success of this experiment, and is greatly appreciated.

Click the Submit button when you have completed all six ratings.

Please note that the Performance scale goes from **Poor** on the left to **Good** on the right.

SUBMIT

Engagement/Affective Reactions/Utility Reactions

Participating in this game was a rather negative experience for me. (reverse-scored)	5 point Likert scale strongly agree strongly disagree
This game was fun.	
I disliked this game. (reverse-scored)	
I couldn't wait for this game to be over. (reverse-scored)	
I found this game to be engaging.	Affective Reactions (Thompson et al., 2008)
I enjoyed doing this activity very much.	
This activity was fun to do.	
I thought this was a boring activity. (reverse-scored)	
This activity did not hold my attention at all. (reverse-scored)	
I would describe this activity as very interesting.	
I thought this activity was quite enjoyable.	
While I was doing this activity, I was thinking about how much I enjoyed it.	
What is your definition of engagement? Was this game engaging? Why or why not?	7 point Likert scale not at all true very true
	Engagement; Interest/ Enjoyment Scale of Intrinsic Motivation Inventory (Deci, 2009)
	Open-ended

Demographics

What is your gender?	1. Male 2. Female
What is your Age?	Open-ended (numerical)
What is your Area of Study?	1. Agriculture & Life Sciences 2. Design 3. Education 4. Engineering 5. Humanities & Social Sciences 6. Management 7. Medicine 8. Natural Resources 9. Physical & Mathematical Sciences 10. Textiles 11. Veterinary Medicine 12. First-Year College 13. Other 14. None

What is your Highest level of school completed?	<ol style="list-style-type: none"> 1. Some High School 2. High School Diploma / GED 3. Some College 4. Associate's Degree (2 yrs) 5. Bachelor's Degree (4 yrs) 6. Masters Degree 7. Doctorate Degree
What is your employment status?	<ol style="list-style-type: none"> 1. Full-time employed for wages 2. Part-time employed for wages 3. Out of work for more than 1 year 4. Homemaker 5. Retired 6. Unable to work 7. None
What is your nationality?	Open-ended
Is English your first language?	<ol style="list-style-type: none"> 1. Yes 2. No
How many hours per week do you spend using any computer?	Open-ended (numerical)
What percent of those hours are spent using the Internet?	Open-ended (numerical)
Please rate your rate your level of expertise when using the Internet.	5 point Likert scale (Novice - Expert)
Where do you most often access the Internet?	<ol style="list-style-type: none"> 1. Home 2. School 3. Work 4. Other

Appendix F: Study 1 Open-Ended Responses

<p>My definition of engagement is "having your undivided attention on a certain task at hand." The game could be fun (definitely got my attention), but I got frustrated with it, because I would click on answers that I was very certain were correct but were counted wrong. I did not like seeing my score go down. It might be more engaging if it were harder, but then that would require a more advanced knowledge of computer warnings. Thus, it became unengaging very quickly.</p>
<p>Engagement is when someone is participating in an activity that requires the person to be focus on the task. I thought this game was engaging because you had an objective and tried to get as many questions right as you can.</p>
<p>How involved you are with participation in the game. this game was engaging because you had to pay attention to minute details in order to get the questions right.</p>
<p>Engagement is learning while participating. No because I learned nothing from this game. All I had to do was memorize the correct answers and click it.</p>
<p>engagement is something that has your full attention where there are no distractions and where someone is grasped by an activity. this game is somewhat engaging because it requires concentration but is rather boring which increases distractions.</p>
<p>Engagement is being very involved. Such as it takes up most of your attention. This game was engaging because you had to think about each warning and figure out if it was real or fake.</p>
<p>Engagement- Keeps ones attention Yes this game was engaging because it kept my attention more and more everytime I got the right answer</p>
<p>I think engagement means being involved. Doing an activity that allows you to be mentally and physically involved. Doing something that involves thought or consideration. This game was engaging because it required you to think about your answer before submitting it. You had to look at the virus and evaluate whether it was real or not.</p>
<p>Yes that was a good exercise. It got me thinking about the diffrent little parts of warnings.</p>
<p>Engagement captivation of ines attention and interest for the durration of a given activity. Not really. It was highly repetitive</p>
<p>Engagement is enjoying an activity and this game was not enjoying and therefore not engaging. I don't understand the warnings.</p>
<p>engagement is a term used to define how active you are in an activity. Yes this game was engaging you had to read ever pop up and decide whether or not it was real.</p>
<p>engagement-deeply interacting with something or someone, being able to hold your attention. I thought this game was engaging, much more so than other experiments I have taken.</p>
<p>Engagement is the drawing in of a person through active participation in an event. Yes this game was engaging as it was interactive and required the participant to focus on each display and carefully select the most logical choice. Also the graphics of the game increased its interest as it was bold and playful rather than monotone and boring.</p>
<p>Engagement is allowing input from both sides and keeps interest throughout whatever activity is taking place. This activity was interesting at first. I did not know that it would warning signs you would see on the Internet.</p>
<p>My definition of engagment is being interactive with. Yes this game was engaging because I had to focus in order to get it done and I did put in effort in clicking on the correct answer.</p>
<p>My definition of engagement is the degree in which one is concentrating on a task. I consider this game to be very engaging because while I was playing it, I didn't think of anything else</p>

and I did not do anything else. I simply concentrated on the task because I thought that the key to the game was looking at the warnings and trying to find differences between them.
Engagement means: does it pull you in and capture your attention. This game was not engaging because it was so repetitive.
I thought it was engaging because i tried to compete with myself to get a good score. I will say that was one of the only things that helped me enjoy this game.
It was interesting for the first few slides then it seemed to just get repetative and unenjoyable.
Engagement- The act of being mentaly and physicaly active in a particular task. This game was engaging because I felt like I was learning something and sharpening my ability to detect fraudulent pop ups. I also liked how the score was displayed making it more compeditive.
I would guess engagement would be synonomous with interesting. This game was somewhat engaging as it was cool to see how I guess viruses could be implemented on ones computer. It definitely will open my eyes and think about what is popping up on my computer! Cool game!
Engagement to me is when something or someone has my complete focus and it is very interesting. This game was not engaging at all because I felt it had no other purpose besides for this data collection.
Engagement is something that can hold someone's attention. This game was not engaging. It provided the same picture of warning signs repeatedly and it was frustrating to get them wrong time and time again.
No I felt that it was a borring and frustrating game. I think there should have been more warnings instead of running through the same ones over and over.
The game was not engaging because it was so repeated and it made me angry when I did not get the answers correct.
Engagement is the level at which your brain has to focus on the task at hand. This game was somewhat engaging in that there were many repeated slides so you had to remember previous answers. You also had to notice some smaller details.
capture and hold my attention. This game was not really engaging it seemed to repetitive.
My definition of engagement is whether or not something has the ability to draw and maintain my attention for a period of time by being interesting or fun in some way. This game was very engaging. I thought it very interesting to learn how terrible I was at spotting computer threats. This game was fun and I felt that it taught me to become better at determining the real messages from the fake.
Fun to do and interested in doing it more. This games was not engaging, because it was repeatative and boring.
Something that gets you involved. The game was semi-engaging. You kind of had to think about each warning the first time you saw it
This game was interesting in how I was able to learn from it. I did not find it that fun once I got the hang of it a bit. The errors also repeated quite a bit. The scoring seemed a bit silly - in fact
Engagement is when something can hold your attention for a long period of time. The game was engaging at first until I figured out what exactly the differences were that gave away the answer. After that it got pretty monotonous.
engagement...able to hold my attention, planning to get married.. NO because I'm not interested in comuters and the same messages were shown over and over and I stopped caring.

