EFFICACY OF REWARD ALLOTMENT ON CHILDREN’S MOTIVATION AND LEARNING: TOWARD A POTENTIAL MEANS OF DEVELOPING 21ST CENTURY KNOWLEDGE BUILDING SKILLS

by

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A thesis submitted in conformity with the requirements for the degree of Master of Arts

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Abstract
The present study assesses the effects of reward allotment for a highly motivating game through the examination of students’ variations in response to different schedules of reinforcement. Fifty-four Chinese children from preschool to grade three participated by playing a number-matching game on Sifteo cubes. Two types of reward allotment—a 25%-chance-of-winning reinforcement schedule, and an escalating 25-75% reinforcement schedule—were examined in the number-matching game. Overall, the results proved that both reinforcement schedules effectively sustained children’s motivation in playing the game. In this experimental study I hypothesized that if the findings could be replicated in an extremely simple game that does not have the manifold array of additional motivators found in commercial successful video games, we could have a powerful motivating element to be used in educational games, given that digital games are potentially beneficial in helping students to develop 21st-century skills such as collaborative and problem-solving skills.
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Chapter One: Introduction

The purpose of this study is to explore how a reinforce schedule sustains children’s motivation in a game context. The present study assessed the effects of reward allotment for a highly motivating game through the examination of students’ variations in response to different schedules of reinforcement. Fifty-four Chinese children from preschool to grade three were recruited to play a number-matching game on Sifteo cubes. Two types of reward allotment—25% only, and the escalating 25-75% reward reinforcement—were examined in this number-matching game. Overall, this experimental study proved that both the 20%-chance-of-winning reinforcement schedule and the 25-75% reinforcement schedule effectively sustained children’s motivation in the number-matching game-play on Sifteos. However, children present a higher level of engagement in the gameplay when the reward frequency changed from 25% to 75%.

Given that motivation plays a central role in determining how we select and persist in processing information, the present study speculates how the use of extrinsic motivation engages students in 21st century knowledge building. Bereiter and Scardamalia (1993) indicated that knowledge building involves the mastery of expert problem solving skills, and it begins with participation in the collaborative process of sharing and distributing expertise. To us, pursuing new ideas in order to push boundaries or to increase one’s expertise may itself be a motivational process. Thus, we need to look for the critical extrinsic factors built into the knowledge building environment and to explore how we appropriate the use of extrinsic motivation in the development of 21st century skills.
A Brief Overview of the Studies of Motivation

Motivation, rooted in human nature, is broadly defined as the drive acting on or within a person that causes the arousal, direction and persistence of goal-directed effort (Houston, 1985). It is considered one of the most important areas of study in organizational science and psychology (Barnet & Simmering, 2006). Prior to 1970, the study of motivation was heavily guided by Skinnerian behavioristic principles; hundreds of studies under this theoretic framework have established that extrinsic rewards enhance performance and increase motivation (Deci, Koestner & Ryan, 1999; Pierce, Cameron, Banko & So, 2003). As a result, this has led to the widespread advocacy of rewards as a motivational strategy used in a variety of applied settings since that time (Lepper, Henderlong & Gingras, 1999; Lepper & Henderlong, 2000). In 1971, a group of social and educational psychologists including Deci, Ryan, Lepper, Greene, Eisenberger, Pierce and Cameron started to investigate the relationship between extrinsic and intrinsic motivation (Deci, 1972; Eisenberger, Pierce & Cameron, 1999; Deci, et. al., 1999, 2001; Pierce, et. al., 2003) Among them, Deci initiated three experiments to examine the effects of the externally mediated rewards on intrinsic motivation. Also, researchers from other laboratories (e.g., Lepper, Greene & Nisbett, 1973) have worked independently to examine the effects of the rewards on intrinsic motivation (Deci, et. al., 1999; Lepper, et. al., 1999).

However, given that motivation is a highly complex construct in nature, together with the diverse backgrounds and aims of its’ researchers (e.g., motivational, attributional and behavior theorists), there has been to date, no single agreement reached with regard to the theory of motivation, rather, there has been a longstanding debate regarding the “undermining effect of extrinsic reward on intrinsic motivation (Houston, 1985; Lepper, et. al., 1999; Wiechman & Gurland, 2009; Mayer, 2003, as cited in Huang, 2011).
Nevertheless, along with developing the intrinsic motivation literature, a few predominant motivation concepts such as self-determination theory (SDT) and cognitive evaluation theory (CET) have also been developed by Deci and Ryan to examine the nature/orientation of motivation, and to differentiate reward contingencies (Ryan, Mims, & Koestner, 1983; as cited in Deci, Koestner & Ryan, 1999). SDT covers human behaviors, and CET explains the intrinsic side of human behavior; humans have three basic innate psychological needs (autonomy, feeling of control, relatedness) as well as a need to feel competent in their interactions with their environment (Schunk, Pintrich & Meece, 2008).

Additionally, an array of studies was conducted to explore the effects of various rewards and other external events onto intrinsic motivation. For example, Eisenberger, Pierce and Cameron (1999) conducted a meta-analysis together with two additional meta-analytic reviews to demonstrate that, rewards, under certain conditions, appear to enhance people's motivation and performance. Specifically, they greatly narrowed their focus to the effect of performance-contingent rewards, indicating that explicit performance standards (e.g., beating 85% of the other participants) tend to increase intrinsic motivation (Deci, et. al., 1999).

In the last two decades, we have seen a major shift from using meta-analytic procedures examining the nature of motivation to the exploration of motivational process and outcomes in a gaming context (Pierce, et. al., 2003; Cameron, Pierce, Banko & Gear, 2005; Ryan & Deci, 2007; Sheldon & Filak, 2008). Building on the existing theoretical frameworks in motivation literature, communication and media may help to structure our understanding of engagement in games.
**Rationale**

In recent years, the study of motivation has gained a new impetus in the field of gaming. Studies of the motivational aspects of video games that have emerged have provided a different route to understanding motivational processes. Recent books by game designers and theorists have pointed out that the world of gaming has produced a huge amount of data illuminating how games are deeply engaging (Chatfield, 2010; Koster, 2005). In a recent TED talk presented by Tim Chatfield, the presenter described how the gaming world discovered that changing the reward frequency from 25% to 75% after 15 or 16 trials increased play time. In prior studies we have seen motivation theories (e.g., Bandura, 1977) that are concerned with outcomes and instrumentalities (i.e., with the process that directs behavior toward desired outcomes), however, we have not seen any further investigations applied to examine the structure of reward and how the change of reward structure may affect motivational process or outcomes. The questions of why certain outcomes are desired have also not been dealt with so far (Deci, Pelletier, & Ryan, 1991).

Moreover, although some analysis of the psycho-structural elements of video games tend to evaluate the relationship between multiple reinforcement and motivational outcomes, few studies, to date, have further examined the structure of reinforcement and its relation to motivational outcomes. The reason for this may be threefold. First, a stereotypical picture of the detrimental effects of extrinsic motivation has long been accepted, based on the vast majority of past research on motivation. Second, there has been a great deal of ambiguity and uncertainty in defining the nature/strength of intrinsic motivation together with the questionable measurements (i.e., self-reporting of levels of satisfaction and enjoyment) employed for evaluating intrinsic motivation, which may act as a hurdle to the evaluation of extrinsic motivation. Third, there is a
distinct lack of consensus on the understanding of the motivational process itself in a game context. It appears that the meaning of the motivational process is a tangled process, where game play triggers a repeated cycle of user judgment (e.g., fun), behavior and feedback (Garris, et. al, 2002). According to a number of theorists (e.g., Crino & White, 1982; Arnold, 1976; Huang, 2011), both “fun” and “feedback” have extrinsic motivational functions to intrinsic motivation, so it is possible that these extrinsic functions could be treated as an intrinsic reinforcement.

To address this relationship and to explore how the motivational outcomes might look in a gaming environment, a simple, straightforward yet highly motivating number-matching game on Sifteo cubes was developed in an attempt to examine players’ responses in two reinforcement conditions. This game consisted of a 25% only reinforcement schedule and a 25-75% reinforcement schedule (increasing from 25% to 75% after 16 trials). It was based on behavioristic principles (i.e., Skinner’s reinforcement theory), suggesting operant variability, for example, that frequency and response rates tend to differ when reinforcement fluctuates (Wagner & Neuringer, 2006). As Catania (1970) indicated, “the experimental analysis of behavior emphasized rate, the spacing of events in time, as a fundamental measure of responses” (p. 2). In this number-matching game, three hypotheses were tested based on the abovementioned principles,

1. The variable reinforcement schedule would lead to a higher perception of fun.
2. The reward scheme would keep children engaging in activities all the time.
3. A change in reward allotment would influence children’s engagement in the play.
Outline of the Study

The remainder of this thesis is structured as follows. In chapter Two, there are two segments mainly—classic motivation definitions and new directions in motivation study. First, the overview of motivation orientation is introduced. It provides a baseline understanding of intrinsic motivation and extrinsic motivation together with two prominent motivation concepts (self-determination theory and cognitive evaluation theory). Second, motivation study in a gaming context is presented, which mainly emphasizes the examination of the motivational appeal of video games through the lens of the psycho-structural aspects of video games; engagement (one of the motivational pulls of video games) is especially emphasized.

In Chapter Three, the methods and results of this experimental study are reported. This includes the introduction of Sifteo cubes and the number-matching game, study design, subjects, procedure, statistical analysis and results. Chapter Four covers the discussion of these findings and their potential contribution to the literature of motivation study, especially in the area of digital gaming and 21st century knowledge building.
Chapter Two

Motivation Studies: An Overview of Classic Definitions and New Directions

What is Motivation?

