THE RELATIONSHIP BETWEEN PLAYING GAMES AND METACOGNITIVE AWARENESS

by

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List of Abbreviations

ACTG	action game
ADG	adventure game
ALL99	all respondents, aged 18 years and older
CoP	community of practice
CWG	coherent world game
EDG	entity-development game
FS21	first and second-year student respondents aged 18 to 21 years
GEQ	game-experience questionnaire
GMU	George Mason University
LSD	Fisher's Least Significant Difference
MAI	metacognitive awareness index
NCWG	non-coherent world game; in pre-survey analysis, NCWG is also a strategy game; in post-hoc analysis, it may not be.
MAC	Measurement of Adaptive Cognition
MMOG	massively, multiplayer online game
MMORPG	massively, multiplayer online role-playing game
MUD	multi-user dungeons (pre-cursor to MMOGs)
RPG	role-playing game
UG21	undergraduate respondents, aged 18 to 21 years
UG24	undergraduate respondents, aged 18 to 24 years
UG99	undergraduate respondents, aged 18 years and older
VGFS	first and second-year student gamers, aged 18 to 21 years
VG21	undergraduate respondent gamers, aged 18 to 21 years
VG24	undergraduate respondent gamers, aged 18 to 24 years
VG99	undergraduate respondent gamers, aged 18 years and older

Abstract

THE RELATIONSHIP BETWEEN PLAYING GAMES AND METACOGNITIVE AWARENESS

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This study investigated how playing different types of video games was associated with different values of metacognitive awareness. The target population was first and second-year college students. The study used a survey methodology that employed two self-reporting instruments: the first to estimate a metacognitive-awareness index (*MAI*), and the second (developed in this study) to: (a) assess a respondent's video- and non-electronic-game experience (including both video and non-electronic games), (b) estimate the time spent playing video games (*time played*) over the prior two years, and (c) characterize the different types of video games that were played (to determine *gamer type*).

Out of 759 surveys distributed in 29 classes (for first and second-year courses), there were 175 respondents. For the main analysis, 80 respondents were eligible because they were video gamers, aged 18 to 21 years, and undergraduates. Juniors and seniors were included to mitigate the risk of too few respondents. The analysis was based on a 2

(time played) x 3 (gamer type) ANOVA for MAI. Gamer type was based on the predominant type of video games played among action games, strategy games, and coherent world games (*CWGs*). A CWG was defined as a role-playing game (*RPG*) in which a player explored a consistent and complex world to solve challenges or an entity-development game (*EDG*) in which the player developed, managed, and operated a complex entity in a consistent world or context. The three gamer types were action, strategy, and CWG.

The initial analysis revealed that action gamers and strategy gamers could not be objectively distinguished. Thus, three new gamer types that were consistent with the study's objectives were specified. The first type played predominantly EDGs; the second, RPGs; and the third, neither EDGs nor RPGs as often. The third type was assumed to play predominantly non-coherent world games (*NCWGs*). Thus, the three gamer types were EDG, RPG, and NCWG.

The results showed that EDG gamers were associated with a significantly higher MAI than NCWG gamers. $F(2, 77) = 4.55$; $p < .05$; partial $\eta^2 = .11$; and power = .76. There was not a significant association for time played or the interaction of time played and gamer type. In a secondary analysis, comprising 64 gamers, aged 18 to 21 years, and first and second-year students only, the results showed that CWG and EDG gamers were associated with a significantly higher MAI than NCWG gamers. $F(3, 60) = 4.29$; $p < .01$; partial $\eta^2 = .18$; and power = .84.

Two possible hypotheses for the results were that playing CWGs foster metacognitive awareness or that those with a higher metacognitive awareness preferred

CWGs. Because the methodology used a one-time survey, neither hypothesis could be confirmed or denied. Due to coverage and nonresponse errors, the sample results were not generalizable. Nevertheless, the results provided evidence of an association between CWG gamers and a higher metacognitive awareness than for NCWG gamers. The implication was that the study could inform methodology design for future research to develop an empirically-based taxonomy on game characteristics, organized according to their association with metacognitive awareness.

Chapter 1: Introduction

In this study, I investigated how playing different types of video games was associated with different values of metacognitive awareness (for first and second-year college students). I used a survey methodology that employed two self-reporting instruments, the first to estimate a metacognitive-awareness index and the second to assess prior game experience. The research questions that I developed "pre-survey" were based on anticipating the distribution of the game-type preferences (for video games) that the respondents would report. However, the distribution found in the initial data analysis was not what I anticipated. Consequently, I revised the research questions in accordance with the study's main goal and in alignment with the original data analysis prescribed. The original research questions are presented at the end of this chapter. The revised questions and the rationale for their revision are presented in Chapter 5.

To be clear, game experience included the play of video games as well as non-electronic games; both are explicitly defined below. However, this study was focused on video games. Non-electronic games were considered a confounding variable; they were also considered in this study. Nevertheless, if the term game or gamer is not otherwise specified, the term video game or video gamer, respectively, will be assumed. Furthermore, the term non-gamer will be used for a respondent who has rarely or never played video games over the prior two years.

Study Overview

The video-game industry is a major, worldwide industry. In the U.S. in 2006, video-game software sales were $7.2 billion (Entertainment Software Association, 2007). Globally, the most popular online game, the World of Warcraft, reached over 9 million subscribers in 2007 (Gamasutra, 2007). In the early days of the industry, "gamers" were mainly teenage males. However, as the industry has evolved and matured, its market appeal has dramatically broadened, and its demographics have become more and more representative of the general population (Fattah & Paul, 2002). The video game has emerged as a new communications media and worthy of scholarly study (Aarseth, 2001). It is possible to study the video game from the perspective of any subject (Aarseth, 2003), and the actual range of research perspectives has been extensive (Egenfeldt-Nielsen, 2007).

One of the major research perspectives for video games has been education because of the promise that many researchers attribute to the video game for improved learning. Paul Gee (2003) offers a de facto proof for the instructional power of video games in the following argument. Consider that the popularity of video games continues to increase, even though they are becoming increasingly complex, and consequently, more difficult to play. Thus, there must be powerful learning principles incorporated in them that enable them to be learned. In addition, learning takes effort and persistence, so apparently those games must encourage those behaviors. Otherwise, no matter how much fun a game would be once learned, people would not put the "work" in to learn them; and those games would not sell. The Darwinian force of natural selection should

reward those games that incorporate the most effective learning principles. Thus, those principles should prevail and continue to be improved over time.

Unfortunately, basic terminology used in the discussion of games research is not standardized. For example, the term "video game" is sometimes used as a synonym for a console game (e.g., Entertainment Software Association, 2007). However, the same term is also used as an "umbrella" to include games played on a computer, console, arcade, mobile, or other digital device (e.g., Juul, 2005). More generally, a video game is a game that includes computing, input and output, and audiovisual capabilities (Esposito, 2005). The term non-electronic games include all games without those capabilities. They are typically played with paper and pencil, cards, game boards, or with miniatures on a tabletop.

In this study I will use the term video game in the broader sense. Furthermore, I will assume that video games and non-electronic games will be inclusive of all games (excluding athletic games[1]). I will use the term video game even when an author has used another term (e.g., computer game) if it appears that the author's intent was to mean video game as described here.

The main focus of this study is on the relationship between playing video games and metacognitive awareness. Simply defined, metacognitive awareness is "thinking about thinking." It involves monitoring and controlling one's thinking, and is regarded as a key capability to enable self-directed, life-long learning. In addition, it can foster

[1] Not to be confused with video-game adaptations of athletic games.

improved strategic thinking (Haynie, 2005) and general problem-solving abilities (Swanson, 1990).

My belief is that there are conditions created in games which foster metacognitive awareness. Chapter 2 will provide support for this opinion. Briefly, the argument is based on the following logic. Metacognitive awareness can evolve and increase throughout one's life. It can be fostered with the proper instructional strategies, particularly by encouraging and supporting its use in a suitably established environment. The conditions that have been proven to foster metacognitive awareness are similar to the conditions established in many games, particularly certain types of video games. Furthermore, research provides evidence that games can encourage metacognitive behaviors. Theoretically, it is possible to empirically test my belief, because there are self-assessment instruments to measure metacognitive awareness that have been proven valid and reliable. However, for practical reasons (to be discussed in Chapter 6), my study was designed to test for an association (and not a cause and effect relationship) between playing certain types of video games and a higher metacognitive awareness.