Engaged is being able to actively pay attention and participate. I did not find the game very engaging because it seemed very repetitive and I didn't have the motivation to try and learn the error messages.
My definition of engagement is when someone is completely in to what they are doing. They are solely paying attention to what they are doing. This game was engaging but only for a short period. Then it got boring.
Engaging to me means keeping the attention of the person playing the game enough that time seems to pass quicker. This game was not engaging. While fun for a little bit it quickly became mind-numbing. I wanted it to end faster.
I thought the game was very engaging but after four rounds I was like when the heck will this thing end? Lol. It was an interesting test for myself to see if I could be fooled-- I didn't think I would but I was! It's scary that they are allowed to make spam ads that look like computer warnings. I will be much more careful reading those after seeing this test!
If something is engaging it is interesting and you don't really notice time passing as you do it. This game was definitely not engaging. It was interesting for the first 3 or 4 problems then it just got really repetitive and boring.
Engagement is the ability for an activity to grab your attention and hold it for the period of time necessary for it to gather results. Using that as the definition the game is not engaging. What are the points for? Maybe a better way to show the point system than the dial would make it more engaging and fun.
Engagement means keeping the mind entertained. This game was not engaging because it was frustrating and confusing.
Engaging in that I learned something less engaging in that it was repetitive after a time.
I felt that it was engaging (requiring activity or requiring active thought and activity to accomplish the task). You really had to pay attention to the details and even then it was hard to discern small discrepancies. It was a very active game mentally.
1. Definition: Being interested and challenged by something; a desire to continue an activity. 2. I think this game was engaging because even though many of the slides were similar some of them had very small changes that meant the difference between Real and Fake. The game required paying close attention and learning from mistakes in order to achieve a high score. It was particularly engaging for me because we currently have some spybot-type viruses on our computer and it pops up with fake virus messages all the time!
engagement is keeping my attention and interest. It was engaging for the first few minutes to see how many fake ones I spotted. However after that it was just repetitive
Engaging means that a person is involved in the task and does not move away until complete. This game was that because I had to answer things quickly and see if I got them right.
Keeping my interest is my definition. It was only because I had to try to figure out why some were fakes. Once I figured it out it became less engaging.
The ability to hold your attention. The game was engaging. The user interface wasn't distracting or hard to use. The game performed well and there was no waiting between steps.
My definition of engagement is whether or not something held my attention and kept me interested in continuing. Yes I found this game engaging. It was engaging because it kept me thinking and trying to improve my detection of fake messages.
Engagement is the period of time between when you propose and when you get married. I don't think this game falls under that category at all. It is a game and engagement is the real deal. My friend is engaged and it is no laughing matter. His engagement seems to me like it is no fun, so I guess in that way this game could be considered engaging.

Appendix G: Study 2 Flash AS3 Code

```
//if pilot study
var pilotStudy:Boolean=false;
//
stop();
loaderInfo.addEventListener(ProgressEvent.PROGRESS,loadProgress);
loaderInfo.addEventListener(Event.COMPLETE,loadComplete);function loadProgress(e:ProgressEvent):void {
    var pct:Number=loaderInfo.bytesLoaded/loaderInfo.bytesTotal;
    loadTxt.text=int(pct*100)+"%";
}
function loadComplete(e:Event):void {
    loaderInfo.removeEventListener(ProgressEvent.PROGRESS,loadProgress);
    loaderInfo.removeEventListener(Event.COMPLETE,loadComplete);
    loadTxt.text="OK";
    nextFrame();
}
b_consent.addEventListener(MouseEvent.CLICK,f_consent,false,0,false);
b_dontConsent.addEventListener(MouseEvent.CLICK,f_dontConsent,false,0,false);function f_consent(evt:MouseEvent) {
    gotoAndStop("page_login");
}
function f_dontConsent(evt:MouseEvent) {
    gotoAndStop("page_dontConsent");
}
dbAlert.visible=false;//be nice and set tab index
login.uid_txt1.tabIndex=1;
login.uid_txt2.tabIndex=2;
login.b_next.tabIndex=3;
//clear text boxes
login.uid_txt1.text=login.uid_txt2.text=login.alert_txt.text="";
login.b_next.addEventListener(MouseEvent.CLICK,f_next,false,0,false);function f_next(e:MouseEvent) {
    var txt1:String=login.uid_txt1.text;
    var txt2:String=login.uid_txt2.text;
//DEVELOPMENT!!!!!!!!!!!!!!!!!!!!
    if (txt1=="XX"&& (txt2=="1" || txt2=="2" || txt2=="3" || txt2=="4" || txt2=="9")) {
        condition=Number(txt2);
        uid=txt1;
        gotoAndPlay("sysInfo");
//END DEVELOPMENT!!!!!!!!!!!!!!!!!!!!
    } else if ( (txt1==txt2) && (txt1.search("@")!=-1) && ((txt1.search(".com")!=-1) ||(txt1.search(".net")!=-1)
|| (txt1.search(".org")!=-1) || (txt1.search(".edu")!=-1)) ) {
sortUID(txt1);
    } else {
        login.alert_txt.htmlText="Please enter a valid email address in both of the fields
```

```

above.<BR>Please try again";
    }
}
//this function sends the email address to the database
//email is converted to MD5 hash and then check to see if it already exists in db
//if it doesnt exist, the hash is returned as the UID and the row ID is returned
//which is converted into one of the three conditions
function sortUID(who:String):void {
    dbAlert.visible=true;
    dbAlert.txt.htmlText="Loggin' in...";
    dbAlert.txt2.htmlText="Please Wait.";
    var request:URLRequest=new URLRequest("URL");
    request.method=URLRequestMethod.POST; var variables:URLVariables = new URLVariables();
    variables.email=who;
    request.data=variables; var loader:URLLoader=new URLLoader(request);
    loader.addEventListener(Event.COMPLETE, onComplete);
    loader.addEventListener(IOErrorEvent.IO_ERROR, onIOError);
    loader.dataFormat=URLLoaderDataFormat.VARIABLES;
    loader.load(request); function onComplete(event:Event):void {
        if (event.target.data.noneShall!="pass") {
            uid=event.target.data.uid;
            //condition 1 = boring
            //condition 2 = flow
            //condition 3 = frustration
            if (pilotStudy) {
                condition=9;
            } else {
                condition=getCondition(Number(event.target.data.id));
            }
            gotoAndPlay("sysInfo");
        }
        else {
            dbAlert.circleLoader.gotoAndStop("sadFace");
            dbAlert.txt.htmlText="Login Failed.";
            dbAlert.txt2.htmlText="It appears that you have already logged into this
experiment.<BR>Please contact the experimenter and ask them to clear your previous login information so you can start
over.";
        }
    }
}
function onIOError(event:IOErrorEvent):void {
    trace("Error loading URL.");
    dbAlert.circleLoader.gotoAndStop("sadFace");
    dbAlert.txt.htmlText="I can't log you in for some reason.";
    dbAlert.txt2.htmlText="Please check your Internet connection and try again by refreshing this
page. Sorry!";
}
}

```

```

}function getCondition(num:int) {
    while (num>3) {
        num=num-3;
    }
    return num;
}
sendSystemInfo(uid);
function sendSystemInfo(uid:String) {
var timeStamp:Date = new Date(); trace("language: " + Capabilities.language);
    trace("os: " + Capabilities.os);
    trace("playerType: " + Capabilities.playerType);
    trace("screenDPI: " + Capabilities.screenDPI);
    trace("screenResolution (Width x Height): " + Capabilities.screenResolutionX+" x
"+Capabilities.screenResolutionY);
    trace("version: " + Capabilities.version);
    trace("timeStamp: "+timeStamp);
    var request:URLRequest=new URLRequest("URL ");
    request.method=URLRequestMethod.POST;
    var variables:URLVariables = new URLVariables();
    variables.uid=uid;
    variables.timeStamp=timeStamp;
    variables.language=Capabilities.language;
    variables.os=Capabilities.os;
    variables.playerType=Capabilities.playerType;
    variables.screenDPI=Capabilities.screenDPI;
    variables.screenResolution=Capabilities.screenResolutionX+" x "+Capabilities.screenResolutionY;
    variables.version=Capabilities.version;
    //trace(variables);
    request.data=variables;
    var loader:URLLoader=new URLLoader(request);
    loader.addEventListener(Event.COMPLETE, onComplete);
    loader.addEventListener(IOErrorEvent.IO_ERROR, onIOError);
    loader.dataFormat=URLLoaderDataFormat.VARIABLES;
    loader.load(request);  function onComplete(event:Event):void {
        if (event.target.data.sent=="success") {
            trace("OK - System info data was sent!");
        } else {
            trace("SYSTEM INFO DATA NOT SENT!!!");
        }
    }
    function onIOError(event:IOErrorEvent):void {
        trace("Error loading URL.");
    }
    }if (pilotStudy) {
    gotoAndStop("pilotFrame");
} else {
    gotoAndStop("clockFrame");
}