In general, motivation concerns energy, direction, intensity, and persistence; however, the diversity of interests and concerns included together with methods applied in the study of motivation has made motivation a difficult term to define (Ryan & Deci, 2000; Houston, 1985). In a psychological sense, the study of motivation is “an inquiry into the why of behavior”, that is, it is to explore the energy and the direction of behavior (Deci & Ryan, 1985, p. 3). For example, in the learning context, motivation could refer to the energy to initiate, to sustain participation in the learning process and eventually to accomplish the goal. From a contemporarily cognitive perspective, motivation entails an individual’s thoughts, beliefs, and emotions (Schunk & Usher, 2012).

The very earliest motivation-related studies date back to McDougall’s instinct theory, which was later replaced by Woodworth’s drive theory (Weiner, 1972). Drives, as Woodworth state, result from “physiological disequilibria and instigate behaviors that return the organism to equilibrium” (Weiner, 1972, p. 14), that is, we are born with certain psychological needs. When needs are not met, tension occurs, and when needs are satisfied, drive is reduced and the organism returns to a state of relaxation. Drive theory is the most well-known and often cited motivational concept in the field. However, the conceptualization of motivation, according to some researchers (e.g. Weiner, Winne, Marx, Dweck and Elliott) has shifted its focus from innate drive to a cognitive orientation (Rueda & Moll, 1994). Over the decades, with the expansion of studies on explaining behaviors, the drive theory that once served as the theoretical foundation of motivation theories has failed to explain the complexities of behavior (1985). For
example, Deci (1975) thought it was not psychologically meaningful because the lack of focus on the process of motivation.

According to Ryan and Deci (2000), motivation involves both internal and external forces that trigger, direct, develop and maintain involvement in an activity. Thus, to understand motivation, it is important to examine motivation concepts that are predominant in the field.

**Intrinsic Motivation and Self-determination Theory (SDT)**

As Lepper, Corpus and Iyergar (2005) indicate, the concept of intrinsic motivation emerged “in the heyday of Skinnerian thought and research” (p. 184), which was intended to contrast to the motivation produced by the popular behavior modification programs of that era. Those programs featured a heavy reliance on more extrinsic incentives and contingencies.

Intrinsic motivation is an innate desire that seeks out novelty and change; it also exercises competence in relation to the environment (Deci, 1975; Cameron & Pierce, 1994; Ryan & Deci, 2000; Dweck & Molden, 2005). As White (1959, 1960, as cited in Lepper and Henderlong, 2000, p. 258) described, people purposefully “seek out challenges to overcome and new skills to master, simply to experience the pleasure of accomplishment itself” The abovementioned researchers defined intrinsic motivation as naturally occurring when an activity satisfies basic human needs for competence and control. In addition, one’s perception of competence could also be treated as a determinant of intrinsic motivation (Boggiano, Main & Katz, 1988). For example, if a person has a positive experience of engaging in an activity, such as playing chess, he or she is more like to voluntarily and more frequently play chess.

Apart from these two variables (feelings and perceptions of competence) intrinsic motivation can also be defined through the lens of structure. Shah and Kruglanski (2000) have proposed, for example, commitment (one aspect of intrinsic motivation) to activities for the goal
attainment represents “the purest structural form of intrinsic motivation” (p.117). At this point, we could assume that Shah and Kruglanski’s conceptual framework is parallel to Deci’s description of intrinsic motivation, that is, one is performing the activity for its own sake or as an end in itself (Shah and Kruglanski, 2000).

Further, Shah and Kruglanski suggest that a person’s perception of his or her relationship with an activity is highly individualized. This is because although the relationship with an activity is considered by some to be intrinsic, it may not actually be so, according to someone else’s definition. Moreover, a person’s choice, his or her degree of persistence and the emotional experiences can be treated as variables to measure his or her relationship with that particular activity in which he or she is engaging (Sansone & Harackiewicz, 2000).

In summary, we could conclude that Shah and Kruglanski’s conceptualization of intrinsic motivation draws heavily cognition and information processing variation, which differs from the early motivation studies that put a greater emphasis on situational manipulations.

With regard to intrinsic motivated human behavior, there are, according to Deci (1975), two types of intrinsically motivated behaviors—seeking out opportunities that allow a person to feel competent (without external reward), or managing challenges that allow the person to feel competence and self-determination. Over three decades, researchers have learned that the quality of experience and performance can be very different when one is behaving for intrinsic versus extrinsic reasons. Deci and Ryan (1985) have pointed out that the study of intrinsic motivation has led to an examination of the importance of self-determination in a wide range of human behavior and experience. As a result, they have developed the self-determination theory (SDT), which is particularly well suited to distinguish motivation based on the different reasons or goals that give rise to an action. Deci, Vallerand, Pelletier and Ryan (1991, as cited in Deci and Ryan
(1991) stated:

“Motivated actions are self-determined to the extent that they are engaged in wholly volitionally and endorsed by one’s self, whereas actions are controlled if they are compelled by some interpersonal or intrapsychic force.” (p. 326).

According to the International Encyclopedia of the Social Sciences, SDT focuses on “self-determined behavior and the conditions that promote it, as well as a set of basic and universal psychological needs, namely those for autonomy, competence, and relatedness, the fulfillment of which is considered essential to vital, healthy human functioning”. As Brown and Ryan (2004) indicated, “an individual has inherent propensities to be intrinsically motivated, to assimilate his or her social worlds, and to integrate external regulations into self-regulations” (as cited in Shroff, Vogel & Coombes, 2008, p.113). These psychological needs are viewed as fundamental and as “part of the common architecture of human nature” (Deci & Ryan, 2000, as cited in McCann, 2010, p. 252).

Autonomy, as Deci and Ryan (1985) have indicated, refers to the need to experience freedom in the chosen activities. It is said that “autonomy concerns the experience of one's actions as emanating from the self” (Deci & Ryan, 1991, as cited in McCann, 2010, p. 243). For example, if a person chooses and plays chess because he or she wants to do so, then, he or she feels autonomous.

Competence refers to the skills or abilities to control one’s environment or an ability to choose to give up control. SDT suggests that an individual’s perception of competence is an important factor supporting intrinsic motivation (Sweet, Guthrie & Ng, 1998; Vallerand & Reid 2004, as cited in Shroff, et. al., 2008). For example, people are good at math, they are more likely intrinsically motivated, and they are more willing to take challenges related to math.
Relatedness involves the development of secure and satisfying connections with others in one’s social environment (Deci et. al., 1991). It is “the sense of belonging that is derived from social relationships of trust, caring and mutual concern for one another’s social and emotional well-being” (Sweet, Guthrie & Ng, 1998, p. 211). Relatedness is facilitated and nurtured by acceptance, warmth, or caring (Ryan & Deci, 2003, as cited in McCann, 2010).

To conclude, SDT is not only a theoretical framework that can guide our exploration of one’s orientation toward motivation, but a differentiated approach to motivation. As Deci & Ryan (2000, 2012) have suggested, it’s also a framework that enables us to predict the quality of one’s behavior, the emotional experience and well-being through the lenses of that person’s experience of needs satisfaction and the quality of his or her social surroundings.

**Extrinsic Motivation and Cognitive Evaluation Theory (CET)**

Extrinsic motivation has always been characterized as either “an opposing pole” to intrinsic motivation or “one end of a continuum”, that is, “the higher the intrinsic motivation and the lower the extrinsic motivation” (Ryan & Deci, 2000; Lepper, et. al., 2005, p. 184; Schunk, et. al., 2008, p. 237). In general, extrinsic motivation refers to the engagement or the performance of an activity being directed by obtaining an external reward or to avoid punishment (Cameron & Pierce, 1994; Schunk, et. al., 2008). If an activity that contains a specific goal and it provides satisfaction rather than the actual activity itself, then, we could call the behavior in this activity an extrinsically motivated behavior.

In terms of extrinsic outcomes, they are “derived from the environment surrounding the task associated with the context of the task” (Dyer & Parker, 1975, p. 456, as cited in Crino & White, 1982, p.96). Environmental surroundings can be financial incentives, work conditions, feedback, rewards, praise, deadlines, evaluations, social recognition, competition, ego
involvements and even pressure or tension (Lepper, Henderlong & Gingras 1999; Deci & Ryan, 1985, 1996, 2001), which can be treated as a reinforcer. However, according to Morse and Kelleher (1970), an environmental event can act as a reinforcer only when there is a particular response following the event and “there is a subsequent increase in the occurrence of similar responses” (p. 139). An environmental event such as reward or feedback is a stimulus only when there appears a change in behavior. For example, a student has no prior background in developmental psychology, and he or she goes to some lectures about motivation and learning, because it is part of a required course. As the student progresses through the lectures, his or her interest is triggered and then he or she started to enjoy the course. He or she may reflect on motivational theories and try to make connections with his or her real life experience. To this end, we could assume that external factors or events such as lectures or peer interaction could have triggered the student’s interest in learning and increased his or her participation in classroom activities in a consistent fashion. Also, from a motivational point of view, the extrinsically motivated behavior has created a platform for the activation of the student’s interest, and this same interest eventually satisfies his or her inner needs for competence and mastery.

Nevertheless, one’s interpretation of the effects of environmental events (i.e. rewards) might differ from those of others, for people can experience an environmental event as a controller of their behavior, or as a choice and an opportunity for self-direction (Deci, et. al., 2001). As a result, the value of using reward to alter human behavior is still being challenged despite five decades of intensive research on motivational orientations (Eisenberger & Cameron, 1996; Banko, et. al., 2003; Marinak & Gambrell 2008).