Background

Research into the potential of games in education and learning has exploded. In his dissertation, Eigenfeldt (2005) provided an excellent and comprehensive review of early research efforts up through papers published in 2004. His review spanned both non-electronic games and video games. He briefly covered military games, business

games, and recreational games, but his main focus was on video games[2] that were used in the K-12 classroom. His main goal was to develop a framework that could classify the research efforts to inform a roadmap for future research and avoid the fragmented research efforts that characterized the field. He found that research evolved from an orientation originally based on behaviorism to cognitivism to constructivism. Earlier research used metrics based on behaviorist principles to determine the effectiveness of using games for education and also their effectiveness compared to traditional instruction. The results were inconclusive (e.g., Randel et al., 1992; Egenfeldt-Nielsen, 2007; Blunt, 2006).

Understandably, however, the evolution in research followed the corresponding evolution in game design. Since the 1990s, games have increasingly included authentic and collaborative environments, situated meaning, and social and cultural perspectives (Egenfeldt-Nielsen, 2007). More recent studies have shown how games could be effectively leveraged as tools, resources, and environments to produce rich, compelling, situated experiences. These games were designed to engage players to try different approaches without actual risk, to leverage visual metaphors that represented environments and problem spaces to encourage collaborative discussions and reflections, and to encourage players to think in terms of the information tools and resources made available to them in the service of solving complex and ill-structured problems (Squire, 2005).

[2] Egenfeldt uses the term computer games, but I believe his usage is consistent with how I have defined video games.

Based on my literature review, I would expect that the types of games described above would cause players to exercise metacognition. Exercising metacognition has been shown to foster its improvement (Papaleontiou-Louca, 2003). However, there have been few empirical studies that investigated relationships between playing games and metacognition. Only one study was designed to detect whether there was a quantitative improvement in metacognitive awareness after playing a game. In that study pre- and post-measurements were taken using a self-assessment instrument (Ke, 2007). No significant change occurred. However, the treatment was only one month long, involved a single relatively simple math game, and metacognitive awareness was measured just before and just after the treatment.

I believe that there is a cumulative effect on metacognitive awareness from all of the games that a person has played, but metacognitive awareness is not likely to measurably increase from playing one game for a relatively short period of time. In addition, I believe that certain characteristics of a game provide the conditions that foster metacognitive awareness. The existence and extent of those conditions might vary for different games and more so for different game types. In addition, the conditions that could best foster metacognitive awareness might vary for different players. Finally, different players might play the same game differently, and the same player might play the same game differently in different sessions; consequently, exposing players to different game characteristics.

These assumptions informed the basic design of this study. Instead of an experiment, this study was based on a survey that assessed a person's prior game

experience along with a corresponding measurement of the person's metacognitive awareness. Whereas an experimental approach could determine whether there was a cause and effect relationship between different types of game experience and metacognitive awareness, a survey approach (with a one-time survey) could only determine whether there was an association. However, I believed that that tradeoff was necessary to increase the probability that a relationship could be detected, assuming it existed.

The methodology for this study presented challenges. They included the selection and sufficient access to a target population, the acquisition and specification of a quality sample frame, and the generation of a sufficient response rate from the sample population for a valid statistical analysis. I expected that the methodology challenges would be lowered by selecting first and second-year students at George Mason University (GMU) for the target population, which afforded me special access to it.

Games that Foster Metacognitive Awareness

Basically, an environment that is mastery-oriented and encourages and supports the development of strategies for problem solving within a particular subject domain should foster metacognitive awareness. That type of environment is provided by the types of games described by Gee in his analysis of the learning benefits of video games (2003). In those games "the player takes on the role of a fantasy character moving through an elaborate world, solving various problems … or … the player builds and maintains some complex entity, like an army, a city, or even a whole civilization" (2003, p. 1).

However, for this study, I prefer the term, *coherent world game* (*CWG*), coined by Juul in his list of main game types (2005, pp. 131 – 133). A CWG contains a coherent world that is based on reality or fantasy. However, the representation of the world within the game's rule set is sufficiently consistent so that a player's suspension of disbelief can be continuously maintained. Juul described coherent worlds as those "where nothing prevents us from imagining them in any detail" (2005, p. 132). I have taken the liberty in adapting Juul's term for my study, in that a CWG is a video game and will involve a significant use of strategy, although it might contain significant action as well. These additions put my description of a CWG in alignment with those described by Gee.

It was my belief that video games could be divided into three types that would be useful for this study. The CWG is the first game type. The following logic was used to specify the second and third types. In an early categorization of games, Crawford made the basic distinction between action and strategy games (2011). Action games required mainly perceptual and motor skills, whereas strategy games required mainly cognitive abilities (1982). Today many people play *casual* games. Casual games have simple rule sets, are easy to learn, and take much less time to play than more sophisticated games, for example, CWGs. Although CWGs might contain significant action, the distinction between action and strategy games is clearer with casual games. The action game (ACTG[3]) is the second game type. The games that are strategy games but are not CWGs are referred to as non-coherent world games (*NCWGs*). The NCWG is the third game type. NCWGs range from cognitively-easy games such as hangman to cognitively-

[3] I used the term ACTG for action game because the term was more convenient and understandable in other chapters. However, when using the term action game is more suitable I will use that term.

intense games such as chess or bridge. Although many NCWGs might be played as non-electronic games, unless otherwise mentioned they will refer to video games (perhaps adapted from their original non-electronic form).[4] Thus, the three video-game types that were proposed for this study were ACTG, NCWG, and CWG. Although I anticipated that CWGs would best foster metacognitive awareness, any video game that could engage metacognitive processes could foster metacognitive awareness to some extent.

It is likely that respondents have played some combination of the three types of video games. However, based on the logic described in Chapters 3 and 4, each video gamer surveyed would be identified as one of three types, based on the preference they showed in playing video games over the prior two years. In addition, respondents who rarely or never played video games over that period were identified as a non-gamer.

Game-Experience Questionnaire

The main purpose of the game-experience questionnaire (GEQ) was to identify members of the three gamer groups described above as well as the group of non-gamers. However, I decided to collect additional data based on the organizing principles identified by game researchers that were anticipated to have an effect on metacognitive awareness. That data could be explored to enable further insights (concerning associations between games and metacognitive awareness) beyond the main analysis. Furthermore, the additional data could be used to mitigate the risk that the criteria for distinguishing gamer types might not generate a sufficient distribution across the three types to enable a statistically valid analysis.

[4] In other words, the game types ACTG, NCWG, and CWG will apply to video games unless explicitly stated otherwise.

The types of data collected and the issues involved are discussed below. Chapters 3 and 4 will discuss how that data were used to identify the three gamer types and to explore the data further.

It would be impractical to survey people on the specific games that they played. First of all, there have been a huge number of games created, particularly video games. This fact alone precluded asking respondents to name the games they played or to ask them to check off games from a list of all possible games. A survey could not handle the volume, and people could not be expected to remember their experience that accurately. Furthermore, respondents could not be expected to distinguish what relative amounts of time they spent on different games. Even assuming that a survey could capture the specific games and the time spent playing them, characterizing each game's anticipated effect on metacognitive awareness to make sense of the data would be impractical as well.

Games are often classified by genre. However, using game genres to define game experience for this study required careful consideration. In addition to genres, organizing principles that distinguish among different characteristics and structures of games were also identified. The principles anticipated to have an impact on metacognitive awareness and could be converted to suitable survey questions were selected. Consequently, the main fields of study reviewed in Chapter 2 include metacognitive awareness, the empirical research for how games affect metacognitive variables, and game studies.

The field of "game studies" began early in this century. Its formal initiation could be attributed to Espen Aarseth, the founder and Editor-in-Chief of Game Studies, the

International Journal of Computer Game Research, in 2001 (Aarseth, 2001). The mission of the journal was, "[t]o explore the rich cultural genre of games; to give scholars a peer-reviewed forum for their ideas and theories; to provide an academic channel for the ongoing discussions on games and gaming" (Game Studies, 2006). Game studies' researchers have stated that there is a need for standard terminology and frameworks for discussing and analyzing game designs (Holopainen & Björk, n.d.). Consequently, a variety of frameworks as well as definitions for common terms have been proposed. This developing knowledge base is reviewed in Chapter 2, and was an important source for identifying organizing principles for the development of the GEQ.

The objective of the GEQ was the assessment of the type of game experience that could foster metacognitive awareness as anticipated from the literature. I assumed that three dimensions were necessary to capture that experience: (a) the types of games that a person has played, (b) the particular ways that a person has played them, and (c) how much time that a person has spent playing.

The game-studies literature provided ideas for how games could be categorized. However, knowing the types of games that people played was not sufficient. Different people might play the exact same game in different ways. For example, a game such as a massively-multiplayer online game (MMOG) is large and complex, and there could be many different types of activities going on within that game at the same time. One person might be interested in working towards a goal specified within the rules of the game, or perhaps, determined and agreed upon by the players. Another person might be solely interested in harassing other players. The range and sophistication of strategies

used for each of these two approaches could be widely different. Playing the game solely to harass other people might have a more limited and simpler set of strategies that could be continually repeated. A person would only need to learn the rules to support the playing style that they would like to use (Lindley, 2003).