```

```

}
b_next.addEventListener(MouseEvent.CLICK,b_next_f,false,0,false);
function b_next_f(evt:MouseEvent) {
    gotoAndStop("gameFrame");
}
}
stop();function tutorial() {    tut_next.visible=false;
    tut_next.addEventListener(MouseEvent.CLICK,tut_next_f,false,0,false);
    function tut_next_f(evt:MouseEvent) {
        tut_slideTimer.stop();
        Tweener.removeTweens(tut_clock);
        gotoAndStop("gameFrame");
    }    //init timer to show gameclock for specified amount of time
    var tut_slideTimer:Timer=new Timer(2000,1);
    tut_time.addEventListener(MouseEvent.CLICK,slideGameClock,false,0,false);
    tut_clock.gotoAndStop(1);
    tut_clock.b_exitGame.visible=tut_clock.b_keepPlaying.visible=false;
    function slideGameClock(evt:MouseEvent) {
        tut_next.visible=true;
        Tweener.addTween(tut_clock, {x: 0, time:1, onComplete:tweenFinish_gameClock });
    }    function tweenFinish_gameClock() {
        tut_slideTimer.addEventListener(TimerEvent.TIMER,timeUp);
        tut_slideTimer.start();
    }    function timeUp(evt:TimerEvent):void {
        tut_slideTimer.reset();
        Tweener.addTween(tut_clock, [x: - tut_clock.width, time:1 });
    }
}
}
tutorial();
stop();
import flash.media.SoundTransform;
import flash.events.*;
import flash.filters.DropShadowFilter;
import flash.media.SoundMixer;import caurina.transitions.Tweener;
import caurina.transitions.properties.ColorShortcuts;
ColorShortcuts.init();var stageWidth:int=980;
var stageHeight:int=680;//
var rows:int=12;
var columns:int=20;
var maxLevels:int;
var won:Boolean=false;
var instructor:MovieClip;
var rateScreen:MovieClip;
var credits:MovieClip;
var canvas:MovieClip;
var tile:MovieClip;

```

```

var hero:MovieClip;
var tileGlow:MovieClip;
var goalTile:MovieClip;
var infoScreen:MovieClip;
var startX:int;
var startY:int;
var level:int=0;
var levelsComplete:int=0;
//store number of moves per level
var movesRay:Array=new Array();
//store number of times GC is clicked per level
var clockClick_level:int=0;
//stores number of times block falls off edge per level
var errors_level:int=0;
//stores change in key directions per level
var directions_level:int;
var currentDir:int;
//store how long each level took
var time_level:Timer=new Timer(1000);
//stores self rate per level for pilot study [0]=difficult, [1]=bored, [2]=frustration
var SR_Ray:Array=new Array();
//stores if pilot ended so can skip to questionnaire
var pilotEnded:Boolean=false;
var moves:int=0;
var tileRay:Array=new Array();
var grid:Array=new Array();
var onMove:Boolean;
//so we know if clock is on screen or not
var clockOn:Boolean=false;
//tile to go to
var t0:Object = new Object();
var t1:Object = new Object();var offsetX:int=565;
var offsetY:int=120;
var tileHeight:int=26;
var tileWidth:int=52;
//used to show game clock after rating screen
//this can happen if the min time is up while the person is looking at the game clock.
var showExitAfterRate:Boolean=false;
//used to end the game
var gameOver:Boolean=false;
var thud:s_thud = new s_thud();
var s_1:s_block1 = new s_block1();
var s_2:s_block2 = new s_block2();
var s_3:s_block3 = new s_block3();
var splash:s_splash = new s_splash();

```

```

var bell:s_bell = new s_bell();var harp1:s_harp1 = new s_harp1();
var harp_c:SoundChannel = new SoundChannel();
var harp_st:SoundTransform = new SoundTransform();
harp_st.volume=.5;var goodRay:Array=new Array("good job!","well done!","well played!","nice one!","excellent!","keep it
up!","way to go!");var levelXML:XML;
var levelLoader:URLLoader=new URLLoader ;//begin everything
loadXMLData();
function loadXMLData() {
    //load popup xml file
    levelLoader.addEventListener(Event.COMPLETE,xmlLoaded,false,0,true);
    levelLoader.addEventListener(IOErrorEvent.IO_ERROR,xmlError,false,0,true);
    levelLoader.load(new URLRequest("xml/levels_"+condition+".xml")); function xmlLoaded(evt:Event) {
        try {
            levelXML=new XML(evt.target.data);
            maxLevels=levelXML.LEVEL.length();
            levelLoader.removeEventListener(Event.COMPLETE,xmlLoaded);
            levelLoader.removeEventListener(IOErrorEvent.IO_ERROR,xmlError);
            //start game
            instruct();
        } catch (err:Error) {
            trace("Could not parse popup XML:\n"+err.message);
        }
    }
    function xmlError(evt:IOErrorEvent):void {
        trace("Error: Could not get popup XML:\n"+evt.text);
    }
}function loadGrid() {
    startX=levelXML.LEVEL.startX[level-1];
    startY=levelXML.LEVEL.startY[level-1];
    for (var i=0; i<rows; i++) {
        grid[i]=levelXML.LEVEL[level-1].ROW[i].split(",");
        for (var d=0; d<grid[i].length; d++) {
            grid[i][d]=Number(grid[i][d]);
        }
    }
}
//INSTRUCTIONSfunction instruct() {
    addChild(instructor = new instructor_mc);
    instructor.y=- instructor.height;
    Tweener.addTween(instructor, {y: 0, time:2});
    instructor.start_b.buttonMode=true;
    instructor.start_b.addEventListener(MouseEvent.MOUSE_DOWN, startGame);
    instructor.start_b.addEventListener(MouseEvent.MOUSE_OVER, startRollOver);
    instructor.start_b.addEventListener(MouseEvent.MOUSE_OUT, startRollOut);
    //
    credits_b.addEventListener(MouseEvent.MOUSE_DOWN, showCredits);

```

```

credits_b.addEventListener(MouseEvent.CLICK, startRollOver);
credits_b.addEventListener(MouseEvent.CLICK, startRollOut);
//
instructor.levelTxt.text="There are "+maxLevels+" levels, try to complete each one in as few moves as
possible.";
//
instructor.block.h_txt="This is the block that you will move around. Notice how it has two different coloured
sides. This will become important as the levels become more difficult.";
instructor.block.addEventListener(MouseEvent.CLICK, startHover);
instructor.grass.h_txt="This is a grass tile. Your block must always be on the grass. This includes both sides of
the block when it is laying down.";
instructor.grass.addEventListener(MouseEvent.CLICK, startHover);
instructor.water.h_txt="This is a water tile. If you move your block onto the water, it will sink and the level will
be restarted.";
instructor.water.addEventListener(MouseEvent.CLICK, startHover);
instructor.goal_any.h_txt="This is a goal tile. You must position the block so that either side of it is standing
vertically on top the goal. Notice how the goal contains both colours.";
instructor.goal_any.addEventListener(MouseEvent.CLICK, startHover);
instructor.goal_pink.h_txt="This is a special goal tile. Notice how the goal is completely pink in colour. Move
the block so that, when it is standing vertically, the block's PINK side connects with this goal. ";
instructor.goal_pink.addEventListener(MouseEvent.CLICK, startHover);
instructor.goal_grey.h_txt="This is a special goal tile. Notice how the goal is completely grey in colour. Move
the block so that, when it is standing vertically, the block's GREY side connects with this goal. ";
instructor.goal_grey.addEventListener(MouseEvent.CLICK, startHover);}function
startRollOver(e:MouseEvent) {
    e.target.gotoAndStop(2);
}function startRollOut(e:MouseEvent) {
    e.target.gotoAndStop(1);
}function startGame(e:MouseEvent) {
    Tweener.addTween(arrowKeys, [x: 866, time:2]);
    Tweener.addTween(credits_b, [x: 930, time:2]);
    Tweener.addTween(instructor, {y: -600, time:1, onComplete:function() {removeChild(instructor);
instructor=null; hideCredits_f(); init(); } });
//
}
function showCredits(e:MouseEvent) {
    showCredits_f();
}function showCredits_f() {
    addChild(credits = new credits_mc);
    credits.y=- credits.height;
    credits.continue_b.addEventListener(MouseEvent.CLICK, hideCredits);
    credits.continue_b.addEventListener(MouseEvent.CLICK, startRollOver);
    credits.continue_b.addEventListener(MouseEvent.CLICK, startRollOut);
    Tweener.addTween(credits, {y: 0, time:2});
    Tweener.addTween(credits_b, [x: 980, time:2]);