In order to develop an in-depth understanding on the effects of extrinsic motivation, and to explore the extent to which a recipient’s interpretation of the rewards is associated with his or her
feelings of self-determination, Deci and Ryan presented the cognitive evaluation theory (CET). CET focuses on one person's cognitive evaluation of an activity and the reasons for his or her engaging in the activity (Deci, 1972; Cameron & Pierce, 1994). According to Cameron and Pierce (1994), CET is based on the assumption that people have innate needs for competence and self-determination; it also explains how both positive and negative rewards affect intrinsic motivation (Deci, Koestner & Ryan, 2001; Banko, et. al., 2003).

Within the CET framework, reward has two functions—controlling and informational. When a reward (i.e. money, bonus) is a controller, it undermines intrinsic motivation, for it is likely to thwart satisfaction of the need for autonomy; whereas rewards such as feedback, is are informational, and they can enhance intrinsic motivation by informing a person’s need for competence being met.

CET, however, has been criticized for only being focused on the administration of reward and for not being able to make distinction between reward and reinforcement. In Carmeron and Pierce’s (1994) studies, they emphasized that both reward and reinforcement cannot be used synonymously; a reinforcer is an event that increases a particular behavior, whereas a reward is a pleasant occurrence that does not necessarily strengthen behavior (Banko, et. al., 2003). For example, when a child finishes reading five books, he or she can get a box of candy bars. According to Cameron and Pierce’s statement mentioned above, a box of candy bars can only be treated as a reward and it has no effects on reinforcing the child’s next response.

**New Directions: Motivation in a Game Context**

Over the last forty years or so computer games solidified a place in the market and in popular culture. According to the Entertainment Software Association, 97% of 12-to-17 year-olds play digital games in the United States, and by the time they turn 21, they have spent 9,000
hours playing digital games, compared to 3,000 hours reading books (Peneberg, 2010). Globally, 350 million people spend a combined 3 billion hours per week playing video games (Gladwell, 2008). Video games sales have far outnumbered the combined global revenues of film box office and digital video discs (DVD). In 2012 the global sales of video games was estimated at $68.4 billion, compared to $41.9 billion in 2007 (Peneberg, 2010; Beaumont, as cited in Arnesen, 2010).

Given the commercial popularity of the digital games with young people worldwide, computer games have also captured the attention of educators and psychologists (Garris, et. al., 2002; Przybylski, et. al., 2010; Boyle, Connolly, Hainey & Boyle, 2012). In the field of education, researchers have begun to establish links between instructional strategies, motivational processes, behavior and learning outcomes. Specifically, over the last two decades we have seen a large number of studies focusing on the psycho-structural aspects of video games in an attempt to examine the motivational appeal of video games related to learning as well as physical and psychological well-being (Ryan, et. al., 2006).

Fun

To study the motivational pull of video game, many researchers have first tried to clarify why people play video games. LeBlanc (2004) has proposed an MDA (mechanics, dynamics and aesthetics) model for game design analysis and found there are eight kinds of fun (e.g., sensation, fantasy, narrative, challenge, fellowship, discovery, expression, and submission) in playing video games (as cited in Wang & Sun, 2011). In addition, Lazzaro has identified that video game could provide four types of fun such as hard fun, easy fun, people fun and serious fun (Wang & Sun, 2011; Werbach, 2012). Moreover, according to Wang and Sun’s (2011) review on video game reward systems, the authors emphasized that reward systems (i.e. scores, points, visual items,
mata-goals, choices, feedbacks, pictures and animations) could provide players with fun experiences. For example, many social games such as *War of Warcraft* have many multi-level goals for players to complete in order to master specific skills. Also, *War of Warcraft* provides high quality of motion pictures that are visually attractive to players, and they serve as stimuli to encourage players’ participation and engagement in the game.

Games are fun (Garris; 2002; Ryan, Rigby & Przybylski, 2006; Przybylski, Ryan & Rigby, 2009), and fun increases motivation (Prensky, 2002). According to Przybylski et. al., (2010), the idea of “having fun” during the game play itself satisfies people’s needs for competence, mastery and autonomy (p.216). Fun motivates people to engage themselves in activities with which they have little experience, and it enables people to take initiative and put forth an effort to whatever they are undertaking without presenting any resentment.

**Engagement**

“People play games because the process of game playing is engaging” (Prensky, 2002). Engagement is one of the aspects to explain the motivational appeal of video game. Over the past 10 years, there has been a surge in interest in examining the intensity of involvement and engagement in digital games (Bolye, et. al., 2012). The exploration of a player’s engagement in the game experience is mostly based on the existing motivation theories. For example, Malone (1981) was one of the earliest scholars to study the intrinsic aspects of motivation in games; he hypothesized that the appeal of games was largely a function of their ability to evoke challenge, fantasy, and curiosity in players (as cited in Rigby & Przybylski, 2009). On the other hand, many theorists of the field (e.g., Malone; Thornton, Cleverland, Gredler, Thomas, Macredie, Crookall, Oxford and Sauders) have identified the potential benefits of video games through the examination of game characters (i.e. interactivity, rules, goals, learner control, challenge, risk,
strategy, competition, chance etc.). They have identified both motive and subjective experience as two key components to the explanations of the appeal of digital games. Moreover, they have divided motive and subjective experience into subcategories and they are enjoyment, immersion, presence, flow and arousal (Grarris, et. al., 2002; Bolye, et. al., 2012). According to Vorderer et al., (2004) and O’Brien and Tom (2008), subjective experience is the core element to the process models of enjoyment and engagement, while others have suggested players’ motives for playing games provide an alternative perspective on understanding player engagement (as cited in Bolye, et al., 2012). However, Bolye, et al., (2012) have supported these claims based on their most recent systematic review on a variety of studies done in the past 10 years (e.g., Ryan, Rigby & Przybylski, 2006, 2009; Yee, 2006; Chou & Tsai, 2007). In addition, Bolye, et al., (2012) have suggested that treating motives and subjective experience as two separated components could enable us to better understand engagement.

Along with the aforementioned two key aspects to explain the motivational pull of video games, a number of studies have also examined the contexts and consequences of different types of engagement in a video play. Two theoretical frameworks are commonly applied in the field to describe motivation to engagement in digital games— self-determination theory (SDT) and the dualistic model of passion (DMP).

According to Wang (2008), SDT is an organismic theory of motivation that accounts for motives and psychological needs for competence, autonomy and relatedness. For example, Przybylski, Rigby and Ryan (2010) proposed a motivational model by applying SDT to evaluate the need-satisfying potential of video games to predict sustained engagement in a video gaming context. According to Ryan et al. (2006), the pull of games largely results from players’ own ability to generate three key feelings of well-being: autonomy, competence, and relatedness (as
cited in Wang & Sun, 2011). Also, in Yee’s (2006) descriptive studies together with his factor-analytic studies on motivation in a gaming context, he has identified three motives (achievement, relationships and immersion) to play video games. This is parallel to Deci and Ryan’s statement of the three basic needs—competence, autonomy and relatedness. In a gaming context competence often relates to achievement, that is, a player seeks game mastery, competitive skills, to gain power via competition with others, or to “beat” a level or outscore his/her previous scores (Yee, 2006; Skal-Gerlock, 2012). With regard to relationships, game players and social players in particular want to interact with others and to develop in-game relationships. In terms of immersion, it means that players desire to escape real life problems, engage in role-play and “be part of the story” (Yee, 2006).

With regard to the dualistic model of passion (DMP), it is “expressly concerned with the nature of passionate engagement in activities”; it is often used in gambling literature to assess the motivational process in the course of engagement (Przybylski, et al., 2009, p. 486). However, it has been a commonly applied theory to guide the exploration of a player’s engaging experience in video game play. Researchers have found that there are many similarities between gambling and video game playing, particularly with regard to the structural characteristics of both activities (King & Delfabbro, 2009). Theoretically, DMP proposes two kinds of motivational contingencies that shape the overall quality of passion: harmonious passion and obsessive passion (as cited in Przybylski, et al., 2009). As Vallerand, Salvy, Mageau, Elliot, Denis, P. L., Grouzet, and Blanchard (2007) noted that passion is thought of as a strong inclination toward an interesting and important activity. Harmonious passion for an activity means the activity is personally important, freely chosen, and it is not controlled by external rewards. In contrast, obsessive passion for an activity is experienced as compelled (Wang, 2008; Przybylski, et al.,
In terms of activity engagement, according to Wang (2008), one’s engagement is a fully absorbing and voluntary state of being; the engagement in activity is more flexible in harmonious passion. On the contrary, obsessive passion would lead to persistence in the activity even without the occurrence of positive emotions.

**New Directions in Motivation Studies**

Given the increase popularity of video games with people across various ages worldwide and the amount of hours spent playing video games, there have been a great deal of studies exploring the motivational appeal of video games. Indeed, much of the literature on video games has placed great emphasis on the exploration of game characters (e.g., reward systems) and the examination of gameplay motivation is based on players’ cognitive processing characteristics. In addition, there have been studies focusing on a game cycle which explains how game features trigger user judgment (e.g., enjoyment, interest), user behaviors (persistence on task), system feedback, and how this cycle results in recurring and self-motivated game play (Garris, et. al., 2002). However, there are few studies on how the structure of a reward system affects a player’s engaging experience in video game play. According to researchers, a variable payoff schedule in a game could result in greater persistence on the task and improve performance (Garris, et. al., 2002). To be able to identify and clarify predictors that might affect a player’s task persistence we need to raise such questions as: How and to the extent of which a change in reward schedule may affect the occurrence of responses? Would the change in reward schedule co-vary with target responses? That is, would a change in reward schedule affect a player’s engagement in the digital gameplay?