These two dimensions (types of games and how people play them) are not independent. In other words, how a person wanted to play a game could influence the types of games that the person would play. In addition, a person might play the same game differently in different sessions. Consequently, these two dimensions informed the organizing principles used for the GEQ in concert with each other. However, in searching the literature it was useful to consider these two dimensions separately.

The third dimension was a measure of the amount of time that a player has played games, preferably divvied up among the types of games played and how they were played. Researchers have often used the number of hours currently played per week as well as the number of years played to characterize a player's experience level (e.g., Squire & Jenkins, 2003; Yee, 2006; Alix, 2005; Beedle, 2005; Entertainment Software Association, 2007). These measures were reasonable for studies that were associated with the current state of a player, for example, a player's motivations for playing games. However, there were two main differences in the requirements for this study than others. First of all, the time played had to account for a compilation of experience instead of a snapshot of current experience. Second, it would be preferable if the total hours played could be apportioned according to game types and playing styles. However, satisfying these conditions was considered impractical. Instead, the time played was based on the

total amount of time played over the prior two years. That time was based on an approximation that is described in Chapter 4.

Problem Statement

There have not been many empirical studies of associations between playing games and metacognitive awareness. Prior studies showed that playing games might foster metacognitive awareness, but the evidence was not strong. All of these prior studies except one used an experimental approach, and each study used only a few games at most. In the one exception (Beedle, 2005), a survey of gamers was used to assess their experience of all of the multiplayer games they played and their opinions of the learning they accrued. Although the results indicated that the games fostered their metacognitive awareness, the results were based on their opinions; thus, the evidence was not strong.

However, based on conditions that are known to foster metacognitive awareness and the recognition that games can establish those conditions, it would seem that games could foster metacognitive awareness. Whereas prior studies were not designed to maximize the detection of that potential, this study was designed specifically to test for it.

Because this study used a survey methodology and not an experiment, the results should indicate whether CWGs were associated with a higher metacognitive awareness than ACTGs and NCWGs; but an association would not necessarily prove a cause and effect relationship. An alternative explanation could be that people with a higher metacognitive awareness would more likely play CWGs.

Research Questions and Hypotheses

For the following research questions, the time period considered was the two years prior to the survey being taken. The two-year period was operationalized as 100 weeks to facilitate respondent answers. Metacognitive awareness was measured by an instrument developed by Haynie (Haynie & Shepherd, 2009). The video game types, ACTG, NCWG, and CWG were described above.

RQ1. Do first and second-year college students, aged 18 to 21 years differ on their metacognitive awareness based on the level of time (Occasional, Moderate, or Often) that they spent playing video games over the prior two years?

RQ2. Do first and second-year college students, aged 18 to 21 years differ on their metacognitive awareness based on the type of video games (ACTG, NCWG, or CWG) that they played over the prior two years?

For RQ1 and RQ2, I did not offer hypotheses. I could not predict what I would find.

RQ3. Do first and second-year college students, aged 18 to 21 years differ on their metacognitive awareness based on the interaction of the time that they spent playing video games and the types of video games that they played over the prior two years?

H3a. The CWG gamers who played video games Often over the prior two years will have a higher metacognitive awareness than the CWG gamers who played video games at an Occasional or Moderate level of time.

H3b. The CWG gamers who played video games Often over the prior two years will have a higher metacognitive awareness than the ACTG and NCWG gamers who played video games at any level of time.

The game types are further discussed in Chapter 3, and the way that the research questions were operationalized is described in Chapter 4. The revised research questions and their rationale are presented in Chapter 5, together with the results.

Chapter 2: Literature Review

Overview

This section provides a brief overview of the literature review. Citations for the claims made in this section will be provided in the succeeding sections.

First, a description of metacognitive awareness and how it develops will be presented. An essential step for testing the study's hypotheses is the ability to measure this variable. Researchers have investigated how to operationalize metacognitive awareness and measure it by self assessment with proven validity and reliability. The instrument selected for this study will be described.

There are a number of proven ways that metacognitive awareness can be fostered. One way is to put a person in an environment that encourages and supports the exercise of metacognition. In fact, the inspiration for this study came from the realization that the conditions that establish that environment are similar to the conditions that are established in many video-game environments. The empirical literature for the effect of playing video games on metacognitive awareness was searched, and the results found will be discussed. There have not been many studies of this connection, and none tried to measure the effect quantitatively based on prior game experience or across a broad range of games. Afterwards, the theoretical reasons that playing games can foster metacognitive awareness will be presented.

An instrument had to be developed to measure the game experience anticipated to foster metacognitive awareness. Three dimensions of game experience were considered: (a) the types of games played, (b) how they were played, and (c) the time spent playing them. The literature that is related to the design and structure of games is part of a discipline called game studies. That literature was reviewed to identify and present organizing principles for distinguishing game types and playing styles.

The final principles and ultimate survey questions used had to be extremely limited, partly because of the target population selected. That population was selected after a review of gamer demographics and the need for a population that could best test the hypotheses and was also practical to survey. Thus, the literature review will conclude with a review of gamer demographics to enable justification and the ramifications of the selection made.

Metacognitive Awareness

Metacognition has been studied extensively since the early 1970s (Flavell, 2004). Earlier research focused on metacognition in children, but since the late 1990s, metacognition in adults has become a thriving area of research as well (2004). The term metacognition is often defined as "thinking about thinking." The term is generally attributable to John Flavell (Livingston, 1997), who is considered the "father of metacognition" (Papaleontiou-Louca, 2003). Cognition and metacognition are two distinct concepts, but they are intertwined in their use (Livingston, 1997). The connection can be simplified by using reading comprehension as an example. Cognition is used to understand what you are reading. Metacognition is used to ensure that you

understood what you read and what actions to take if you didn't. Metacognitive awareness is the awareness of metacognition and of one's own metacognitive abilities. It is the ability to think about, understand, and control one's thinking (Flavell, 1976).

Over time, Flavell and other researchers extended the definition of metacognition, in particular to include the affective states (i.e., the psychological states such as emotions). The definition of metacognition should include at least the following ideas, "knowledge of one's knowledge, processes, and cognitive and affective states; and the ability to consciously and deliberately monitor and regulate one's knowledge, processes, and cognitive and affective states" (Hacker, 1998, p. 11).

Metacognition is an important ability that can enhance learning (Schraw, 1998a) as well as strategic thinking (Haynie, 2005). Bransford, Brown and Cocking (2000) have highlighted a broad range of research that demonstrates the benefits of metacognition for learning, knowledge transfer, and problem solving. In addition to its benefits for learning in an academic setting, metacognition is also beneficial for learning in the workplace (Munby, 2002).

Developing metacognitive awareness. Children as young as kindergartners have metacognitive ability (Schneider, 1985, as cited in Hacker, 1998), and that ability continues to increase and evolve throughout childhood, adolescence, and adulthood (e.g., Rasnak, 1995; Schraw, 1998a; Schraw, 1998b; Papaleontiou-Louca, 2003; Cooper, 2005; Vukman, 2005). Many researchers believe that metacognitive ability is domain general (Schraw, 1998b). As students learn to think critically within a subject domain, they learn strategies for working within that domain. As they learn to think in more and more

domains, and particularly if they reflect on their thinking, they may construct general metacognitive knowledge and skills that are transferable to other domains. Thus, metacognitive ability may be best learned within the context of a subject domain, but it eventually develops into a domain-general ability (Schraw, 1998b).

Research shows that the level of adults' metacognitive ability increases with age, at least through the late 40s (Rasnak, 1995; Cooper, 2005; Vukman, 2005), and it continues to evolve into at least the late 60s (Rasnak, 1995; Vukman, 2005). Older adults (beyond traditional college age) show qualitatively different metacognitive abilities than younger adults (aged 18 to 23 years). The difference may stem from a different orientation to learning between the two groups. Older adults draw on a mastery orientation that relates to future applications outside the classroom, and they abstract meaning from facts and data; whereas younger adults employ a performance orientation based on immediate rewards such as test scores (Rasnak, 1995). The different orientations to learning may account, at least partially, for the results described below.

Older adults use more of two study strategies referred to as generation of constructive information and hyperprocessing (Justice & Dornan, 2001). The former strategy uses elaboration, reorganization, and integration of information. The latter strategy uses extra processing to understand difficult or challenging information. These two strategies, used to increase comprehension and integration of information, are relatively sophisticated strategies compared to those used by the younger adults.