```

```

}function hideCredits(e:MouseEvent) {
    hideCredits_f();
}
function hideCredits_f() {
    if (credits!=null) {
        Tweener.addTween(credits_b, [x: 930, time:2]);
        Tweener.addTween(credits, {y: -600, time:1, onComplete:function() {removeChild(credits);
credits=null;}});
        //
    }
}
}arrowKeys.h_txt="Use the arrow keys on your keyboard to move the block around in the direction that this image
indicates.";
arrowKeys.addEventListener(MouseEvent.ROLL_OVER, startHover);
function init() {
    //gather level data
    clockClick_level=0;
    errors_level=0;
    directions_level=undefined;
    currentDir=undefined;
    time_level.reset();
    time_level.start();
    //if completed game and won!
    if (won) {
        levelsComplete++;
        won=true;
        //end game
        removeGame();
        bell.play();
        //if game is not over yet
    } else if (! gameOver) {
        Tweener.addTween(credits_b, [x: 980, time:2]);
        canMove=false;
        if (canvas!=null) {
            Tweener.addTween(canvas, {_brightness: .8, time:.5});
        }
        movesTxt.text=0;
        level++;
        loadGrid();
        levelTxt.text=level;
        addChild(infoScreen=new infoScreen_mc);
        infoScreen.levelTxt.text=level;
        if (level==1) {
            infoScreen.txt.text="get ready!";
            //start game clock
            startClock();
        }
    }
}

```

```

        } else {
            levelsComplete++;
            //store moves
            movesRay.push(moves);
            moves=0;
            infoScreen.txt.text=goodRay[Math.floor(Math.random()*goodRay.length)];
        }
        infoScreen.y=- infoScreen.height;
        Tweener.addTween(infoScreen, {y: 0, time:3, onComplete:removeInfo});
    }
}function removeInfo() {
    Tweener.addTween(credits_b, [x: 930, time:2]);
    Tweener.addTween(infoScreen, {y: -600, time:1});
    //, delay:.5, onComplete:initMap
    initMap();
}stage.addEventListener( KeyboardEvent.KEY_DOWN, keyDownHandler );
stage.addEventListener( KeyboardEvent.KEY_UP, keyUpHandler );
var pressedKeys:Object={};
function keyDownHandler( e:KeyboardEvent ):void {
    if (pressedKeys[e.keyCode] ) {
        return;
    }
    pressedKeys[e.keyCode]=1;
    moveBlock(e);
}function keyUpHandler( e:KeyboardEvent ):void {
    delete pressedKeys[ e.keyCode ];
}
// Modifies the 'hero' object, handles collision detection ('hero' and wall)
// Any tile less then 200 is walkable, anything above is not.
function moveBlock(e:KeyboardEvent):void {
    if (canMove) {
        moves++;
        movesTxt.text=moves;
        var Y:int=hero.ypos;
        var X:int=hero.xpos;
        var curFrame:int=hero.blocky.currentFrame;
        //get change in direction for level info
        changeDirections(e.keyCode);
        //UP
        if (e.keyCode==38) {
            if (hero.currentFrame==1) {
                t0.xpos=t1.xpos=X;
                t0.ypos=t1.ypos=Y-1;
                hero.gotoAndStop(2);
                s_2.play();
                if (curFrame==2) {

```

```

        hero.blocky.gotoAndStop(2);
    }
    hero.ypos--;}
else if (hero.currentFrame == 2) {
    t0.xpos=X;
    t0.ypos=Y-1;
    t1.xpos=X;
    t1.ypos=Y-2;
    hero.gotoAndStop(1);
    s_1.play();
    if (curFrame==1) {
        hero.blocky.gotoAndStop(2);
    }
    hero.ypos-=2;}
else if (hero.currentFrame == 3) {
    t0.xpos=X;
    t0.ypos=Y-1;
    t1.xpos=X+1;
    t1.ypos=Y-1;
    hero.ypos--;
    s_3.play();
}
//DOWN
} else if (e.keyCode==40) {
    if (hero.currentFrame==1) {
        t0.xpos=t1.xpos=X;
        t0.ypos=t1.ypos=Y+2;
        hero.gotoAndStop(2);
        s_2.play();
        if (curFrame==1) {
            hero.blocky.gotoAndStop(2);
        }
        hero.ypos+=2;}
    else if (hero.currentFrame == 2) {
        t0.xpos=X;
        t0.ypos=Y+1;
        t1.xpos=X;
        t1.ypos=Y+2;
        hero.gotoAndStop(1);
        s_1.play();
        if (curFrame==2) {
            hero.blocky.gotoAndStop(2);
        }
        hero.ypos++;}
    else if (hero.currentFrame == 3) {

```

```

        t0.xpos=X;
        t0.ypos=Y+1;
        t1.xpos=X+1;
        t1.ypos=Y+1;
        s_3.play();
        hero.ypos++;
    }
    //RIGHT
} else if (e.keyCode==39) {
    if (hero.currentFrame==2) {
        t0.xpos=X-1;
        t0.ypos=Y;
        t1.xpos=X-2;
        t1.ypos=Y;
        hero.gotoAndStop(3);
        s_1.play();
        if (curFrame==2) {
            hero.blocky.gotoAndStop(2);
        }
        hero.xpos-=2;}
    else if (hero.currentFrame == 3) {
        t0.xpos=t1.xpos=X-1;
        t0.ypos=t1.ypos=Y;
        hero.gotoAndStop(2);
        s_2.play();
        if (curFrame==1) {
            hero.blocky.gotoAndStop(2);
        }
        hero.xpos--;}
    else if (hero.currentFrame == 1) {
        t0.xpos=X-1;
        t0.ypos=Y;
        t1.xpos=X-1;
        t1.ypos=Y+1;
        s_3.play();
        hero.xpos--;
    }
}
//LEFT
}

else if (e.keyCode==37) {
    if (hero.currentFrame==2) {
        t0.xpos=X+1;
        t0.ypos=Y;
        t1.xpos=X+2;
        t1.ypos=Y;
    }
}

```

```

        hero.gotoAndStop(3);
        s_1.play();
        if (curFrame==1) {
            hero.blocky.gotoAndStop(2);
        }
        hero.xpos++;
        else if (hero.currentFrame == 3) {
            t0.xpos=t1.xpos=X+2;
            t0.ypos=t1.ypos=Y;
            hero.gotoAndStop(2);
            s_2.play();
            if (curFrame==2) {
                hero.blocky.gotoAndStop(2);
            }
            hero.xpos+=2;}
        else if (hero.currentFrame == 1) {
            t0.xpos=X+1;
            t0.ypos=Y;
            t1.xpos=X+1;
            t1.ypos=Y+1;
            s_3.play();
            hero.xpos++;
        }
    }
    moveAll();
}
}function moveAll():void {
    hideCredits_f();
    deleteHover(hero);
    //if block falls of edge
    if (grid[t0.ypos][t0.xpos]>=200||grid[t1.ypos][t1.xpos]>=200) {
        errors_level++;
        splash.play();
        canMove=false;
        if (tileRay[t0.ypos][t0.xpos]!=undefined&&tileRay[t0.ypos][t0.xpos].water!=null) {
            tileRay[t0.ypos][t0.xpos].water.play();
        }
        if (tileRay[t1.ypos][t1.xpos]!=undefined&&tileRay[t1.ypos][t1.xpos].water!=null) {
            tileRay[t1.ypos][t1.xpos].water.play();
        }
        }
        initPlayer(0);
    } else {
        hero.x = (tileWidth/2)*(hero.ypos-hero.xpos)+offsetX;
        hero.y = (tileHeight/2)*(hero.ypos+hero.xpos)+offsetY;
        checkGoal();
    }
}

```

```

    }
}function checkGoal():void {
    var beatLevel:Boolean=false;
    if (hero.currentFrame==2) {
        if (grid[hero.ypos][hero.xpos]==111) {
            beatLevel=true;
        } else if (grid[hero.ypos][hero.xpos]==112 && hero.blocky.currentFrame==1) {
            beatLevel=true;
        } else if (grid[hero.ypos][hero.xpos]==113 && hero.blocky.currentFrame==2) {
            beatLevel=true;
        }
    }
}
if (beatLevel) {
    //only way to win is to come through here
    if (level==maxLevels) {
        won=true;
    }
    //stop timing level
    time_level.stop();
    bell.play();
    if (pilotStudy) {
        rateLevel();
    } else {
        saveLevel();
        init();
    }
}
}function changeDirections(num:int) {
    if (num!=currentDir) {
        directions_level++;
        currentDir=num;
    }
}
function saveLevel() {
    var timeStamp>Date = new Date();
/*
    trace("uid      "+ uid);
    trace("timeStamp  "+ timeStamp);
    trace("condition  "+ condition);
    trace("level      "+ level);
    trace("GC_times   "+ clockClick_level);
    trace("time       "+ time_level.currentCount);
    trace("errors     "+ errors_level);
    trace("directions  "+ directions_level);
    trace("moves      "+ moves);
*/
}