Furthermore, with the evaluation of video games into visual worlds, we need more
comprehensive motivational models to explain the motivational appeal and to expand our psychological understanding of video games. Also, we need models that can discover specific motivational qualities of games in order to enhance learning and other meaningful experiences outside the domain of entertainment.
Chapter Three: Methodology

3.1 Introducing Number-matching Game on Sifteo Cubes

Sifteo Cubes

Sifteo cubes are also called Siftables (see https://www.sifteo.com/). They are motion-aware blocks (36mm × 36mm × 10mm) with touch-sensitive screens (see Figure 1). Each Sifteo cube has sensing, graphic display and wireless communication capacity. That is to say, a cube can sense its own motion when it is being lifted, tilted shaken, pressed or placed next to another cube. Each cube also can “sense” and “communicate” wirelessly with one another or with a nearby computer (Merrill, Kalanithi, & Maes, 2007; Hunter & Merrill, 2010, Roark, 2012). According to Merrill (2007, 2010), one of the designers of Sifteo cubes from MIT Media Laboratory at Cambridge, “the design of Siftables was inspired by observing the skills that humans have at sifting, sorting and manipulating large numbers of small physical objects” (p. 75).

Sifteo cubes are aimed mainly at children (Barbara, 2011). With the tactile nature of Sifteo cubes, they create a gaming experience that can enhance children’s engagement with digital content by merging physical and digital representations in an interactive environment.

Given that Sifteo cubes are highly tactile and they provide a platform for building interactive games, a number-matching game was developed and programmed on these cubes to test children’s motivation in the gameplay (see Figure 2). In order to test children’s motivational experiences playing with Sifteo cubes, two variable ratio reinforcement schedules were embedded in the number-matching game to examine the variation in their responses to different reinforcement schedules.
Figure 1. Sifteo cubes. Each cube (36mm × 36mm × 10mm) can sense its own motion when it is being lifted, tilted shaken, pressed or placed next to another cube. (Photo taken by the researcher)
**Number-matching Game**

The *number-matching* game is a simple yet motivating video game using *Sifteo* cubes. It was programmed based on B. F. Skinner’s reinforcement theory, in order to test children’s responses to different reinforcement schedules. The purpose of this study was to explore how a reinforcement schedule sustains children’s motivation in a game context.

According to Catania (1970), a reinforcement schedule is the precise rule that is used to present reinforcers following a specified type of operant behavior. The rule is defined by the time or the number of responses required presenting a reinforcer. There are two reinforcement schedules in the *number-matching* game: a 25% chance of getting reinforced from having a winning condition and an escalating 25-75% chance of having a winning condition. Each reinforcement schedule was tested separately by randomly chosen participants.

Both the 25% and the 25-75% reinforcement schedules are fixed ratio schedules. The fixed ratio schedule requires a certain number of operant responses to produce the next reinforcer. For example: in the *number-matching* game, the 25% reinforcement schedule means that children can get reinforced after 4 responses. The escalating 25-75% reinforcement schedule followed the idea that the required number of responses may be fixed from one reinforcer to the next.

A total of six *Sifteo* cubes were used in the *number-matching* game, among which there was a master cube to direct a player’s decisions to start or stop the game. A player could also use the master cube to choose a reinforcement schedule. The rest of five cubes were assigned to five Arabic numbers (1, 2, 3, 4, and 5), and each cube could only display one number at a time. In the *number-matching* game, each cube would display a randomly chosen number, and two of the five cubes were programmed to display the same number. Once a game trial was finished, the numbers would automatically be shuffled and randomly re-assigned to the five cubes.
The Number-matching Game-play Procedure

Given the objective of the number-matching game, the first step playing the game is to place the touch-screen of each cube (except for the master cube) on the table surface. Then the player shakes the master cube once in order to choose a reinforcement schedule. Once the reinforcement schedule is chosen, the master cube is placed on the table and with its touch screen facing up.

The second step is to press the touch screen of the master cube to start the game. When the master cube is pressed, a short piece of music starts to play indicating a match. The game player can randomly pick one of five cubes, flip it over and place it on the table with its screen facing up. The game player will keep choosing the cubes and flipping them over until he or she finds the number that matches the very first cube that has been flipped over. Once a pair of matching numbers has been found, the master cube emits a “beep” – an audio signal to indicate the game player wins the match. At the same time, a small picture of a “smiling face” appears in the lower right-hand corner of the master cube to indicate the win.

Soon after a pair of matching numbers has been found, one round ends and the game player can start another round of the trial by flipping the five cubes over and keeping the screens facing down on the table. In each round the gameplay sequence remains the same as stated above. When the player finishes playing the game, the master cube records the number of trials being played and demonstrate it at the center of its screen (see figure 3).

The number of trials is unlimited, and it is determined by a player’s interest or motivation in the gameplay.
The Sifteo SDK has a tool-chain and C++ framework for creating applications for Sifteo Cubes. In this study, Sifteo software development kit (SDK) is used to develop the number-matching game on Sifteo cubes.

Figure 2. Sifteo software development kit (SDK). The Sifteo SDK has a tool-chain and C++ framework for creating applications for Sifteo Cubes. In this study, Sifteo software development kit (SDK) is used to develop the number-matching game on Sifteo cubes.

Figure 3. Sifteo simulator. The Number-matching game is being test on the Sifteo simulator.
3.2 Design

This study assessed the effects of reward allotment through the examination of children’s variations in response to two different reinforcement schedules in a number-matching game on Sifteo cubes. It had two testing sections. The purpose of the first section was to observe each participant’s gameplay state, and it was 10 to 20 minutes in length ($M_{\text{time}} = 10.52, SD = 7.18$). During this section, the researcher first did a brief demonstration to teach each participant how to carry out the number-matching game, and then asked the participant to start his or her gameplay. The second section involved a paper-and-pencil demographics questionnaire and a post-test questionnaire evaluating the participants’ responses to the two reinforcement schedules.

Demographics questionnaire

A paper-and-pencil demographics questionnaire requested information from the participants about the gender, date of birth, whether they played video games, what kind of video games they played and how often they played. Considering the participants were very young and not very literate, the researcher verbally administered the questionnaires and recorded the participants’ responses to each question.

Post-test questionnaire

A 5-item instrument was administrated on an individual basis to all of the participants in a quiet empty classroom immediately after his or her gameplay. Each item was presented in a five-point Likert scale (“strongly agree”, “agree”, “neutral”, “agree”, and “strongly agree”) to ask the participant to rate his or her level of enjoyment and task persistence. In order to make the rating scale compatible with the participants’ age and their level of understanding if the task they were undertaking, the researcher employed five different cartoon facial expressions to represent the
scale levels for children to choose from. In this section, the researcher also verbally administered the questionnaires and recorded the participants’ responses to each of the questions.

There were two open-ended, follow-up questions to request information related to the participants’ perceptions of the number-matching game using Sifteo cubes and his or her gameplay experience. The questions were, “what did you like the most when you played?” and “why did you think it was fun?”

In addition, there were no external rewards such as verbal praise or material rewards offered to reinforce children’s participation in the game play, apart from a “beep” audio signal indicating a win in that particular round. A participant’s engagement in play was measured based on three aspects: the number of trial a participant played, his or her judgments about whether the game was fun, and whether he or she wanted to continue to play.

3.3 Subjects

This study was carried out at a private kindergarten in Shanghai and a public primary school in Hubei Province, People’s Republic of China. A total of fifty four Chinese children (23 boys and 31 girls, $M_{\text{age}} = 6.9$ years, age range: 5-10 years) served as participants in this study (see Table 1). They were divided into two groups: a control group (10 boys and 16 girls) and an experimental group (13 boys and 15 girls). Participants in the control group were assigned to play the number-matching game using only a 25% reinforcement schedule; participants in the experimental group were assigned to play the number-matching game with an escalating 25-75% reinforcement schedule. Children were randomly assigned to either the control group or the experiment group, and they were tested individually in a quiet private room.

Given that the Siftables game requires a certain level of cognitive skill (e.g. reasoning, memorization, and concentration), age is therefore expected to influence the outcomes of the
gameplay experience. Thus, participants were divided into two groups based on their developmental stages: The early childhood stage ($M_{age} = 5.5$ years) and the middle childhood stage ($M_{age} = 7.3$ years).

In terms of game-play experience, a total of 48 children reported their weekly game-play routine: nine children played zero video games, eight children rarely played video games each week, seven children occasionally played, and another seven children played video games approximately once per week. A total of seventeen children played video games frequently; they played video games twice, three times or even more than three times per week (see Table 2).
Table 1.

**Descriptive Statistics for Categorical Variables (Gender, Developmental Stages, and Reward Conditions)**

<table>
<thead>
<tr>
<th>Gender (N = 54)</th>
<th>Developmental Stages</th>
<th>Reward conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early childhood (24 – 72 months)</td>
<td>Middle childhood (73 – 120 months)</td>
</tr>
<tr>
<td>Boy</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Girl</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>41</td>
</tr>
</tbody>
</table>

Table 2.

**Descriptive Statistics for Categorical Variables (Gender and Video Game Play Frequency)**

<table>
<thead>
<tr>
<th>Gender (N = 54)</th>
<th>None</th>
<th>Rarely</th>
<th>Occasionally</th>
<th>Usually (once per week)</th>
<th>Frequently (2, 3 or more than 3 times per week)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boy</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>Girl</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>17</td>
<td>48</td>
</tr>
</tbody>
</table>
3.4 Procedure

**Recruiting Participants**

The procedure of recruiting participants has strictly followed the University of Toronto ethical guidelines for research. Participation in this study was voluntary, anonymous and confidential. The researcher first contacted selected school principals by email with an attached informed consent letter. Once schools were recruited for participation and approval was given by the principal, the researcher contacted the parents of the participants via an informed consent letter to obtain their consent for the participation of their children. Further, verbal consent was also obtained from each participant before he or she started to play the *number-matching* game.