Vukman (2005) studied the problem-solving abilities of individuals in four age ranges (based on years): (a) adolescents (16 to 17), (b) young adults (21 to 23), (c) mature

adults (40 to 47), and (d) older adults (63 to 70). He found that the mature adults were the best at solving ill-structured problems which required integration of diverse data and synthesis of different perspectives, whereas young adults were the best at closed-form problems with all information provided and one correct solution.

It should be noted that it is not age per se that fosters development of metacognitive awareness. Rather it is the proper knowledge and experience gained that generally accompanies an increasing age that matters. For example, Cooper (2005) found that teachers' levels of metacognitive awareness increased with their years of experience regardless of age. She concluded that the type of work that teachers do, reflecting on their students' thinking and learning progress and verbalizing their own cognitive and metacognitive processes to the students, was beneficial to increasing their own metacognitive awareness. In another study, Huggins (2001) found that teachers who taught courses which required their critical reflection of their thoughts had higher metacognitive awareness than teachers who taught vocational-skills courses which did not require critical reflection. These two studies suggest that any adult who engages in reflective thinking as part of their professional duties may foster their metacognitive awareness.

In concluding this section, researchers have discovered the important but surprising finding that metacognition does not correlate with traditional measures of intelligence such as IQ (Schraw, 1998a) and abilities such as the American College Testing (ACT) scores (Schraw, 1998b). Although a higher IQ is useful in developing cognitive abilities, the higher-level abilities of metacognition are constructed gradually

with experience and without regard to particular stages or ages or aptitudes (Schraw, 1998b).

Operationalizing metacognitive awareness. Metacognition is a complex concept. Its definition has evolved as researchers have extensively studied it from a wide range of disciplines and for varying purposes (Hacker, 1998). Consequently, it has been operationalized in many different ways dependent on its intended application and context. These ideas are discussed here to lay the foundation for the instrument used to measure metacognitive awareness for this study, including the instrument from which it was adapted.

Most researchers agree that the definition of metacognition should include two basic components, knowledge of cognition and regulation of cognition (Schraw & Moshman, 1995). Knowledge of cognition (also referred to as metacognitive knowledge) is comprised of one's knowledge about cognition in general as well as knowledge of one's own capabilities in using cognition. Regulation of cognition is used to control cognition.

Metacognitive knowledge includes: (a) knowledge of person variables (i.e., how people learn and process information including their own learning processes); (b) knowledge of task variables (i.e., nature of the task as well as demands that the task will place on oneself); and (c) knowledge of strategy variables (i.e., cognitive and metacognitive strategies as well as when and where to use them) (Livingston, 1997). An alternative view of metacognitive knowledge includes: (a) declarative knowledge of *what*

you know, (b) procedural knowledge of *how* to utilize that knowledge, and (c) conditional knowledge of *when* and *why* to use it (Schraw & Dennison, 1994).

Regulation of cognition includes: (a) planning (i.e., "planning, goal setting, and allocating resources *prior* to learning"); (b) information management (i.e., "skills and strategy sequences used on-line to process information more efficiently," e.g., "organizing, elaborating, summarizing, and selective focusing"); (c) monitoring (i.e., "assessment of one's learning or strategy use"); (d) debugging (i.e., "strategies used to correct comprehension and performance errors"); and (e) evaluation (i.e., "analysis of performance and strategy effectiveness after a learning episode") (Schraw & Dennison, 1994, pp. 474-475).

The monitoring and regulation of cognition are referred to as the executive processes (Kluwe, 1982, as cited in Papaleontiou-Louca, E., 2003). Metacognitive knowledge is used to inform the monitoring of cognition to ensure "on-line awareness of comprehension and task performance" (Schraw, 1998a, p. 115). The feedback from that monitoring is subsequently used as an input for regulating cognition. In other words, monitoring cognition, a component of regulating cognition, is the bridge that connects knowledge of cognition to regulation of cognition.

In addition to metacognitive knowledge as a resource to inform one's decisions, a person can also rely on metacognitive experience (Flavell, 1981, as cited in Papaleontiou-Louca, 2003). That experience concerns the conscious feelings one has during a cognitive activity. For example, during a communication you may sense that you do or do not understand or that you feel hesitancy in the choice that you made (Papaleontiou-

Louca, 2003). Haynie (2005) considers metacognitive knowledge and experience as two resources available to inform metacognitive regulation. Metacognitive experience adds the affective aspect to metacognition.

Measuring metacognitive awareness. There are several general methods for assessing metacognition: think-aloud protocols, interviews, and questionnaires. In a think-aloud protocol the subject describes his or her thinking while working on a cognitive activity such as solving a problem. During an interview the subject reports his or her thinking during a previous cognitive activity. Both of these methods are often video or audio taped and analyzed afterwards to determine what cognitive and metacognitive behaviors were engaged.

These two methods have often been used in studies of the association of games and metacognitive variables. Using a think-aloud protocol, players describe their actions while they are playing (e.g., Hong & Liu, 2003; Pillay, Brownlee, & Wilss, 1999; Pillay, 2002). The game play is sometimes followed by interviews, prompted with excerpts from the videotaped play to elicit further information, particularly the reasons for the actions taken during play (e.g., Pillay, 2002). One study (Henderson, 2005) used the "stimulated-recall" technique which does not use the think-aloud protocol during play, relying solely on a post-play interview with prompts from videotaped excerpts of the play. This method is used to avoid the intrusion to cognition during the game play, but is considered a reliable technique if the interview is held within 48 hours after the activity, uses visual prompts from the activity, and incorporates a strict interview protocol (2005).

Think-aloud protocols and interviews can provide valuable information concerning the cognitive and metacognitive behaviors used during an activity. However, these methods do not yield numeric values of a person's metacognitive capabilities. Furthermore, the methods are labor intensive and would not be efficient in a study with a substantial sample size as well as a variation of game characteristics across many different games.

Alternatively, the third general method uses questionnaires as self-assessment instruments to provide numeric values for a person's metacognitive awareness. These instruments have been created for different age ranges, domains, and ways of operationalizing metacognition. They usually provide an overall index for metacognitive awareness and often provide separate indices for sub-constructs. Examples include instruments for reading comprehension (Mokhtari, 2002), listening comprehension (Vandergrift, 2006), learning in a formal educational context (Schraw & Dennison, 1994), problem solving (Swanson, 1990), and decision making (Haynie, 2005). It should be noted that all of these instruments measure the strength of a varying assortment of metacognitive processes that support a particular application (e.g., reading comprehension, problem solving, decision making, etc. in a particular context). This point will be revisited in describing the instrument used in this study.

Schraw and Dennison's Metacognitive Awareness Inventory (SDMAI[5]). The first instrument considered for this study was developed by Schraw and Dennison (1994). They developed the SDMAI to measure the metacognitive awareness of adolescents and

[5] Schraw and Dennison referred to their instrument as the MAI. However, I will refer to their instrument as the SDMAI to avoid confusion in this study with Haynie's instrument (Haynie & Shepherd, 2009).

adults in support of generalized learning in a formal educational context. Two experiments showed that metacognitive awareness can be operationalized as two factors that correspond to knowledge of cognition and regulation of cognition. The two factors were found reliable (α = .90) and intercorrelated (r = .54). "Knowledge of cognition measured an awareness of one's strengths and weaknesses, knowledge about strategies, and why and when to use those strategies. Regulation of cognition measured knowledge about planning, implementing, monitoring, and evaluating strategy use" (1994, p. 471). Furthermore each of the two factors made a unique contribution to cognitive performance.

The instrument yields an overall index for metacognitive awareness and a separate index for each of the two main factors, knowledge and regulation of cognition. The instrument consists of an inventory of 52 statements, for which the respondent indicates the level of agreement with each statement on a scale ranging from *not very much like me* to *very much like me* (Schraw & Dennison, 1994).

For the current study, the main problem with the SDMAI was that it is geared to learning capability in a traditional, objectivist-based educational setting; rather than to problem solving and adaptive decision making in a complex, uncertain, and dynamic environment that games may provide (to varying extents). Fortunately, Haynie (2005) created a newer instrument for measuring metacognitive awareness that provides a better match for the type of instrument best suited for this study.

Haynie's Measurement of Adaptive Cognition (MAC). Haynie (2005) was studying the effects of metacognitive awareness on entrepreneurial decision making. The

entrepreneur works in an uncertain and changing environment. Cognitive adaptability is a capability that allows the entrepreneur to let go of previously-held beliefs in the face of conflicting data to change strategies and meet the ever-changing environment and task demands. Haynie believed that increased metacognitive awareness would increase the entrepreneur's cognitive adaptability and lead to better decision making.