```

```

    if (pilotStudy) {
        trace("SR_difficult  "+ SR_Ray[0]);
        trace("SR_bored    "+ SR_Ray[1]);
        trace("SR_frustration "+ SR_Ray[2]);
    }
    */
    var request:URLRequest=new URLRequest("URL ");
    request.method=URLRequestMethod.POST;
    var variables:URLVariables = new URLVariables();
    variables.uid=uid;
    variables.timeStamp=timeStamp;
    variables.condition=condition;
    variables.level=level;
    variables.GC_times=clockClick_level;
    variables.time=time_level.currentCount;
    variables.errors=errors_level;
    variables.directions=directions_level;
    variables.moves=moves;
    variables.SR_difficult=SR_Ray[0];
    variables.SR_bored=SR_Ray[1];
    variables.SR_frustration=SR_Ray[2];
    //trace(variables);
    request.data=variables;
    var loader:URLLoader=new URLLoader(request);
    loader.addEventListener(Event.COMPLETE, onComplete);
    loader.addEventListener(IOErrorEvent.IO_ERROR, onIOError);
    loader.dataFormat=URLLoaderDataFormat.VARIABLES;
    loader.load(request);  function onComplete(event:Event):void {
        if (event.target.data.sent=="success") {
            trace("OK - System info data was sent!");
        } else {
            trace("SYSTEM INFO DATA NOT SENT!!!");
        }
    }
    function onIOError(event:IOErrorEvent):void {
        trace("Error loading URL.");
    }
}
function rateLevel() {
    trace("RATE LEVEL!!!!!!!!!!");
    canMove=false;
    b_checkClock.visible=false;
    if (pilotStudy) {
        if (b_exit!=null) {
            b_exit.visible=false;
        }
    }
    if (rateScreen!=null) {

```

```

        removeChild(rateScreen);
    }
    addChild(rateScreen = new rateScreen_mc);
    rateScreen.y=- rateScreen.height;
    Tweener.addTween(rateScreen, {y: 0, time:2});
    rateScreen.continue_b.buttonMode=true;
    rateScreen.continue_b.addEventListener(MouseEvent.CLICK, continueRate);
    rateScreen.continue_b.addEventListener(MouseEvent.CLICK, startRollOver);
    rateScreen.continue_b.addEventListener(MouseEvent.CLICK, startRollOut);
    //set scales
    for (var d=0; d<3; d++) {
        rateScreen["rate_"+d].num=d;
        for (var a=0; a<10; a++) {
            rateScreen["rate_"+d]["rad"+a].num=a;
            rateScreen["rate_"+d]["rad"+a].buttonMode=true;
            rateScreen["rate_"+d]["rad"+a].addEventListener(MouseEvent.CLICK,
selectRate);
        }
    }
    function selectRate(e:MouseEvent) {
        for (var a=0; a<10; a++) {
            e.target.parent["rad"+a].gotoAndStop(1);
        }
        e.target.gotoAndStop(2);
        SR_Ray[e.target.parent.num]=e.target.num+1;
    }
    function continueRate(e:MouseEvent) {
        saveLevel();
        if (pilotEnded) {
            if (b_exit!=null) {
                b_exit.visible=false;
            }
            removeGame();
        } else {
            init();
            canMove=true;
            if (pilotStudy) {
                if (showExitAfterRate) {
                    showExit();
                    showExitAfterRate=false;
                }
            } else {
                b_checkClock.visible=true;
            }
        }
    }
    removeChild(rateScreen);
    rateScreen=null;

```

```

    }
}function removeTiles() {
    for (var d:int=0; d<canvas.numChildren-1; d++) {
        canvas.removeChildAt(d);
    }
}function removeGame() {
    //this is the final game play time
    playTime=playTimer.currentCount;
    //
    SoundMixer.stopAll();
    Tweener.removeAllTweens();
    hideCredits_f();
    stage.removeEventListener(MouseEvent.CLICK, removeStartInfo);
    if (canvas!=null) {
        removeChild(canvas);
        canvas=null;
    }
    if (b_checkClock!=null) {
        removeChild(b_checkClock);
        b_checkClock=null;
    }
    if (gameClock!=null) {
        removeChild(gameClock);
        gameClock=null;
    }
    if (infoScreen!=null) {
        removeChild(infoScreen);
        infoScreen=null;
    }
    if (credits!=null) {
        removeChild(credits);
        credits=null;
    }
    if (b_exit!=null) {
        removeChild(b_exit);
        b_exit=null;
    }
    }
    gameOver=true;    stage.removeEventListener( KeyboardEvent.KEY_DOWN,
keyDownHandler );
    stage.removeEventListener( KeyboardEvent.KEY_UP, keyUpHandler );    //capture moves if not
complete
    if (level!=movesRay.length) {
        movesRay.push(moves);
    }
    //trace("moves = "+movesRay);
    //trace("levels complete = "+levelsComplete);
    //trace("levels attempted = "+level);
    nextFrame();
}
function startInfo() {
    //if user is already hovering over something - we need to remove that
    if (whoHovers!=null) {

```

```

        deleteHover(whoHovers);
    }
    hover(canvas);
    moveTip(null);
    stage.addEventListener(MouseEvent.CLICK, removeStartInfo);
}function removeStartInfo(e:MouseEvent) {
    canvas.h_txt="";
    stage.removeEventListener(MouseEvent.CLICK, removeStartInfo);
    deleteHover(canvas);
    trace(canvas.h_txt);
}function initMap():void {
    if (! gameOver) {
        if (canvas!=null) {
            removeChild(canvas);
        }
        canMove=false;
        var delayTime:Number=0;
        addChild(canvas = new MovieClip);
        canvas.addChild(hero=new hero_mc );
        //general click start info
        canvas.h_txt="Click on the game board to begin!";
        //make sure gameclock is above map
        setChildIndex(gameClock,numChildren-1);
        hero.h_txt="Use your arrow keys to move this block so that it is standing up on top of the goal in
the center of the board.";
        hero.addEventListener(MouseEvent.ROLL_OVER, startHover);
        harp_c=harp1.play();
        harp_c.soundTransform=harp_st;
        for (var d = 0; d<rows; d++) {
            tileRay[d]=new Array();
            for (var a = 0; a<columns; a++) {
                delayTime+=.01;
                canvas.addChild(tile= new tile_mc);
                tileRay[d].push(tile);
                switch (grid[d][a]) {
                    case 100 :
                        tile.gotoAndStop(1);
                        tile.walker.gotoAndStop(Math.ceil(Math.random()*tile.walker.totalFrames));
                        break;

                    case 200 :
                        tile.gotoAndStop(2);
                        //tile.water.gotoAndStop(Math.ceil(Math.random()*tile.water.totalFrames));
                        break;
                }
            }
        }
    }
}

```

```

case 111 :
tile.gotoAndStop(3);
tile.h_txt="This is the goal. Move the block so that it is standing vertically on top of this goal.";
tile.addEventListener(MouseEvent.ROLL_OVER, startHover);
goalTile=tile;
break;

case 112 :
tile.gotoAndStop(4);
canvas.h_txt="For this level, make sure you match the correct end of the block with the goal. Roll over the goal
for more info. Click on the game board to begin!";
tile.h_txt="This is a special goal. Move the block so that, when it is standing vertically, the block's PINK side
connects with this goal.";
tile.addEventListener(MouseEvent.ROLL_OVER, startHover);
goalTile=tile;
break;

case 113 :
tile.gotoAndStop(5);
canvas.h_txt="For this level, make sure you match the correct end of the block with the goal. Roll over the goal
for more info. Click on the game board to begin!";
tile.h_txt="This is a special goal. Move the block so that, when it is standing vertically, the block's GREY side
connects with this goal.";
tile.addEventListener(MouseEvent.ROLL_OVER, startHover);
goalTile=tile;
break;
}
tile.x = (tileWidth/2)*(d-a)+offsetX;
tile.y=-100;
Tween.addTween(tile, {y: (tileHeight/2)*(d+a)+offsetY, time:.2,
delay:delayTime});
}
}
initPlayer(delayTime);
}
startInfo();
}function initPlayer(delayTime:Number):void {
if (! gameOver) {
canvas.setChildIndex(hero,canvas.numChildren-1);
hero.xpos=startX;
hero.ypos=startY;
hero.gotoAndStop(2);
hero.x = (tileWidth/2)*(hero.ypos-hero.xpos)+offsetX;
hero.y=-100;
Tween.addTween(hero, {y: (tileHeight/2)*(startY+startX)+offsetY, time:.2, delay:delayTime,
onComplete:function() { canMove=true; hero.grass.visible=true; thud.play();});