**Gameplay Sequence**

Firstly, participants were individually invited to a quiet room at the school at a time convenient to the administration and teachers, and in such a fashion not to compromise the confidentiality of the participants. Prior to the gameplay experiment, the researcher provided each participant with a brief, age-appropriate verbal instruction of the gameplay as well as the questions that would be asked of them in the questionnaire.

Secondly, in order to track the level of the participants’ engaging experience in the gameplay, two questions were asked while they were playing the game. These two questions were asked in a repeated manner, that is, in every 4 trails the researcher repeated the two questions to inquire about the participant’s state of being; and the questions were “Is it fun to play?” and “Would you like to continue?” Moreover, participants in the experimental group (N = 28) had their reinforcement condition changed from 25% chance of winning to 75% chance of winning after 16 trials. However, the researcher managed the shift for each participant.
Thirdly, each participant was asked to complete a short questionnaire and to answer two open—ended questions immediately after playing the game. The research recorded the answers. Finally, upon completion of the experiment and the interview, the researcher thanked each child for his or her participation.

3.5 Statistical Data Analysis

In this experimental study, four types of measurements were used in this study to analyze the data and to evaluate the three hypotheses stated in Chapter One. A computer software package, the Statistic Package for Social Study (SPSS), was used to run these measures. The measures were an independent $t$-samples test, a one-way analysis of variance (ANOVA), analysis of covariance (ANCOVA), correlations and regressions. The $t$-test answered the question of whether the average number of trials children played differed between the control group (25%) and the experimental group (25-75%). The ANCOVA was to evaluate: 1) whether there was a relationship between the reinforcement schedules and children’s motivation to play the game and, 2) the extent to which children’s motivation related to the reinforcement schedules. The two ANOVA tests were to explore whether children’s weekly video gameplay routine and their developmental stages related to their motivation revealed in the number-matching gameplay.

In addition, both correlation and regression tests were performed to further identify the relationships among different variables (i.e., age, number of game trial, time spent playing the game, and the motivation level) as well as the strength of each variable in the prediction of motivation.

In the present study, the evaluation of fun and a child’s engagement in the number-matching game was based on the number of game trials and the amount of time spent playing the
game. The assessment of a child’s motivation level was based on his or her level of enjoyment, willingness and task-persistence. Thus, the variable *MOTIVATION* is defined and computed as a composite variable (a combination of enjoyment, willingness and task-persistence). However, given that there were approximately 10 missing cells\(^1\) presented in the category of task-persistence in the SPSS data file, the composite variable *MOTIVATION* only counts 44 (54 minus 10 equals 44) cells, thus there were 44 participants involved when analyzing the relationship between motivation and reinforcement schedules.

In addition, the variable, the number of games trials, was defined by the overall trials played in the game, rather than by the number of cubes being flipped in each trial. The definition of the variable, the time spent playing the game, was also based on the overall time a child spent playing the entire game, rather than the time spent to find the matching number in each trial.

### 3.6 Results

This section is broken down into two parts reflecting the three hypotheses posted in Chapter One. First, I present the results of the measurements for the number of game trials played by children from both the control group and the experimental group. Next, I examine the strength of the relationship between the reinforcement schedules and the children’s motivation. Further, I look at the relationships between motivation and some other variables (e.g., age, developmental stages, time spent playing the game, etc.) in attempt to explore whether these variables could impact children’s motivation in the number-matching game-play on the *Sifteos*.

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\(^1\) Given that some of the participants were very young and they usually did not have access to computers, when the researcher interviewed them, they did not provide an answer to this question. Therefore, this has caused ten missing cells in this study.
Finding One

The two tailed $t$-test was performed and the analysis revealed that on average children from the experimental group ($M = 53.18$, $SD = 26.64$) played more trials than those from the control group ($M = 33.88$, $SD = 42.82$) (see Figure 5.). However, the difference was not statistically significant $t(52) = -1.97, p = .051$. The 95% confidence interval for the difference in means was large, ranging from -38.62 to .03.

The ANCOVA indicated the strength between reward schedules and motivation was significantly strong, $F(1, 41) = 13.84$, $MSE = 5.71$, $p = .00$, partial $\eta^2 = .25$. As assessed by the eta square index ($\eta^2$), the reward schedules accounted for 25% of the variant in children’s motivation in the number-matching gameplay, holding constant with their age (see Figure 6).
Figure 5. Error bars. The mean value of the number of trials for the control group (a 25% reinforcement condition) and the experimental group (a 25-75% reinforcement condition).

Figure 6. Scatterplot of motivation in the number-matching game. Graph showing the differences in motivation between the 25% reward condition and the 25-75% reward condition.
Finding Two

There were two ANOVA tests performed in this study. The first ANOVA test was to examine whether there is a relationship between the children’s video gameplay weekly routine and their motivation revealed in the number-matching gameplay (see Table 3). The second ANOVA test was to evaluate the relationship between the children’s developmental stages and their motivation in gameplay (See Table 4).

Before conducting the one-way ANOVA, the assumption of normality for the dependent variable (MOTIVATION) was checked at each level of the independent variable (Fre_Videoplay). The histogram showed the overall distribution of the frequency of the children’s weekly gameplay routine was slightly skewed (See, Figure7.). However, Levene’s test ($p > .05$) was not significant. Therefore, the assumption of homogeneity of variance was met.

The ANOVA was not statistically significant, $F(3, 34) = .53, p = .71$. There was no relationship between the motivation revealed in the number-matching gameplay and children’s weekly video gameplay routine, as assessed by $\eta^2$, with the children’s game-play weekly routine accounting for 6% of the variance of the dependent variable (MOTIVATION). The effect size, (partial $\eta^2$) is .06 and it is statistically small. We could assume that there is not a relationship between the children’s weekly video gameplay routine and their motivation revealed in playing the number-matching game.

In terms of the relationship between the children’s developmental stages and their motivation revealed in the number-matching gameplay (see Table 4.), the results from the one-way ANOVA were significant, $F(1, 42) = 8.05, p = .01$. There was a statistically significant relationship between children’s developmental stages and their motivation in the gameplay, as
assessed by $\eta^2$, with the children’s developmental stages accounting for 16% of the variance of the dependent variable (MOTIVATION). The effect size, partial $\eta^2$ is .16.

In this analysis, the assumption of normality was also checked, and the histogram suggested that each level of children’s developmental stages (see Figure 8) was skewed. Additionally, Levene’s test ($p > .05$) was not significant indicating the assumption of the homogeneity of variance was met, thus, this analysis is statistically meaningful.
### Table 3.
**Descriptive statistics for motivation and children’s gaming experience**

<table>
<thead>
<tr>
<th>Frequency of video game play weekly</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>Std Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>8</td>
<td>2.38</td>
<td>.44</td>
<td>.28</td>
</tr>
<tr>
<td>Rarely</td>
<td>6</td>
<td>2.50</td>
<td>.89</td>
<td>.32</td>
</tr>
<tr>
<td>Occasionally</td>
<td>6</td>
<td>2.75</td>
<td>.69</td>
<td>.32</td>
</tr>
<tr>
<td>Usually (once per week)</td>
<td>3</td>
<td>3.00</td>
<td>1.00</td>
<td>.46</td>
</tr>
<tr>
<td>Frequently (2,3 or more than 3 time per week)</td>
<td>16</td>
<td>2.75</td>
<td>.86</td>
<td>.20</td>
</tr>
</tbody>
</table>

### Table 4.
**Descriptive statistics for motivation and developmental stages**

<table>
<thead>
<tr>
<th>Developmental stages</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>Std Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early childhood (24-72 months)</td>
<td>12</td>
<td>2.17</td>
<td>.54</td>
<td>.20</td>
</tr>
<tr>
<td>Middle childhood (73-120 months)</td>
<td>32</td>
<td>2.84</td>
<td>.76</td>
<td>.13</td>
</tr>
</tbody>
</table>
Figure 7. The distribution of children’s motivation in the number-matching game-play is checked at each level of children’s video game experience.

Figure 8. The distribution of children’s motivation in the number-matching game-play is checked at each level of children’s developmental stages.
Finding Three

Both correlation and regression tests were performed to evaluate the relationships among age, the number of game trials, the time spent playing the game, and the motivation revealed in playing the number-matching game. In Table 5 and Table 6, the mean scores were presented cross both the control group children and the experimental group children. As can be seen in Table 5, the correlation between the number of game trials and motivation was significant, $r(44) = .61$, $p = .00$; the relationship was positive. It suggested that motivation increases, when the number of game trials increases.

The correlation between time spent playing the game and motivation was also significant, $r(44) = .49$, $p = .00$. The relationship was positive, indicating as the time spent playing the game increases, the motivation increases. In addition, the correlation between number of game trials and age was statistically significant, $r(44) = .42$, $p < .05$; as age increases, the number of game trials also increase. However, the correlation between time spent playing the game and age was not significant, $r(44) = .26$, $p > .05$. 
Table 5

Results of Analyses of Correlations between Four Variables (age, the number of game trial, time spent playing the game, and motivation)

<table>
<thead>
<tr>
<th></th>
<th>Number of game trial</th>
<th>Time spent playing the game</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>.61**</td>
<td>.49*</td>
<td>.52*</td>
</tr>
<tr>
<td>Number of game trial</td>
<td>.87*</td>
<td></td>
<td>.36*</td>
</tr>
<tr>
<td>Time spent playing the game</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05;  **p < .01; ns = not significant

Table 6

Descriptive statistics for the Three Predictors: Mean and Standard Deviation

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>2.79</td>
<td>.70</td>
</tr>
<tr>
<td>Number of game trial</td>
<td>42.59</td>
<td>31.18</td>
</tr>
<tr>
<td>Time spent playing the game</td>
<td>10.27</td>
<td>6.33</td>
</tr>
<tr>
<td>Age (months)</td>
<td>83.59</td>
<td>16.94</td>
</tr>
</tbody>
</table>

Table 7

The Bivariate Correlation of the Predictors with Motivation

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Correlation between each predictor and motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of game trial</td>
<td>.55</td>
</tr>
<tr>
<td>Time spent playing the game</td>
<td>.44</td>
</tr>
<tr>
<td>Age</td>
<td>.33</td>
</tr>
</tbody>
</table>
Finding Four

Three regressions were conducted to further investigate the extent to which the three variables (i.e. the number of game trial, the time spent playing the game and age) relate to motivation (see Table 7).