To test his belief he needed an instrument that could measure the capability as embodied in his ideas and based on the foundations of metacognitive theory. He decided that the SDMAI would provide a good foundation but needed modifications to support the measurement of the capability in the proper context that he needed for his study. Beginning with the 52-item inventory of the SDMAI, Haynie rewrote the items to remove the educational context and deleted nine items that were too difficult to disentangle from that context. In addition, he added 11 items to support the additional dimensions of his model for the metacognitive processes he needed to measure.

After statistical analysis and validation the instrument was reduced to a 36-item inventory. The 30% reduction from the 52 items in Schraw and Dennison's instrument was a benefit because the smaller instrument would take less time for subjects to complete. Haynie named his instrument the Generalized Metacognitive Awareness Inventory (2005).

Afterwards, he and colleagues continued working with the instrument as well as further testing it (Haynie, Grégorie, & Shepherd, 2005). The final instrument was modified slightly from its original version. As their thinking evolved, they realized that they were capturing the construct of cognitive adaptability and renamed the instrument

accordingly as the Measurement of Adaptive Cognition, or simply, the MAC (Haynie & Shepherd, 2009; J. M. Haynie, personal communication, June 7, 2008).

The MAC is based on five dimensions: (a) goal orientation, (b) metacognitive knowledge, (c) metacognitive experience, (d) metacognitive choice, and (e) metacognitive monitoring. In the context of cognitive adaptability, these dimensions were defined as follows. Goal orientation considers the influence of context and motivations on each other. It represents the extent that an individual considers the task environment from the wide variety of personal, social, and organizational goals. Goal orientation engages metacognitive knowledge and experience resources. These resources refer respectively to the cognitive and affective knowledge that an individual can elicit for considering appropriate decision frameworks that could suit the task and environment at hand. Metacognitive choice is the extent that the individual engages in selecting the particular decision framework. Finally, metacognitive monitoring represents the extent that the individual utilizes feedback from the previous four dimensions for managing the changing environment.

The reliability and validity of the MAC were determined to be strong. The internal consistency of the MAC was used as a measure of the instrument's reliability. It was calculated using Cronbach's alpha across all items of the inventory. The high value (α = .885) indicated a high degree of internal consistency and consequently a high reliability (Haynie & Shepherd, 2009).

Structural validity was established (between factors of the measure) for both convergent as well as discriminant validity (Haynie & Shepherd, 2009). Convergent

validity indicates that all items associated with each factor correlate highly with each other (i.e., loading is greater than .5). Discriminant validity indicates that each item correlates higher with its own factor than with any other factor (Chau & Tam, 1997).

Nomological validity (between the MAC and other measures) was also established (Haynie & Shepard, 2009). Validity is established if individuals' scores for a measure are correlated with scores to a measure that is theoretically expected to be positively correlated and vice versa. Testing established that scores on the MAC were highly correlated with scores on Cacioppo, Petty, and Kao's *Need for Cognition Scale* (1984). People who are motivated to engage in 'effortful' cognitive activity would be expected to have higher scores on the MAC. Conversely, comparing scores on the MAC with the *Conservative-Liberalism Scale* (Mehrabian, 1996), an extremely different type of measurement, showed no significant correlation.

Haynie's instrument showed promise for measuring individual differences in entrepreneurship research (2005). I decided that it would be well suited for this study as well. Adaptive decision making in an uncertain and changing environment is a valuable problem-solving capability, for example, to improve management and navigation of life in general. Furthermore, games provide this type of environment to different extents dependent on the type of game. Thus, this measure should be useful for comparing different game-experience profiles.

As previously noted, a number of instruments have been developed for measuring metacognitive awareness. Those instruments measured an individual's strengths in certain metacognitive processes that captured particular abilities, for example, reading

comprehension, listening comprehension, and learning capability. The contexts for these abilities varied as well. For example, Schraw and Dennison's instrument was based on a formal educational context; while Haynie's instrument was based on a typical entrepreneurial environment. However, similar to the other instruments measuring metacognitive awareness, Haynie's instrument measured the strength of metacognitive processes as well. Thus, it was appropriate to use the MAC to measure metacognitive awareness for my study. However, to avoid confusion in this study the value returned by the MAC will be referred to as the *Metacognitive Awareness Index* (*MAI*).

Fostering metacognitive awareness. Review of the literature has established that instructional strategies can foster metacognitive awareness for both children and adults, and that improvement benefits learning, strategic thinking, and problem solving (Hacker, 1998; Schraw, 1998a; Bransford, Brown & Cocking, 2000; Papaleontiou-Louca, 2003; Cromley, 2005).

Papaleontiou-Louca (2003) contended that teaching about metacognitive awareness may not be as effective as providing activities that model use of the skill and encourage students to develop it on their own. She compiled a list of classroom activities from the research literature that have shown to be effective for fostering metacognitive awareness. The activities include identifying what you know and what you don't know, planning and organizing strategy (for learning), generating questions, choosing consciously, setting and pursuing goals, evaluating the way of thinking and acting, identifying the difficulty, paraphrasing and elaborating students' ideas, labeling students' behaviors, debriefing the thinking process, problem solving and research activities, role

playing, thinking aloud (particularly in problem solving), interactive multimedia learning environments, keeping a thinking journal, cooperative learning (peer-to-peer teaching), and teacher modeling thinking out loud (both cognitive and metacognitive thinking).

Shraw (1998b) identified three likely methods that foster development of metacognitive knowledge for all ages: (a) direct learning (often of specific strategies for particular applications), (b) peer-regulated learning (based on modeling of strategy use by more proficient peers or by cooperative problem solving), and (c) autonomous learning (in environments that encourage learners to create their own strategies for problem solving with as little scaffolding as possible and particularly reflecting on those strategies after creation).

Although a person may have the knowledge and strategies to accomplish a particular task, significant effort and persistence is often necessary. Research has shown that a mastery, rather than a performance, orientation is a key characteristic of successful learners. "A number of studies indicate that high-mastery students are more successful overall because they persevere, experience less anxiety, use more strategies, and attribute their success to controllable causes" (Ames & Archer, 1988, in Schraw, 1998a, p. 122). An environment that promotes these attributes should help foster metacognitive awareness.

Summary of metacognitive awareness. Metacognitive awareness is a general capability that can benefit learning, strategic thinking, and problem solving across multiple subject domains. It is first observed in early childhood and generally increases and evolves throughout one's life. Haynie's self-assessment instrument captures adaptive

cognition by measuring the strength of five metacognitive processes in supporting decision making in a dynamic and uncertain environment. The instrument has proven reliability and validity in its application and context. It seems well matched for the requirements of this study.

The development of metacognitive awareness can be fostered with appropriate strategies, particularly within the proper environment. That environment should be mastery-oriented and encourage and support the development of strategies for problem solving within a particular subject domain.

Games and Metacognitive Awareness

This section will present empirical evidence that playing games can engage metacognitive behaviors, plus some indication that games can foster metacognitive awareness. Afterwards, theoretical justification for why games have that potential will be discussed.

Empirical evidence. The literature was systematically searched to find empirical studies of associations between playing games and either metacognitive awareness or cognitive adaptability. Online databases of articles and dissertations were searched first, using the following Boolean expressions:

- (metacognitive OR metacognition) AND (games or gaming)
- ((adaptive AND cognition) OR (cognitive AND adaptability)) AND (games or gaming))

In addition to the individual keywords, this search would pick up keyword terms such as metacognitive awareness, cognitive adaptability, adaptive cognition, video

games, computer games, etc. After this initial search, the reference sections of the articles and dissertations found were used to identify additional studies. However, after both phases of the search, not many empirical studies were found (including zero studies found of associations of playing games with cognitive adaptability). This result is consistent with a previous researcher who found "a remarkably limited research literature in this area" (Henderson, 2005, p. 1).[6]

In view of the lack of research, the conclusions reached in the studies found have been insufficiently replicated to be considered conclusive. Nevertheless, the research provides sufficient evidence to establish a context for this study and to inform aspects of the research design. This literature is reviewed in the following.

In their mixed-methods experiment (Antonietti & Mellone, 2003), 40 undergraduates (mean age of 23 years) played Pegopolis, a solitaire strategy game, as a non-electronic board game and as a video game on a computer. The two versions of the game were implemented as similarly as possible, so that the computer version did not provide extra features beyond the intrinsic features that a computer provides. Those intrinsic features include interactivity, multi-sensory stimulation, immediate feedback, etc. Great care was taken in the design of the experiment to eliminate extraneous effects from confounding variables, such as gender, general intelligence, major field of study, game-playing habits, prior experience with Pegopolis, and any practice effects of playing the game during the experiment. Results showed that the performance levels attained and

[6] The search of the online databases was repeated in May, 2011 and did not find any additional journal articles or dissertations that were relevant to the empirical evidence.

strategies used by the students were not significantly different between the two versions of the game across all of the variables studied.