```

```
        hero.grass.visible=false;
        //show exit button
        if (pilotStudy&&minTimeUp&&b_exit!=null) {
            b_exit.visible=true;
        }
    }}
#####
//Tool Tip v.3.0*****
#####
var m_hover:MovieClip;
var whoHovers:MovieClip;function startHover(e:MouseEvent) {
    //check to see if hover is already activated for the "click to start" hover box
    if (m_hover==null) {
        e.target.addEventListener(MouseEvent.ROLL_OUT, removeTip);
        e.target.addEventListener(MouseEvent.MOUSE_MOVE,moveTip);
        hover(e.target);
    }
}
function hover(tmp_name:MovieClip) {
    whoHovers=tmp_name;
    hoverTxt = new TextField();
    hoverTxt.mouseEnabled=false;
    hoverTxt.selectable=false;
    hoverTxt.defaultTextFormat=new TextFormat(new Libraryfont().fontName, 18,0x000000);
    hoverTxt.antiAliasType=AntiAliasType.ADVANCED;
    hoverTxt.width=200;
    hoverTxt.autoSize=TextFieldAutoSize.LEFT;
    hoverTxt.wordWrap=true;
    hoverTxt.embedFonts=true;
    hoverTxt.multiline=true;
    hoverTxt.text=tmp_name.h_txt;
    //
    m_hover = new MovieClip();
    addChild(m_hover);
    m_hover.visible=false;
    m_hover.mouseEnabled=false;
    m_hover.graphics.beginFill(0xFFFFCD,.9);
    m_hover.graphics.drawRect(0, 0, 200, hoverTxt.height);
    m_hover.graphics.endFill();
    //(distance:Number = 4.0,
    //angle:Number = 45,
    //color:uint = 0,
    //alpha:Number = 1.0,
    //blurX:Number = 4.0,
    //blurY:Number = 4.0,
```

```

//strength:Number = 1.0,
//quality:int = 1,
//inner:Boolean = false,
//knockout:Boolean = false,
//hideObject:Boolean = false)
m_hover.filters=[new DropShadowFilter(5,45,0x000000,.7,3,3,1,3)];
//
m_hover.addChild(hoverTxt);
}function moveTip(e:MouseEvent) {
    if (stage.mouseX>stageWidth-300) {
        m_hover.x=stage.mouseX-m_hover.width-15;
    } else {
        m_hover.x=stage.mouseX+15;
    }
    if (stage.mouseY<stageHeight-m_hover.height-300) {
        m_hover.y=stage.mouseY+15;
    } else {
        m_hover.y=stage.mouseY-m_hover.height-15;
    }
    m_hover.visible=true;
}function removeTip(e:MouseEvent) {
    deleteHover(e.target);
}function deleteHover(tmp_name) {
    if (m_hover!=null) {
        tmp_name.removeEventListener(MouseEvent.MOUSE_MOVE, moveTip);
        tmp_name.removeEventListener(MouseEvent.ROLL_OUT, removeTip);
        removeChild(m_hover);
        m_hover=null;
        whoHovers=null;
    }
}
#####
//*****GAME CLOCK*****
#####
var b_checkClock;
var b_exit;
//total gameplay time
var playTime:int;
//game clock
var gameClock:MovieClip;
//store when user checked on timer
var whenClick:Array=new Array ;
var playTimer:Timer=new Timer(1000);
//init timer to show gamedclock for specified amount of time
var slideTimer:Timer=new Timer(2000,1);
//stage screen timer
var stageTimer:Timer=new Timer(5000,1);

```

```

//used to determine if gameclock should show that minimum time is up
var minTimeUp:Boolean=false;
function startClock() {
    addChild(b_checkClock=new b_checkTime );
    b_checkClock.x=28;
    b_checkClock.y=648;
    //game clock button
    b_checkClock.addEventListener(MouseEvent.CLICK,slideGameClock,false,0,false);
    if (pilotStudy) {
        b_checkClock.visible=false;
    } //game clock
    addChild(gameClock=new m_gameClock );
    //show time is not up to start with
    gameClock.gotoAndStop(1);
    gameClock.b_exitGame.visible=gameClock.b_keepPlaying.visible=false;
    gameClock.x= (-gameClock.width);
    gameClock.y=580; //start the timer
    playTimer.start();
    clockTimer();}function clockTimer():void {
    var GC_minTime:Number;
    if (pilotStudy) {
        //minimum pilot time is 20 minutes
        GC_minTime=20;
    } else if (uid=="XX ") {
        //minimum developer time is 30 seconds
        GC_minTime=.5;
    } else {
        //minimum time is 10 minutes
        GC_minTime=12;
    }
    trace("min time= "+GC_minTime);
    var changeClockTimer:Timer=new Timer(GC_minTime*60000,1);
    changeClockTimer.addEventListener(TimerEvent.TIMER,changeClock);
    changeClockTimer.start();    function changeClock(evt:TimerEvent):void {
        minTimeUp=true;
        trace("MINIMUM TIME HAS BEEN MET!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!");
        Tweener.removeTweens(gameClock);
        slideTimer.reset();
        if (pilotStudy) {
            gameClock.gotoAndStop(3);
            //dont show game clock if user is rating level..it will be very confusing otherwise
            if (rateScreen==null) {
                showExit();
            } else {
                //when rate screen is completed - then show game clock

```

```

        showExitAfterRate=true;
    }
} else {
    gameClock.gotoAndStop(2);
    slideGameClock_f();
}
gameClock.b_exitGame.visible=gameClock.b_keepPlaying.visible=true;
gameClock.b_exitGame.addEventListener(MouseEvent.CLICK,f_exitGame,false,0,false);
gameClock.b_keepPlaying.addEventListener(MouseEvent.CLICK,f_keepPlaying,false,0,false);
changeClockTimer.stop();
}
}
function showExit() {
    addChild(b_exit=new b_exitButton );
    b_exit.x=28;
    b_exit.y=648;
    //game clock button
    b_exit.addEventListener(MouseEvent.CLICK,exit_f,false,0,false);
    setChildIndex(gameClock,numChildren-1);
    slideGameClock_f();
}function exit_f(evt:MouseEvent) {
    setChildIndex(gameClock,numChildren-1);
    Tweeners.addTween(gameClock, [x: 0, time:1, onComplete:tweenFinish_gameClock });
}function f_exitGame(evt:MouseEvent) {
    if (pilotStudy) {
        pilotEnded=true;
        //don't make them rate the level if they havent really tried it
        if (moves<3) {
            removeGame();
        } else {
            timeUp(null);
            rateLevel();
        }
    } else {
        removeGame();
    }
}function f_keepPlaying(evt:MouseEvent) {
    timeUp(null);
}function slideGameClock(evt:MouseEvent) {
    //store this click
    whenClick.push(playTimer.currentCount);
    //stores game clock clicks per level
    clockClick_level++;
    //
    slideGameClock_f();
}