Regression with one predictor. The independent variable (number of game trials) significantly predicted the dependent variable (MOTIVATION) \( \beta = .55, t(42) = 4.28, p = .00 \), the number of game trial accounted for 30% variance in motivation; \( R^2 = .30, F(1,42) = 18.27, p < .05 \), indicating the independent variable (number of game trial) is a significant predictor of dependent variable (MOTIVATION). Further, the Pearson’s value was .55, which suggested that when the number of game trial increased, motivation increased. The 95% confidence interval for the slope, .007 to .018, it was very close to zero. However, we could say the overall strength of number of game trial is slightly related to the overall change in motivation.

Regression with two predictors. The value of \( R^2 \) has increased from .30 to .31, which suggests that the number of game trials and time spent playing the game account for 31% of the variance in motivation. As indicated in the regression with one predictor, the number of game trials accounted for 30% of the variance in motivation. Therefore, we saw approximately 1% of variance increased in motivation. To this end, we could assume that, compared to the second predictor (time spent playing the game), the number of game trials is a more significant predictor of motivation. However, the overall regression was significant, \( F(2,41) = 9.15, p = .001 \); therefore, we could conclude that the independent variable (time spent playing the game) is still a significant predictor to motivation.
**Regression with three predictors.** Age was not a statistically significant predictor to the dependent variable (MOTIVATION), $\beta = .19, t(40) = 1.34, p > .05$. The value of $R^2$ was .34, indicating these three predictors account for 34% of variance in motivation. Comparing to the two previous variables (number of game trials and time spent playing the game), $R^2 = .31$, there was a 3% increase in the variance of motivation. $F(3, 40) = 6.82, p = .001$, age predicted significant over the motivation. Further, there was a modest Pearson’s value (.33) in this regression, which suggested that motivation also increases with age.

To conclude, the overall findings from this study have suggested that both the reinforcement schedules presented were effective in motivating children in the number-matching gameplay. Children from both the control group and the experimental group demonstrated a high level of engagement in the gameplay. Further, this study has indicated that a change in reward frequency influenced the children’s engagement in the play. Children from the experimental group (the 25-75% reinforcement condition) experienced a higher level of engagement in the gameplay, compared to those from the control group (the 25% only reinforcement condition).
Chapter Four: Discussion

Summary of the Results

Overall, this experimental study proved that both the 25%-chance-of-winning reinforcement schedule and the 25-75% reinforcement schedule were effective in terms of motivating children to play the number-matching game on Sifteos. However, children present a higher level of engagement in the gameplay when the reward frequency changed from 25% to 75%. This also provided evidence that when a similar reinforcement is scheduled for each of the concurrent responses, the response receiving the higher frequency of reinforcement will increase in rate. Furthermore, the response requiring the least effort will increase in rate, and the response providing the most immediate reinforcement will increase in rate. In the experimental group, children were reinforced by the 25% chance of winning, and after 16 trials, the number-matching game was automatically changed to the 75% reinforcement schedule. Thus, children had a much higher chance of getting reinforced.

On the other hand, since the frequency of getting reinforced after one response is much higher in the 25-75% reinforcement schedule than that of in the 25% only reinforcement schedule, the intensity of children getting reinforced could become strong. Also, the efforts to make a win were becoming less demanding to the children. The overall findings of this study also replicated Garris, Ahlers and Driskell’s (2002) statement mentioned in chapter two that a variable payoff schedule in a game could result in greater persistence on the task, and could also improve performance.

In this study, both children’s age and developmental stages played a role in their motivation in playing the number-matching gameplay. As children’s age increased, they were more likely to present higher levels of motivation in the gameplay. The results from the post-test
questions could explain this finding. The following three protocol examples provide illustrations of children’s understanding as well as their interpretations of the number-matching game on Sifteos. The three children presented here were 8 years old.

**Intervener:** *What did you like the most when you played?*

**Student A:** *I really liked it. I think it is simple and easy to play the game. I also found it interesting. The number on each cube changes automatically which is something that you can’t control.*

**Student B:** *This game gave me a chance to exercise my brain muscle and my memory. I needed to remember and think about which number is which in order to win. The numbers are funny; there are only five numbers and they are easy to remember.*

**Student C:** *I liked this game. I needed to use my brain in order to find the same cubes. This game can make me smarter, because the numbers were always changing. I like to compete with myself and get more wins.*

A child’s perceptions and attitudes toward a video game have an important influence on his or her willingness and engagement in gameplay. For example, some participants treated the number-matching game as an opportunity to compete or a game that is good for his or her development in memory and intelligence, so they wanted to win as many trials as possible. As mentioned in Bolye, Main and Katz’s (2012) journal article, *Children’s Preference for Challenge: The Role of Perceived Competence and Control*, a player’s motives for playing games provide an alternative perspective on understanding his or her engagement. Thus, we could conclude that a child’s idea of competition or an opportunity of developing memory and intelligence can be treated as motives explaining his or her engagement in the number-matching game. However, we could also assume that the two reinforcement schedules may not necessarily have been the only motivators that influenced the children’s engagement in game-play.
Children’s cognitive skills may have some potential influence on children’s engagement in gameplay. Children who have a higher level of cognitive skill may have a better chance of figuring out how to win the game. Thus, they are more likely to get immediate reinforcement, and their responses are also likely to increase in rate.

According to Piaget’s definition on the stages of cognitive development (Mcdevitt & Ormrod, 2011), children start to show many forms of logic thoughts when they are 6 or 7 years old, children who are in middle childhood stage are more likely to present a higher level of logic thinks skills. This could explain why children’s developmental stages have a strong relationship with motivation.

In terms of reward functions, there were two types of rewards applied in the number-matching game in addition to the 25% and the 25-75% reward schedules, and these rewards were audio feedback and a smiling cartoon face presented on the master cube to indicate a win. These two types of rewards, based on cognitive evaluation theory (CET), could have informed a player’s need for competence being met. Therefore, it might have enhanced his or her intrinsic motivation. However, whether these rewards increase or strengthen a participant’s behavior in game-play, there needs to be a closer examination of their role in the number-matching game. According to Cameron and Pierce’s (1994) description of the distinction between rewards and reinforcement, both the audio feedback and the smiling cartoon face might just be “a pleasant occurrence” to the participants.

**Limitations**

**Issues with the Sample**

Study limitations are noted in terms of the sample. For instance, there were almost twice as many girl participants as boy participants; another issue of representativeness pertains to the
heterogeneity that existed in the children’s developmental stages. There were 32 children in the middle childhood stage, comparing to 12 children who were in their early childhood. Therefore, a more balanced simple size could increase the statistical power of the analyses performed. To minimize these concerns, future research should consider expanding and balancing the sample size to determine whether the present findings could be generalized to a larger, more diverse group of children.

**Issues with Sifteo Cubes and the Number-matching Game**

In this study, *Sifteo* cubes were used as a platform for the participants to play the *number-matching* game. Given *Sifteo* cubes are high-tech, interface devices with graphs and audio display and motion sensing, the novelty of *Sifteo* cubes could serve as a reinforcer for the participants. On the other hand, there were limitations in terms of the methods of playing the *number-matching* game. For example, a child assigned to a 25% reinforcement schedule could mean he or she is reinforced by every $n^{th}$ response, but the odds for a child to pick the right matching number are much more likely based on his or her “luck”. A child could find the matching number when he or she flipped the 2$^{nd}$ cube or the 5$^{th}$ cube. Thus, the ratio presented here is rather random. This could lead to the speculation that this randomness might have been served as an invisible variable ratio schedule to reinforce children keep flipping the cubes to get a win.

**Issues with Concerning Variables Definition**

Given that the purpose of this study was to explore how a reinforcement schedule sustains children’s motivation in a game context. Two fixed ratio reinforcement schedules were examined and compared based on the levels of children’s motivation in the gameplay. There were two major indictors to the levels of motivation: the number of game trials and the time spent playing
the game. However, the number of game trials was evaluated based on the macro-level, that is, the overall number of game trials a child played in the entire game. This also goes with the evaluation of time spent playing the game—the overall time spent playing the entire game. In the future study, the evaluations of both the number of game trials and the time spent playing the game could be based on how many cubes being flipped in each trial in order to get a win and how much time spent on each trial. This could lead to a more accurate assessment on the efficacy of reinforcement schedule on motivation.

In this study, there were two reinforcement schedules being examined: a 25% only reinforcement schedule and an escalating 25-75% reinforcement schedule. The independent t-test has indicated that children played more trials when they were assigned to an escalating 25-75% reinforcement schedule, compared to the 25% only schedule, however, the difference was not statistically significant. Could greater significance exist when the escalating 25-75% reinforcement condition is compared to a 75% only reinforcement condition?

Last but not least, this research is only a question-controlled experiment. Given the nature of ethical human statistics, there may have been other variables operating in an unknown fashion which affected the results.