The two researchers concluded that the associations studied between playing games and cognitive and metacognitive variables were transmedic, meaning that they were due to the content of the game and not on the media on which the game was implemented (Antonietti & Mellone, 2003). A key limitation for generalizing the results is that only one game (i.e., Pegopolis) was used in the experiment.

A number of studies have been conducted to identify the metacognitive processes engaged while playing games in which strategy was important. Most of these studies used qualitative methodologies that were generally based on videotaped think-aloud protocols during game play. Subsequently, interviews were used to gain further insights into the thinking used during play. After data collection, these studies used a grounded-theory coding analysis to identify the cognitive and metacognitive processes engaged. The studies found that strategy games encouraged players to engage in a wide range of metacognitive behaviors (Antonietti & Mellone, 2003; Doolittle, 1995; Henderson, 2005; Hong & Liu, 2003; Horak, 1990; Ke, 2007; Pillay, Brownlee, & Wilss, 1999; Pillay, 2002). Practicing metacognition fosters metacognitive awareness (Papaleontiou-Louca, 2003). Thus, metacognitive awareness should be fostered by playing these types of games.

Even the simplest games can elicit the practice of metacognition and foster metacognitive awareness. For example, there are two basic phases in problem solving: (a) creative thinking to identify possible strategies to use and (b) evaluation to determine

whether the strategy chosen is progressing towards a solution (Doolittle, 1995). Doolittle found that simple word tables, riddles, and simple computer games could encourage college undergraduates to brainstorm multiple solution possibilities and to evaluate their suitability to the problems posed by these "games." More importantly, he found that the primary skill that students learned was a willingness to let go of unsuccessful strategies and try other strategies.[7] In a quasi-experiment, Doolittle (1995) found that undergraduates who played these games subsequently showed increased levels of critical and creative thinking abilities, whereas a control group which did not play the games did not.

At a higher level of game complexity, Pillay, Brownlee, and Wilss (1999) studied the cognitive and metacognitive processes that students used while playing a more sophisticated video game. In their study, 21 high-school students (aged 14 to 18 years) operated a control pad and used onscreen monitors to control the flight of a machine called a "gyrocopter" in the game Pilot Wings. Using a qualitative approach in which the subjects would describe their actions and reasons for them during play, their cognitive and metacognitive processes could be identified. As the players gained experience, they used metacognitive reasoning to move from trial-and-error approaches to more strategic approaches. These strategic approaches combined analytical reasoning in concert with the complex and interacting information structures to make sense of it and properly control the gyrocopter.

[7] This latter ability was referred to as cognitive adaptability by Haynie (2005).

In a subsequent experiment, Pillay (2002) determined using a mixed-methods approach that the students who played the video games showed improved performance in subsequent technology-based educational tasks. Furthermore, the extent of that improvement depended on the types of games played. His experiment utilized a population of 36 students, aged 14 to 16 years and all experienced in playing a variety of video games. They were randomly assigned to a control group or to one of two treatment groups in which each group played a different type of strategy video game. Based on the results as viewed through his theory he concluded that students who play video games use cognitive and metacognitive reasoning to form two types of knowledge schema. One type is functional based on the subject content. The other type is structural based on formatting and organizing the information for more efficient navigation and use of the content. The structural schema appeared to be transferable to other situations, namely the educational-based tasks, which enabled the higher performance. Pillay conjectured that since students play a range of different types of games, they would presumably form a variety of structural schema which could enhance their subsequent performance on technology-based educational tasks.

As novices gain experience playing video games, presumably they would progress in their game-playing abilities for the types of games that their enhanced abilities would enable. As described above, some of those abilities will be general and transferable cognitive and metacognitive abilities. There is evidence that those abilities will provide expertise that is qualitatively different than a novice's abilities. In a mixed-methods experiment, Hong and Liu (2003) showed that novice and expert video-game

players demonstrated qualitatively different thinking strategies while playing the video game "Klotski." This game is a simple strategy game with the goal of moving smaller blocks out of the way so that a larger block can be moved out of an exit. Seventy-six elementary school students were chosen to play this game with the added goal to use as few moves as possible and in the least amount of time. The top five performers were identified as experts and the bottom five as novices. The ten students played the game again while a think-aloud protocol was employed and videotaped to record their thinking strategies while playing the game. Three thinking strategies were identified: (a) analogical (deciding on a strategy to use before taking action), (b) heuristic (taking action with regard to previous results), and (c) trial-and-error (taking action without planning). The main difference shown by the subjects were that the experts used more analogical thinking and the novices used more trial-and-error thinking.

Remember that cognition is the thinking done in accomplishing a task. Metacognition is the reflection on the result of the task and the strategy used in accomplishing it. Going from trial-and-error thinking to heuristic thinking to analogical thinking demonstrates a progression to higher levels of metacognitive awareness. However, does a person progress to higher levels as a consequence of playing the games? This progression is necessary for a novice to improve performance in video games, and it is reasonable to expect that at least some players may progress in that way. In fact, Bartle (2003) noted that it was common for players of multiplayer role-playing games to progress to different playing styles as they became more knowledgeable and familiar with

the game. This progression created a learning mechanism (as described by Bartle later in this chapter) that could foster metacognitive awareness.

In concluding this section, there are two more studies worthy of mention, because they incorporated particular aspects relevant to this study. The first used a proven instrument to measure metacognitive awareness, and the second used a survey that included an assessment of prior game experience.

Ke (2007) studied the interactive effects of a "math treatment" intervention in interaction with alternative "classroom goal structures" on the cognitive and metacognitive processes of 486 fifth graders, randomly assigned to the treatment variations. The intervention used either a math video game or a set of pencil drilling exercises. The alternative goal structures were cooperative (working on a team to support each other in learning), competitive (working to get the top performance compared to others), and individualistic (working independently towards one's own goals without regard to others). The mixed-methods experiment included quantitative measures of cognitive and metacognitive performance before and after the intervention, as well as a think-aloud protocol during the intervention. The experiment was conducted for one month.

Metacognitive awareness was measured with the *Junior Metacognitive Awareness Inventory Version A* (Sperling, et al. 2002), a 12-item self report on a 3-point Likert scale. The quantitative results showed no change in metacognitive awareness as a result of the intervention. Furthermore, the classroom goal structure had no noticeable effect on metacognition. However, the qualitative results suggested that the students who played

the game were more engaged in metacognitive regulation during the game compared to those who did the exercises. The lack of improvement shown by the quantitative results was attributed to the short one-month treatment provided (Ke, 2007).

In the second study mentioned above, Beedle (2005) conducted a survey of people who played online multiplayer video games to determine their perceptions of any learning benefits gained, particularly those involving higher-order thinking skills. He posted the survey on online bulletin boards for multiplayer gamers, and depended on word of mouth and self selection to obtain his respondents. He obtained 346 suitably-completed responses. The results showed that the games encouraged the players to engage in metacognitive behaviors. Those behaviors included: (a) strategy discussions with other players outside the game, including discussions with individuals from a diverse range of backgrounds; (b) joint problem solving with other players; (c) exposure to new ideas; and (d) consideration of multiple options and scenarios.

Beedle's study was the only one I found that used a survey methodology to determine a measure of past game experience (i.e., amount of time playing online multiplayer games per week and the number of years played) and matched that to a measure of higher-order thinking abilities attributable to that experience, albeit the latter measure was based on player perceptions. However, because the survey did not use a randomly-chosen sample of the target population, the results cannot be considered valid beyond the sample respondents.

Theoretical justification. Considering the wide variety of game types, a consensus epistemology that could make the connection between the general principles

involved in playing games and the principles of learning would be useful (Klabbers, 2003). Klabbers considered two epistemological orientations: (a) one based on an acquisition view of knowledge (i.e., the objectivist, traditional view of learning) and (b) the other on an interaction view (i.e., the constructivist view of learning). He considered the former view most appropriate for training and the latter view most appropriate for education. There are different games that can suit each of these two viewpoints. However, games are most powerfully suited for education by allowing the player to construct meaning in interaction with the subject content of the game and with other players (Gee, 2003).

In light of these ideas, Klabbers (2003) rejected the notion that studying individual games in context for deep insights of educational value was necessarily the most fruitful area of educational games research. Instead, he studied game structures and characteristics across a broad range of games. With that knowledge, he developed an epistemology that he operationalized as a "semiotic theory of learning" with a specified syntax, semantics and pragmatics for describing a particular game. The building blocks for his "language" were actors, rules, and resources, which he considered as the units for describing a social system at the roots of his language. The actors are the players who interact with one another and utilize the game resources according to the rules of a particular game. Klabbers' language could be useful for an analyst to describe a game from an epistemological perspective.[8]

[8] In fact, Klabber's language was used to resolve an arbitration case by classifying two similar but different games (2003).