```

```

}function slideGameClock_f() {
    clockOn=true;
    //make sure clock stays on top of all objects
    setChildIndex(gameClock,numChildren-1);
    Tweeners.addTween(gameClock, [x: 0, time:1, onComplete:tweenFinish_gameClock });
    trace("num of clicks = "+whenClick.length+" times = "+whenClick);
}
function tweenFinish_gameClock() {
    if (! minTimeUp) {
        slideTimer.addEventListener(TimerEvent.TIMER,timeUp);
        slideTimer.start();
    }
}
function timeUp(evt:TimerEvent):void {
    clockOn=false;
    slideTimer.reset();
    Tweeners.addTween(gameClock, [x: - gameClock.width, time:1 });
}
continue_b.addEventListener(MouseEvent.CLICK, startQuestions);
continue_b.addEventListener(MouseEvent.CLICK, startRollOver);
continue_b.addEventListener(MouseEvent.CLICK, startRollOut);
continue_b.buttonMode=true;
star_mc.visible=false;
function startQuestions(e:MouseEvent) {
    if (pilotStudy) {
        gotoAndStop("page_questions");
    } else {
        nextFrame();
    }
}
//TEXT
if (won) {
    star_mc.visible=true;
    bigTxt.htmlText="Congratulations!";
    bodyTxt.htmlText="You are a super-star!<BR><BR>You completed all "+maxLevels+" levels!!!";
} else {
    bigTxt.htmlText="Nice Try.";
    bodyTxt.htmlText="Ahh, too bad, you didn't complete all of the levels.<BR><BR> Maybe next time!";
}
continueTxt.htmlText="Click on the continue button to answer a few questions. It shouldn't take long.<BR><BR>Once you
have completed the questions you will be given a completion code. You must send that code to the experimenter for
credit.";
//
initTLX();

#####

```

```

//*****TLX*****
#####

//stores the final workload score in same order as the answer arrays
var scaleAnswers:Array=new Array();
var workLoad:Array=new Array();
var workLoadWeighted:Array=new Array();
var workLoadScore:Number=0;
//if pair = true, then people have to answer the 15 pairings,
//otherwise they go straight to the scale answers
var pair:Boolean=false;
function initTLX() {
    //instructions
    var instructions:MovieClip;
    //-----
    //-----TILES-----
    //-----
    var tileContainerRay:Array = new Array();
    var tlxTile:MovieClip;
    var i:int;
    var numTiles:int=0;
    var orderRay:Array=new Array();
    //store answers
    var tileAnswers:Array=new Array();
    //this is the starting arrangement of the tiles
    //they directly correspond to the frame number that each tile is on.
    //the display order will be randomized
    var tileRay:Array=[[1,2],[2,4],[1,5],[0,4],[4,1],[4,3],[5,4],[3,0],[2,0],[0,1],[3,2],[5,0],[2,5],[3,5],[1,3]];
    //this will store the weights of the tallied-up tiles
    //the order of this array directly corresponds to the order that the scale items are shown
    //0 = mental demand
    //1 = physical demand
    //2 = temporal demand
    //3 = performance
    //4 = effort
    //5 = frustration
    var tileWeights:Array=new Array(0,0,0,0,0,0);
    //-----
    //-----SCALE-----
    //-----
    var ratingSheetRay:Array = new Array();
    var tickRay:Array=new Array();
    var ratingSheet:MovieClip;
    //-----
    //-----WEIGHTS-----

```

```

//-----
//the following are instantiated at the top
/*
        //stores the final workload score in same order as the answer arrays
        var scaleAnswers:Array=new Array();
        var workLoad:Array=new Array();
        var workLoadWeighted:Array=new Array();
        var workLoadScore:Number=0;
        */
        initInstructions();
//*****
//*****INSTRUCTIONS FUNCTIONS*****
//*****
function initInstructions() {
    addChild(instructions = new tx_instructions);
    if (! pair) {
        //instructions without the pairings
        instructions.gotoAndStop(2);
    }
    instructions.x=stage.stageWidth/2;
    instructions.y=stage.stageHeight/2;
    instructions.b_start.addEventListener(MouseEvent.CLICK,startTLX,false,0,false);
    function startTLX(evt:MouseEvent) {
        removeChild(evt.target.parent);
        if (pair) {
            initTiles();
        } else {
            initScale();
        }
    }
}
//*****
//*****TILES FUNCTIONS*****
//*****
function initTiles() {
    //get random order
    randomDisplay(tileRay.length);
    trace(orderRay);
    //
    var tileContainer:MovieClip=new MovieClip ;
    addChild(tileContainer);
    tileContainerRay[0]=tileContainer;
    for (i=0; i<15; i++) {
        tileContainerRay[0].addChild(txTile = new tx_tile);
        txTile.gotoAndStop(orderRay[i]+1);
        txTile.y=stage.stageHeight/2;
        txTile.x=(stage.stageWidth/2)+(txTile.width*i) + (i*(txTile.width/2)+(120*i)+120);
    }
}

```

```

        txTile.b_submit.addEventListener(MouseEvent.CLICK,submitTile,false,0,false);
        //radio buttons
        //store which workload sources on on the tile
        txTile.r0.num=tileRay[orderRay[i]][0];
        txTile.r1.num=tileRay[orderRay[i]][1];
        //store which tile it is
        txTile.whichTile=orderRay[i];
        txTile.r0.addEventListener(MouseEvent.CLICK,radioClick,false,0,false);
        txTile.r1.addEventListener(MouseEvent.CLICK,radioClick,false,0,false);
        txTile.r0.buttonMode=txTile.r1.buttonMode=true;
    }
    //submit button
    function submitTile(evt:MouseEvent) {
        if (tileAnswers[evt.target.parent.whichTile]!=null) {
            var tileWidth:int=evt.target.parent.width+evt.target.parent.width/2;
            if (numTiles<14) {
                //slide in next tile
                Tweener.addTween(tileContainerRay[0], [x: tileContainerRay[0].x-tileWidth-
120, time:1]);

                numTiles++;
            } else {
                removeChild(tileContainerRay[0]);
                tileContainerRay[0]=null;
                tallyTiles();
                initScale();
            }
        }
    }
    //tile radio buttons
    function radioClick(evt:MouseEvent) {
        //first make them both go back to frame 1 (reset)
        evt.target.parent["r"+0].gotoAndStop(1);
        evt.target.parent["r"+1].gotoAndStop(1);
        //now show selected radio
        evt.target.gotoAndStop(2);
        //now store answer
        tileAnswers[evt.target.parent.whichTile]=evt.target.num;
        trace(tileAnswers);
    }
    //this tallies up the total weights and stores them in a new array
    function tallyTiles() {
        for (i=0; i<tileAnswers.length; i++) {
            tileWeights[tileAnswers[i]]+=1;
        }
        trace("tile weights = "+tileWeights);
    }
    //this is used to create an array of unique random numbers
    //it is used to display the tiles randomly
    function randomDisplay(total:int) {

```

```

var tmpRandom:Array=new Array ;
while (orderRay.length<total) {
    var tmp:int=Math.floor(Math.random()*total);
    if (! tmpRandom[tmp]) {
        tmpRandom[tmp]=true;
        orderRay.push(tmp);  }}}
//this functions rounds to the nearest nth decimal place
function roundNumber(num:Number,decimal:int) {
    return (Math.round(Math.pow(10, decimal) * num) / Math.pow(10, decimal));}
//*****
//*****SCALE FUNCTIONS*****
//*****

function initScale() {
    addChild(ratingSheet = new tlx_ratingSheet);
    ratingSheet[0]=ratingSheet;
    for (i=0; i<6; i++) {
        ratingSheet[0][i]scale"+i].num=i;

ratingSheet[0][i]scale"+i].addEventListener(MouseEvent.CLICK,scaleClick,false,0,false);
        ratingSheet[0][i]scale"+i].buttonMode=true;  }
    ratingSheet[0].b_submit.addEventListener(MouseEvent.CLICK,submitScale,false,0,false);  }
function scaleClick(evt:MouseEvent) {
    if (tickRay[evt.target.num]!=undefined) {
        tickRay[evt.target.num].x=ratingSheet[0].mouseX;
        tickRay[evt.target.num].y=evt.target.y+10;
    } else {
        var scaleTick:MovieClip;
        ratingSheet[0].addChild(scaleTick=new tlx_tick);
        tickRay[evt.target.num]=scaleTick;
        scaleTick.x=ratingSheet[0].mouseX;
        scaleTick.y=evt.target.y+10;}
//According to the TLX instructions - the selection number needs to be rounded to the
//nearest 5 *to the right* of where the user made their selection.
var tmpNum:Number=Math.round((evt.target.mouseX/evt.target.width)*100);
//trace("tmp number = "+tmpNum);
var tmpDigit:Number=Number(tmpNum.toString().charAt(tmpNum.toString().length-1));
//trace("tmp digit = "+tmpDigit);
if (tmpDigit>=0&&tmpDigit<5) {
    tmpNum-=tmpDigit;
    tmpNum+=5;
} else if (tmpDigit >5 && tmpDigit<=9) {
    tmpNum +=(10-tmpDigit);}
//trace("tmp number final = "+tmpNum);
//store answers in array
scaleAnswers[evt.target.num]=tmpNum;