According to Ducharme (2008), researchers have determined ecological and antecedent conditions as the major factors that cause behavior change, especially difficult behavior in children. Ecological factors consist of a range of psychosocial (e.g., poverty, parenting difficulties, marital conflict) and emotional variables (e.g., depression). For example, children raised in poor families often have less access to computers or digital games. Simply being hungry or lacking a warm, nutritious breakfast could correlate with difficult behavior in children in a morning class. Although the intent of this research was not to study children’s problem
behavior, given that the participants\(^2\) were from different regions with diverse social-economic backgrounds, these ecological or antecedent conditions could play a role influencing the quality of a child’s game-play on that particular day.

**Conclusion and Future Directions**

The objective of the present study was to explore how a reinforcement schedule sustains children’s motivation in a game context. The overall findings in this study proved that a reinforcement schedule resulted in greater persistence on the player’s performance. Reinforcement schedules and rewards such as feedback or social reinforcement (e.g., verbal praise) can be used as a motivational intervention tool to help academically unmotivated children to establish and maintain their persistence in learning. Despite the fact that from the 1970’s onward there is an array of controversial literature on how rewards affect intrinsic motivation, these extrinsic motivators are often regarded as positive reinforcement, and they have been frequently used to promote the likelihood of children’s success in learning. Therefore, a deeper understanding of the principles of reinforcement would lead one to expect that frequent reward would promote persistence. We especially need an in-depth understanding of how a particular extrinsic motivator mediates one’s responses and how this mediation plays a role in the activation of one’s inner needs for competence and mastery.

Motivation study in the digital game environment has provided us with a rather unique perspective to understand extrinsic and intrinsic motivation. For example, in a recent TED talk presented by Tom Chatfield, he described how the gaming world discovered that changing the

\(^2\) Shanghai is often regarded as a developed region in China; participants recruited from Shanghai generally have better economic conditions, compared to those from the second city of Wuhan.
reward frequency from 25% to 75% after 15 or 16 trials increased play time. Recent books by game designers and theorists have pointed out that the world of gaming has produced a huge amount of data that illuminated how games increase fun (Chatfield, 2010; Koster, 2005). Thus, the polarization between extrinsic motivation and intrinsic motivation in the existing motivation literature may potentially jeopardize the way how we view the relationship of extrinsic motivation to behavior change in the digital gaming world or knowledge-building forums in the 21st century.

With the emergence of sophisticated information and communications in the modern era, we are living in an environment where digital technology is pervasive. This phenomenon is transforming the way how we live and how we view learning. Educators and policy makers are very much focused on equipping students with the essential skills helping them to meet the fast-paced, ever-changing demands of modern life and work. Therefore, "21st-century skills" has become one of the most ubiquitous terms in today's education debate. The present study also speculates how the use of extrinsic motivation engages students in their development of 21st-century skills. The “21st-century skills”, as Silva (2009) referred to, are the skills that relate to how we use knowledge, rather than what knowledge we have. Specifically, these skills are expert problem-solving skills, critical thinking skills, creativity, collaboration, and complex communication.

Today's children were born into a digital world, and they are likely to bring different skills, interests and needs to the classroom. As learners of 21st century, they not only need to develop skills that are important in the traditional educational setting, but to master skills that are essential in the 21st century. In order to address these needs, one of the best approaches is to bring the best features of game-based learning into the formal classroom, helping students to
learn 21st century skills through playing multi-player epistemic games (e.g., World of Warcraft).

**Final words**

In the present study I hypothesized that if the findings could be replicated in an extremely simple game that does not have the manifold array of additional motivators found in commercially successful video games, we could have a powerfully motivating element that could be used in educational games, given that digital games are potentially beneficial in terms of helping students to develop 21st-century skills such as collaborative and problem-solving skills. In my study I wanted to see if the students would play longer and if they perceived their play as fun. The results confirmed my conjectures. This study reveals how one finding from the gaming world can be used to improve the efficacy of educational games. Given the copious amount of data the gaming world produces daily, there are undoubtedly many more design elements that will be discovered and applied to educational games. Gaming is now helping to advance our understanding of educational games well beyond the work of Thomas Malone (1980). Given the powerful motivating effects that commercial gaming has demonstrated, I believe more study of how extrinsic motivators can be used to increase student’s intrinsic perceptions of fun and the desire to learn and understand would be beneficial to both educators and eventually, their students.
References


Dear Dr. Woodruff and Ms. Zhenhua Xu,

Re: Your research protocol entitled, "The effect of reward allotment on children's learning and motivation"

ETHICS APPROVAL
Original Approval Date: May 7, 2012
Expiry Date: May 6, 2013
Continuing Review Level: 1

We are writing to advise you that the Social Sciences and Humanities Research Ethics Board (REB) has granted approval to the above-named research protocol under the REB's delegated review process. Your protocol has been approved for a period of one year and ongoing research under this protocol must be renewed prior to the expiry date.

Any changes to the approved protocol or consent materials must be reviewed and approved through the amendment process prior to its implementation. Any adverse or unanticipated events in the research should be reported to the Office of Research Ethics as soon as possible.

Please ensure that you submit an Annual Renewal Form or a Study Completion Report 15 to 30 days prior to the expiry date of your current ethics approval. Note that annual renewals for studies cannot be accepted more than 30 days prior to the date of expiry.

If your research is funded by a third party, please contact the assigned Research Funding Officer in Research Services to ensure that your funds are released.

Best wishes for the successful completion of your research.

Yours sincerely,

Margaret Schneider, Ph.D.,
C.Psych
REB Chair

Daniel Gyewu
REB Manager
APPENDIX B: LETTER OF INFORMED CONSENT FOR SCHOOL PRINCIPAL

(will be printed on institutional letterhead in Mandarin Chinese)

Dear Principal:

This letter is an invitation to participate in a study focused on how a reward reinforces children’s learning. I would like to ask your permission to invite your students to take part in this study. Please allow me to introduce myself, this study, and what your students’ involvement would entail.

My name is Zhenhua Xu, and I am an MA student at the Ontario Institute for Studies in Education (OISE) at the University of Toronto in Canada. My study is to explore how a reward reinforces children’s engagement in gameplay, and to examine whether a reward sustains children’s motivation in learning activities. This study will be carried out under the supervision of Professor Earl Woodruff, Department of Human Development and Applied Psychology (HDAP). The data will be collected for my MA thesis.

I will invite child participants to play a concentration game on five Siftables. Siftables are electronic cubes that display either numbers or pictures (see the pictures below). The goal of the concentration game is to find a matching pair. In the game, five Siftables are faced down on a surface; a participant will flip one Siftable over at a time till he/she finds the matching cube. Each participant is expected to play 24 to 30 rounds. After playing the game, a short questionnaire will ask participants to provide some simple demographic details (i.e. gender and age), thoughts about his/her game-playing experience, and to rank his/her level of enjoyment playing the game. The expected duration of game play is 20 minutes; the questionnaires will take approximately 10 to 15 minutes.

The research will take place in the school during regular school hours and will be conducted in a manner that is the least disruptive to the school and most convenient to your schedule. Game-play and the follow-up questionnaire will be done one-on-one, between each student and myself.

I am seeking the participation of 30 students from ages 4 to 6.

Potential Risks: The risk of research is very low. The Siftables game should be an enjoyable experience for the young participants. However, it is possible during the course of game play that the participant may experience a certain amount of pressure due to the complexity of the game. There is no reason to expect that this will put any more stress on the individuals than they might normally encounter playing any video or computer game. Nevertheless, the participant will be reminded before beginning the game that they have the ability to withdraw at any time with no consequences.
Potential Benefits: It is hoped that this study will not only enable me to develop an in-depth understanding on the nature of motivation to children’s development, but also form a referential document for those who aspire to implement motivation-related learning strategies in their classrooms. To the young participants, the Siftables game will be an enjoyable experience for them.

Confidentiality: Participation in this study is anonymous and confidential. The data being collected in this research is via anonymous questionnaire. The process of the data collection and analysis will follow the University of Toronto’s ethical guidance for research. All information pertaining to the study will be kept strictly confidential in a locked file in my office and will only be available to my supervisor and myself. One year following the completion of this study, all raw data will be destroyed – all written records will be shredded. Once the study is completed, all participants will have the opportunity to view the results and it will be available to them upon their requests. During the course of the questionnaire, participants may decline to answer any of the questions. Further, he/she may decide to withdraw from this study at any time without any negative consequences by advising the researcher. However, since the data being collected in this research is via anonymous questionnaire, only participants who opt to withdraw up until the point of submitting the questionnaires can have their questionnaire destroyed. It will be communicated to them that they will not encounter any adverse effects or consequences as a result of withdrawal from the study.

Contact: Participants are invited to contact the Office of Research Ethics for any pertinent questions about their rights as research participants in this research project. The contact number is 416-946-3273 and the email address is ethics.review@utoronto.ca.
You may also contact me, the researcher, or my faculty supervisor, Dr. Earl Woodruff, with any questions relating to the study (see contact information below).
I sincerely thank you for your participation!

Principal Investigator: Zhenhua Xu
Department of Human Development and Applied Psychology, OISE, the University of Toronto
416-808-7721
zhenh.xu@utoronto.ca

Faculty Supervisor: Professor Earl Woodruff
Department of Human Development and Applied Psychology, OISE, the University of Toronto
416.978.1068
earl.woodruff@utoronto.ca

I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature: ___________________________ Date: ___________________________
Principal
Signature: ___________________________ Date: ___________________________
Principal Investigator
This study has been reviewed and approved by University of Toronto’s Research Ethics Board (File# 27617).
Dear Parents:

This letter is an invitation to participate in a study focused on how a reward reinforces children’s learning. The principal of your child’s school has carefully evaluated this study and granted me permission to send you this letter. I would like to ask your permission to invite your child to take part in this study. Please allow me to introduce myself, this study, and what your child’s involvement would entail.