There are a number of theories that explain how playing games can benefit learning. Before discussing them, an operational definition of a game will be presented, and game goals and basic game structures will be discussed.

Definition of a game. Juul claimed that defining the term "game" is a common pursuit for game-studies' researchers (2005). For his part, he compiled definitions for "game" from some of the prominent games' researchers. He then created a new definition that represented a synthesis of the major ideas expressed by those researchers as well as his own insights. According to Juul (2005, pp. 6-7), a game is:

1. a rule-based system;
2. with variable and quantifiable outcomes;
3. where different outcomes are assigned different values;
4. where the player exerts effort in order to influence the outcome;
5. the player feels emotionally attached to the outcome; and
6. the consequences of the activity are optional and negotiable.

The definition contains six conditions that are necessary and sufficient for an activity to be considered a game. Furthermore, Juul (2005) maintained that there are three main perspectives for analyzing a game, the game itself, playing the game, and the relationship of the game and its play with the external world.

The definition reflects the view of game researchers that games are transmedic. In other words, playing a game would produce the same cognitive and metacognitive impacts on a player whether implemented as a non-electronic game or as a video game. However, there are significant advantages that video games can provide that are not

possible for non-electronic games. The computing power in a video game can reduce a player's cognitive load. By chunking data and concepts into higher-level forms (e.g., with visual metaphors), the player can spend more time at a strategic rather than at a tactical level in decision making.

Game goals and basic structures. According to Juul (2005), a clear and explicit goal is a defining characteristic of a game. Some researchers ascribe the main difference between a game and a toy to be the presence or absence of a goal (Caillois, 2001; Crawford, 2011). There is not an explicit goal present in SimCity, and Will Wright, its creator, agrees that it should be considered a toy (Juul, 2005). However, SimCity is often played with a particular goal that the players or someone else (perhaps a teacher) specifies.[9] When SimCity is played with a goal it is a game. On the other hand, it is likely that players would consider it a game in responding to a survey, no matter how they play it.

From a slightly different perspective, Klabbers refers to a game in which the goals and motivations to play the game are embedded in the rules as allotelic; and a game in which the players create their own goals and motivations as autotelic (2003). He claims that in an allotelic game, a player is driven to learn by acquiring information from the game in accordance with the rule-based goals; and in an autotelic game, the player learns by constructing his or her own meaning through interactions with the game and with other players. In this view, an allotelic activity would constrain player actions by the rules, whereas an autotelic activity would provide more freeform play. This difference is

[9] SimCity has received acclaim for its learning potential (Pahl, 1991; Prensky, 2001).

similar to the distinction made by Caillois (2001) between ludus and paidea (or between a game and a toy).

SimCity would be considered intrinsically autotelic where players could explore the results of their different designs. However, if an external source, for example a teacher, established a goal for the game, then the game would be allotelic. Many games include explicit rule-based goals within an elaborate and complex world with sufficient freedom to enable individual players to play the game in either form (or even both forms) as an allotelic or autotelic game. For example, in this type of game, some players may be most interested in winning the game. However, others may be most interested in socializing within the game with other players; and still others may be most interested in killing off the characters encountered. Either of these latter two goals may further the main goal as specified by the rules, but either may be a main goal in itself of the players.

A related concept concerns the distinction between an exogenous game and an endogenous game (Rieber, 1996). In an exogenous game, the rules including the goals stand separate from the subject content of the game. In other words, different subject contents can be switched in and out of a game shell constructed of the rules. For example, games such as hangman, Jeopardy, Who Wants to Be a Millionaire? are games with specific rule sets that can be used with any subject content. However, any type of game that could have a different subject content substituted in without affecting how the players substantively pursue the goal would be exogenous. Conversely, in an endogenous game, the rules and goals are incorporated as part of the subject content. Thus, accomplishing the goal requires reasoning through concepts in the subject content.

The subject content of an endogenous game cannot be replaced with a different subject content simply substituted in its place. In an exogenous game, the goal can distract the player from thinking of the content. An endogenous game requires a person to reason with the content to win the game. Obviously, an endogenous game is more immersive and has more flow potential (to be discussed below) and consequently can better engage a player's attention in the game's content than an exogenous game.

Another prime distinction in types of games concerns the difference between progressive and emergent games (Juul, 2005). In a progressive game a player needs to advance to particular game states that are progressively closer to the goal. Usually this will require that the player follows a particular path, or a relatively small number of possible paths, to successfully accomplish the goal of the game. The rule set of a progressive game constrains the types of strategies and actions that a player might take at any point in the game. The classic example of this type of game is the adventure game. Conversely, the rule set of an emergent game generally allows a seemingly endless number of possible paths for playing. An emergent game will allow the player much more flexibility in creating strategies than the progressive game. Chess is a classic example of an emergent game.

Epistemological theories. CWGs were introduced in Chapter 1. They are often played with other players, but not always. Below is a brief description of a number of epistemological theories that CWGs support. These ideas were mainly informed by Gee (2003), although I have extended them to suggest how CWGs could foster metacognitive awareness.

Situated meaning. CWGs support situated meaning and learning (Gee, 2003). In this orientation, meanings are constructed by the players through interaction and negotiation with others and with the resources provided by the virtual world of the game in the context of specific situations.

I would expect that emergent games, based on more flexible rule sets than progressive games, would better encourage players to create their own meanings and develop more creative strategies to act within the game world. Furthermore, larger, more complex, and more detailed game worlds would provide more opportunities and perspectives from which to create meanings.

Active learning. CWGs encourage active learning, which is a powerful independent-learning mechanism. Active learning in video games involves a cyclical learning process, which is also intrinsic in scientific investigation (Gee, 2003). In this repeating cycle, the player probes the world (i.e., interacts with it); uses the information learned to hypothesize how the world works; re-probes to test the hypotheses; and reflects on what is learned to improve future performance. This process is similar to the one theorized by Kolb to explain the mechanism of experiential learning (Kolb, 1984, as cited in Egenfeldt-Nielsen, 2007); and used by Egenfeldt-Nielsen (2007) at the core of his framework to explain how video games produce learning. In Kolb's cyclic learning process, the player gains concrete experience by interacting with the world, reflects on the observations made, postulates abstract concepts to make sense of the world, and tests those ideas with active experimentation.

Well-designed games provide easily reachable goals early in the game for players to learn basic skills and knowledge required for the game. The game then presents increasingly more difficult goals for continued challenge and motivation as well as to push the player's skill and knowledge development to continue succeeding in the game. A typical game-design technique is to provide increasingly difficult game levels or to enable the virtual character (guided by the player) to increase the character's abilities so that the player can take on more difficult challenges. Games that provide increasingly difficult goals are incorporating Vygotsky's zone of proximal development,[10] a well-known pedagogical technique.

Communities of practice. Players may join a group within a multiplayer game to collaborate and work together, for example, within a guild in a multiplayer game. These groups, which are referred to as affinity groups by Gee (2003), share game interests and values and develop shared game goals and perspectives as they "live" game experiences together.

Gee's affinity groups are similar to communities of practice (CoPs) as described by Wenger (1998). For example, in a CoP, the community members work on their practice, developing tools and resources for their shared use, as well as supporting their fellow-members' improvement, all for the collective good. Newer players (within a game) observe more experienced players, assume greater responsibilities in the practice within their communities, and thereby learn the practice as they move from the practice "periphery" towards its "core." This type of learning can be viewed through the "lens" of

[10] Vygotky's zone of proximal development is described in Driscoll (2000, pp. 246 – 248).

legitimate peripheral participation as described by Lave and Wenger (1991). Improving the practice will enable the group to take on more difficult challenges.

Aside from in-game communities, players may also join online communities outside the game to discuss particular games or genres, including game strategies, game designs, genre characteristics, etc. These groups can also be communities of practice, perhaps focusing at a higher "meta-level" than the in-game communities. Communities of practice, inside and outside the game, will encourage reflection and discussion of the game and meta-game, respectively. Furthermore, role playing will encourage and facilitate that reflection by forcing conscious consideration of identity in decision making as described in the next section.

Role playing and identity transformation. Role playing provides a powerful learning mechanism through identity transformation (Gee, 2003). This transformation can be analyzed by deconstructing identity into three concepts: (a) the player's real-world identity, (b) the virtual identity (through the character played), and (c) the projective identity which is a bridge between the real world and the virtual identity (2003).