```

```

        //trace(scaleAnswers)}
        function submitScale(evt:MouseEvent) {
        var allAnswered:Boolean=true;
        workLoadScore=0;
        if (scaleAnswers.length==6) {
            for (i=0; i<6; i++) {
                if (scaleAnswers[i]==undefined) {
                    allAnswered=false;}
                if (pair) {
                    workLoadScore+= (tileWeights[i]*scaleAnswers[i])/15;
                    //round numbers
                    workLoadWeighted[i] = roundNumber((tileWeights[i]*scaleAnswers[i])/15,
6);

                workLoad[i]=roundNumber(workLoadWeighted[i]/scaleAnswers[i],6);
                } else {
                    workLoadScore+=scaleAnswers[i]/6;
                    workLoadWeighted[i]=roundNumber(scaleAnswers[i]/6,6);

                workLoad[i]=roundNumber(workLoadWeighted[i]/scaleAnswers[i],6);
                }}
            if (allAnswered) {
                removeChild(ratingSheet);
                gotoAndStop("page_questions");
                trace("Scale answers = "+scaleAnswers);
                trace("Workloads = "+workLoad);
                trace("Weighted workloads = "+workLoadWeighted);
                trace("Overall workload score = "+ workLoadScore);
            }
        }}}
initQuestions();
#####
//*****QUESTIONNAIRE*****
#####//stores the questionnaire answers
var qAnswers:Array=new Array();
function initQuestions() {      var i:int;
    var qCon:MovieClip;
    var tileNum:int=0;
    //squares
    var square:MovieClip;
    var squareCon:MovieClip;
    var squareConRay:Array=new Array();
    initTiles(); function initTiles() {      addChild(qCon = new question_tile);
        qCon.which=tileNum;
        qCon.gotoAndStop(tileNum+1);
        qCon.y=stage.stageHeight/2;

```

```

qCon.x=stage.stageWidth+qCon.width/2;          f_tween_questions(false);
if (squareCon==null) {
    addSquare();
} } function qButtons() {
qCon.b_submit.addEventListener(MouseEvent.CLICK,submitQuestion,false,0,false);
var d:int=0;          if (qCon.txt!=null) {
    qCon.txt.text="";
}          while (qCon["rad"+d]!=null) {
qCon["rad"+d].addEventListener(MouseEvent.CLICK,qClick,false,0,false);
qCon["rad"+d].buttonMode=true;
qCon["rad"+d].num=d;
d++;}
function qClick(evt:MouseEvent) {
for (var i=0; i<d; i++) {
    //first make them both go back to frame 1 (reset)
    qCon["rad"+i].gotoAndStop(1);}
//now show selected radio
evt.target.gotoAndStop(2);
evt.target.parent.ans=evt.target.num;
//trace(evt.target.num);}}
function addSquare() {
addChild(squareCon = new MovieClip);
for (var i=0; i<qCon.totalFrames; i++) {
    squareCon.addChild(square = new questions_where);
    squareConRay[i]=square;
    square.y=10;
    square.x=((square.width+10)*i)+10;
    trace(square.x, square.width);
} }
//submit button
function submitQuestion(evt:MouseEvent) {          if (evt.target.parent.txt!=null) {
    if (evt.target.parent.txt.text!="") {
        //remove commas
        var tmpTxt:String;
        tmpTxt=evt.target.parent.txt.text.split(",").join("-");
        tmpTxt=tmpTxt.split("***").join("STAR");
        tmpTxt=tmpTxt.split("SELECT").join("HEY:select");
        tmpTxt=tmpTxt.split("DROP").join("Hey:drop");

        evt.target.parent.ans=tmpTxt;}}

if (evt.target.parent.ans!=undefined) {
    qAnswers[evt.target.parent.which]=evt.target.parent.ans;
//init next tile buttons

```

```

        if (qCon.currentFrame!=qCon.totalFrames) {
            f_tween_questions(true);
            tileNum++;
            squareConRay[tileNum-1].gotoAndStop(2);
        } else {
            removeChild(qCon);
            qCon=null;
            removeChild(squareCon);
            squareCon=null;
            gotoAndStop("page_sendData"); }}

        trace("qAnswers = "+qAnswers);
    }
    function killQuestion() {
        removeChild(qCon);
        qCon=null;
        initTiles();
    }
    function f_tween_questions(kill:Boolean) {
        var questionWidth:int=qCon.width+qCon.width/2;
        if (kill) {
            //Tweener.addTween(qCon, [x: qCon.x-questionWidth, time:.25,
onComplete:killQuestion});
            Tweener.addTween(qCon, {alpha: 0, time:.2, onComplete:killQuestion});
        } else {
            Tweener.addTween(qCon, [x: qCon.x-questionWidth, time:.5, onComplete:qButtons});
        }
    }
}
page_finalData();
#####
//*****SEND FINAL DATA*****
#####
function page_finalData() {    sendFinalData();
    b_sendAgain.addEventListener(MouseEvent.CLICK,sendFinalData,false,0,false);
    b_sendAgain.visible=false;
    function sendFinalData():void {
        b_sendAgain.visible=false;
        dbAlert.txt.htmlText="Sending Data...";
        dbAlert.txt2.htmlText="Please Wait. If a connection cannot be established, please copy ALL of the
text below and send it to exp@playgraph.com";
        var request:URLRequest=new URLRequest("URL ");
        request.method=URLRequestMethod.POST;
        var variables:URLVariables = new URLVariables();
        variables.uid=uid;
        variables.condition=condition;
        variables.playTime=playTime;
        variables.totalTime=playTimer.currentCount;
        variables.levels=levelsComplete;
    }
}

```

```

variables.levelsAttempted=level;
won?variables.won=1:variables.won=0;
variables.moves=movesRay.toString();
if (pilotStudy) {
    variables.GC_times="n/a";
    variables.GC_whenClick="n/a";
    variables.TLX_scaleAnswers="n/a";
    variables.TLX_workLoad="n/a";
    variables.TLX_workLoadWeighted="n/a";
    variables.TLX_workLoadScore="n/a";
} else {
    variables.GC_times=whenClick.length;
    variables.GC_whenClick=whenClick.toString();
    variables.TLX_scaleAnswers=scaleAnswers.toString();
    variables.TLX_workLoad=workLoad.toString();
    variables.TLX_workLoadWeighted=workLoadWeighted.toString();
    variables.TLX_workLoadScore=workLoadScore;}
variables.questions=qAnswers.toString();
trace(variables);
request.data=variables;
sendDataTxt.text=variables.toString();
var loader:URLLoader=new URLLoader(request);
loader.addEventListener(Event.COMPLETE, onComplete);
loader.addEventListener(IOErrorEvent.IO_ERROR, onIOError);
loader.dataFormat=URLLoaderDataFormat.VARIABLES;
loader.load(request);
function onComplete(event:Event):void {
    if (event.target.data.sent=="success") {
        sendDataTxt.text="";
        dbAlert.circleLoader.visible=false;
        dbAlert.txt.htmlText="Thank you very much!";
        dbAlert.txt2.htmlText="Your experiment completion code is: 'PG-PT4-
"+uid.substr(0,10)+"<BR><BR>mTurk Users: Please copy the completion code above and enter it into the field located in
the HIT – you will then be approved shortly.<BR><BR>You may now close your browser.";
    } else {
        dbAlert.circleLoader.gotoAndStop("sadFace");
        dbAlert.txt.htmlText="Failed: Data Not Sent";
        dbAlert.txt2.htmlText="Please Click the 'Send Again' button to try again. If
the data still cannot be sent - copy ALL of the text below and send it exp@playgraph.com.";
        b_sendAgain.visible=true;}}
function onIOError(event:IOErrorEvent):void {
    trace("Error loading URL.");}}

```

Appendix H: Block Walk Game

Game Rules

Block Walk

Level: Moves:

Goal: To complete each level, move the block so that it is standing up over the goal.

Game Elements: Mouse over each element to learn more about them. Also, during game play, you can mouse over the block and goal elements to be reminded about what they do.

Controls: Use your keyboard's arrow keys to move the block up, down, left, and right. The image at right shows the direction that each key will move the block.

Levels: There are 24 levels, try to complete each one in as few moves as possible.

Start Game

Easy Level Setting



Difficult Level Setting



Difficult Level Setting with Block Lying on its Side