My name is Zhenhua Xu, and I am an MA student at the Ontario Institute for Studies in Education (OISE) at the University of Toronto in Canada. My study is to explore how a reward reinforces children’s engagement in gameplay, and to examine whether a reward sustains children’s motivation in learning activities. This study will be carried out under the supervision of Professor Earl Woodruff, Department of Human Development and Applied Psychology (HDAP) at the University of Toronto in Canada. The data will be collected for my MA thesis.

I will invite child participants to play a concentration game on five Siftables. Siftables are electronic cubes that display either numbers or pictures (see the picture below). The goal of the concentration game is to find a matching pair. In the game, five Siftables are faced down on a surface; a participant will flip one Sitable over at a time till he/she finds the matching cube. Each participant is expected to play 16 to 24 rounds.

After playing the game, a short questionnaire will ask participants to provide some simple demographic details (i.e. gender and age), thoughts about his/her game-playing experience, and to rank his/her level of enjoyment playing the game. The expected duration of game play is 20 minutes; the questionnaires will take approximately 10 to 15 minutes. I will go over the questions one-on-one with your child. If you wish, you may join us during the game or questionnaire.

Potential Risks: The risk of research ranks very low: the Siftables game should be a rather enjoyable experience for your child. However, it is possible during the course of game play, that your child may experience a certain amount of pressure due to the complexity of the game. There is no reason to expect that this will put any more stress on them than they might normally encounter playing any video or computer game. Nevertheless, I will remind your child before beginning the game that they have a right to withdraw at any time with no consequences.
Potential Benefits: It is hoped that this study will not only enable me to develop an in-depth understanding on the nature of motivation to children’s development, but also form a referential document for those who aspire to implement motivation-related learning strategies in their classrooms. To your child, the Siftables game should be a rather enjoyable experience.

Confidentiality: The participation in this study is anonymous and confidential. The data being collected in this research is via anonymous questionnaire. The process of the data collection and analysis will follow the University of Toronto’s ethical guidance for research. All information pertaining to the study will be kept strictly confidential in a locked file in my office and will only be available to authorized research personnel. One year following the completion of this study, all raw data will be destroyed – all written records will be shredded. Once the study is completed, you will have the opportunity to view the results and it will be available to them upon their requests.

During the course of questionnaire, participants may decline to answer any of the questions if he/she may wish. Further, he/she may decide to withdraw from this study at any time without any negative consequences by advising the researcher. However, since the data being collected in this research is via anonymous questionnaire, only participants who opt to withdraw up until the point of submitting the questionnaires can have their questionnaire destroyed. It will be communicated to them that they will not encounter any adverse effects or consequences as a result of withdrawal from the study.

Contact: You are invited to contact the Office of Research Ethics for any pertinent questions about you or your child’s rights as research participants in this project. The contact number is 416-946-3273 and their email address is ethics.review@utoronto.ca.

You may also contact me, the researcher, or my faculty supervisor, Dr. Earl Woodruff, with any questions relating to the study (see contact information below).

I sincerely thank you for your participation!

Principal Investigator: Zhenhua Xu
Faculty Supervisor: Professor Earl Woodruff
Department of Human Development and Applied Psychology, OISE, the University of Toronto
416-808-7721
zhenh.xu@utoronto.ca

Department of Human Development and Applied Psychology, OISE, the University of Toronto
416.978.1068
earl.woodruff@utoronto.ca

I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature: ___________________________ Date: ___________________
Parent
Signature: __________________________ Date: __________________________
Principal Investigator

This study has been reviewed and approved by University of Toronto’s Research Ethics Board (File#27617).
APPENDIX D: SURVEY QUESTIONNAIRE FOR PARTICIPANTS

This questionnaire is going to ask you a few simple questions about the game you just played. It will help me understand how games help students like you to learn. It will only take about 10 minutes. If you need help, please let me know. Thank you for participating in my project!

Section 1: Demographic information

1. Are you a boy or girl?
   ☐ Boy
   ☐ Girl

2. How old are you?
   ______

3. Do you play computer/video games?
   ☐ Yes
   ☐ No

   Activity 1. ________________________________
   Activity 2. ________________________________
   Activity 3. ________________________________

5. How often do you play computer/video games every week?
   ☐ Zero   ☐ Once   ☐ Twice   ☐ Three or more times
Section 2: The Number-matching Game-play on Sifteo Cubes

Please look at each sentence on the left. Then pick the face that best describes how you feel and color it in.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is easy to play.</td>
<td>☹️</td>
<td>☹️</td>
<td>☹️</td>
<td>☺️</td>
<td>☺️</td>
</tr>
<tr>
<td>It is fun to play the Siftables blocks.</td>
<td>☹️</td>
<td>☹️</td>
<td>☹️</td>
<td>☺️</td>
<td>☺️</td>
</tr>
<tr>
<td>It is fun to play the number-matching game.</td>
<td>☹️</td>
<td>☹️</td>
<td>☹️</td>
<td>☺️</td>
<td>☺️</td>
</tr>
<tr>
<td>I wanted to continue playing this game.</td>
<td>☹️</td>
<td>☹️</td>
<td>☹️</td>
<td>☺️</td>
<td>☺️</td>
</tr>
<tr>
<td>I want to play this game in my spare time.</td>
<td>☹️</td>
<td>☹️</td>
<td>☹️</td>
<td>☺️</td>
<td>☺️</td>
</tr>
</tbody>
</table>

Thank you for your time and participation!
APPENDIX E: CHILDREN GAME-PLAY RECORD CARD--- GAME TRIALS

25% Condition (___)  

25-75% Condition (___)

<table>
<thead>
<tr>
<th>Name:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age:</td>
<td>Start Time:</td>
</tr>
<tr>
<td>Grade:</td>
<td>End Time:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial</th>
<th>Comments</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
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<td>3</td>
<td></td>
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<tr>
<td>4</td>
<td></td>
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<tr>
<td>5</td>
<td>Fun (?)</td>
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<tr>
<td></td>
<td>Continue (yes)</td>
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<tr>
<td>6</td>
<td>Fun (?)</td>
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<tr>
<td></td>
<td>Continue (yes)</td>
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<tr>
<td>7</td>
<td>Fun (?)</td>
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<td></td>
<td>Continue (yes)</td>
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<tr>
<td>8</td>
<td>Fun (?)</td>
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<td>Continue (yes)</td>
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<tr>
<td>9</td>
<td>Fun (?)</td>
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<td>Continue (yes)</td>
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<td>10</td>
<td>Fun (?)</td>
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<td>Continue (yes)</td>
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<td>11</td>
<td>Fun (?)</td>
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<td>Continue (yes)</td>
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<td>12</td>
<td>Fun (?)</td>
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<td>Continue (yes)</td>
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<td>13</td>
<td>Fun (?)</td>
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<td>Continue (yes)</td>
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<td>16</td>
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</tr>
<tr>
<td>17</td>
<td>Fun (?)</td>
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<td></td>
<td>Continue (yes)</td>
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<td>Continue (yes)</td>
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<tr>
<td>22</td>
<td></td>
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<td>23</td>
<td></td>
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<tr>
<td>24</td>
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</tbody>
</table>

Fun (?)               Continue (yes)             (no)
APPENDIX F: PRE-SCRIPT FOR CONDUCTING THE NUMBER-MATCHING GAME ON SIFTEO CUBES

10 to 15 minutes to set up the game, and to get ready.

“Hello, how are you today? What is your name? I am Imogene, and I am here to ask you to play a game with me.”

“Look! (I will show the child participant the Siftables cubes.) Have you played with something similar to these cubes? These cubes are called Siftables, and they are fun and easy to play with.”

“Okay, before we play I’d like to ask you to use this spray to clean your hands.”

“Good boy/girl. Okay, let’s start.”(After cleaning his/her hands)

“Look! (I am explaining and demonstrating the game.) I will flip these five cubes over and place them face them down on the surface of the table, and then I will ask you to flip one cube over at a time and leave it facing up. When you find a cube that shows the same number as the first cube you win the game. You can play this game as long as you like.”

“Okay, let’s play with these cubes.”

I will flip all the cubes over and place them face down on the surface of the table, press the master cube, and ask the child participant to play.

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When a child participant has played four rounds of the Siftables game I will stop him/her and ask two simple questions:

“Was it fun to play?”

“Would you like to continue?”

The child participant continues to play.

I will also ask the child participant the same two questions after every four rounds of play. A child participant is expected to play an average of **16-24 rounds** of the game.

*****

After the child participant has played 16 to 24 rounds, I will switch the game to the next level (75%), without telling him/her I made the change.

“Excuse me!” (I will press the master cube and change it from the 25% reward scheme to the 75% reward scheme.)

After the child participant has played the four rounds, I will stop him/her and ask two simple questions:
“Was it fun to play?”
“Would you like to continue?”

The same two questions will be asked after every four rounds the child participant has played.

Within this 75% reward scheme framework, a child participant is expected to play up to 30 or 40 rounds of this game.

When he/she finishes playing I will ask him/her a few simple survey questions.

“Was it fun to play with these blocks?”
“What did you like about this game?” “Why was it fun?”
“Would you like to play this game in your spare time?”
“Do you play computer games?”
“How often do you play every week?”

After asking the survey questions

“(Name), great! Thank you for playing the game with me today!”

The child leaves

“Bye-bye!”

5 or 10 minutes will be spent to organize the notes before interviewing the next participant.