When role-playing a character, the player is explicitly aware of the virtual identity in terms of the character's traits, capabilities, and values; as well as the character's limitations and advantages. Furthermore, the virtual character assumes motivations and aspirations that are driven and constrained by the rules, but ultimately demonstrated by the moves that the player directs the virtual character to make. Once the player selects or creates the virtual character, the player cannot affect the character's capabilities directly. Rather, the player influences the development of the virtual character by directing the

characters decisions and actions in interaction with the virtual world and its inhabitants. The subsequent game experience gained by the character provides rewards and penalties, which affects the virtual character's development.

Usually, the player selects a character from an assortment of types (e.g., different "races"), which establishes the initial values of the character's attributes and the ranges of values for those attributes to vary. Then, the player is provided a number of "points" that may be distributed among the attributes to initiate the virtual character as a unique member of a particular character type. Players might create a particular or similar type of character when they play, or they might try out different characters in different games or replays of the same game. Survey data from players of non-electronic role-playing games show evidence that long-time players of the same game (for over five years) gravitate to a particular character they like to play. Before that point, players may try out a variety of characters (Darcy, 2000).

During the game, the player reflects on a projective identity for how the player would like the virtual character to develop. That projective identity reflects the aspirations and values of the player for the character. Conversely, the consequences to the virtual character affect the virtual identity which will cause it to evolve towards or away from the projective identity. In other words, playing the game explicitly exposes identity to the player as the player makes decisions to align the virtual and projective identities. In turn, the degree of alignment provides feedback to the player which may be enabling for the player to transform the player's real-world identity. For example, a

player's lack of self-efficacy may be repaired through this process after persevering to succeed in the game (Gee, 2003).

Finally, when players interact within a game, they bring their own values as well as the values they may adopt for their virtual identities with which they may play the game. However, as the players are members of a community within the game, they develop shared goals and game experiences, which foster group perspectives (and values). All of these perspectives may either reinforce or challenge the player's existing perspectives, which may cause them to assess those perspectives. Gee refers to this process as an "appreciative system" (2003). Recognizing and reflecting on one's values from multiple perspectives to determine action should foster metacognitive awareness.

Semiotic domains. Each game has its own semiotic domain (Gee, 2003) that depends on and is constrained by the game's rule set and enables players to interact with the game (to play it) and communicate with one another. In emergent, multiplayer games, the semiotic domain of each game's communities (i.e., its clans and guilds) as well as the entire game community is not static. A semiotic domain develops within a game's community as the members engage in its practice. The semiotics is a tool that members use to probe and learn about the world and its inhabitants and subsequently to act on those as necessary or desired. Thus, similar to any language, a game's semiotics provides a way of knowing, which is subsequently used to develop tools and resources for the community, including further development of the semiotics.

Games from similar genres will have similar semiotics. Thus, players can more easily learn new games in genres with which they are already familiar. Although the

particular subject content may be new to a gamer, familiarity with the game genre will enable the gamer to more efficiently learn and use the new content. However, there will still be variations across the genre due partially to different subject contents as well as some variations in rule sets.

Mastery environment. A mastery environment provides a comprehensive and realistic representation of the subject domain it supports, which enables nuanced thinking and the development of expertise in that domain. A mastery environment encourages and supports persistence in overcoming difficult challenges that stretch a person's critical thinking skills, but are not overly difficult to cause frustration. The environment will encourage and support calculated risk taking, so that a person might consider and try out more creative solutions. Furthermore, the environment will allow a person to successively try different solutions for the same problem to view and consider the varying consequences.

Although a game might provide frightening consequences to the virtual character, the risks are not real to the actual player. Furthermore, in most games there are ways for the character to recover or rejoin the game anew or for a sequence of the game to be replayed. In other words, the games support risk taking to encourage the player to try different actions in the simulated world. Many of these games support cooperation and collaboration among other players and often as part of teams. The games depend on exploring and interacting with the world to gain continuing understanding of it to support strategies and actions to meet the challenges provided in alignment with the explicit

(allotelic) goals of the game or those created or identified by the players (autotelic), perhaps as sub-goals to the explicit main goal.

In other words, players begin in a world that is mostly alien to them, although they may have prior knowledge of it through reference materials. However, college undergraduates, who are natives to computers and video games (Prensky, 2001a), prefer to learn a game by playing it rather than learning by reading how to play it. In fact, the earlier levels in these games often serve as a tutorial for learning sufficient skills and knowledge to succeed in relatively easy game goals. In games well designed for learning, reaching those goals provide practice to prepare the player for higher levels with more difficult goals. These new goals will require more advanced skills that build on previous skills.

A mastery environment should foster metacognitive awareness by encouraging and supporting the player to: (a) feel safe and take risks; (b) identify, reflect, and decide on strategies, preferably in collaboration with others; (c) monitor progress and results; and (d) take corrective actions when needed.

Game Experience

The key challenge of this study was to create a questionnaire to assess prior game experience that could foster metacognitive awareness. I assumed that game experience is comprised of three dimensions: (a) the types of games played, (b) the playing styles used, and (c) the time spent in playing. There were several difficulties here. For this study to be feasible, the compilation of each person's gaming experience had to be summarized by a small set of descriptors and values. In addition the descriptors had to be relevant to

metacognitive awareness as anticipated by the literature. Numerous game titles have been sold, and it was likely that each study participant would have played different assortments of games, possibly with different playing styles, and for varying amounts of time.

What was needed was a categorization system that could fulfill the needs described above and which a survey respondent could easily and reliably answer. The challenge was to identify organizing principles that have been used or proposed for categorizing games to inform the development of a suitable game-experience model that could be translated to a quality survey questionnaire. These principles could be found in genres, typologies, and taxonomies for categorizing games and game characteristics. In addition, they could be found in the general literature of game studies.

Genre, typology, and taxonomy. The terms genre, typology, and taxonomy have often been used interchangeably in the gaming literature. To avoid confusion, these terms will be described here and used accordingly in this study. Merriam-Webster's Online Dictionary (n.d.) defines genre as "a category of artistic, musical, or literary composition characterized by a particular style, form, or content."

Many researchers have categorized video games into genres. If you analyze the genre collections created by different researchers, you will find that the organizing principles that distinguish among genres are often not orthogonal. For example, it is not unusual for some genres in a single collection to be distinguished based on theme while others are distinguished based on structure (e.g., Wolf, 2002).

For my purposes, the information gained from any set of genres was the one or more organizing principles that were used. My particular interest was in any organizing principle that might distinguish the type or degree of impact on metacognitive awareness. If such an organizing principle was also one that should be clear to the target population of my study, then that principle would serve my purpose. It would distinguish important game structures or characteristics that could impact metacognitive awareness; furthermore, the target population would understand the classification.

Typologies and taxonomies are hierarchically-ordered classifications of a subject domain, for example, video games that are organized based on the main dimensions or characteristics of that domain, in other words, by their "organizing principles." Either of these classification types is different from a set of genres in that a game could be classified in the former case based on the values for a number of characteristics. Some researchers have used the term typology or taxonomy synonymously; however, other researchers have considered these to be two distinct concepts (Lambert, 2006).

In this latter view, a typology is derived conceptually, informed by established theories or from one's own creative insights. Typologies are mostly qualitative classifications. Conversely, a taxonomy is derived empirically by exhaustively compiling the concepts of a domain and determining the emergent categories that best represent the compilation of concepts, often by multivariate factor analysis. A typology is descriptive but has limited generality; a taxonomy is descriptive and predictive. Since a taxonomy is based on an exhaustive compilation of concepts that are organized quantitatively, it is well suited for organizing a database of research of the subject domain (Lambert, 2006).

In considering the progression from initial observations in a new field of research to ultimate theory development based on empirical evidence, it is useful to consider typologies and taxonomies as distinct concepts. In this view, concepts are representations of observations that can be communicated, and theories are organizations of concepts and relationships among them that organize the observations in a way that can usefully describe and predict phenomena arising in that discipline. In this perspective, the information compiled from initial observations and hypotheses could be represented in typologies which could then be used for input to develop a taxonomy. Thus, an empirically-proven taxonomy is a valuable source for developing quality predictive theories (Lambert, 2006).

As defined here, the only taxonomies that I have found in the gaming literature were from studies that classified the motivations and behaviors of players (Alix, 2005; Yee, 2006). However, some researchers have referred to their genre collections or typologies as taxonomies (e.g., Crawford, 2011; Klabbers, 2003; Lindley, 2003). I believe that it would be worthwhile to use these terms (genre, typology, taxonomy) as I have defined them here. In this view, a taxonomy is a worthy goal of game research. However, one has not yet been developed for how different game types could affect a player. I believe that one reason for that lack is that the methodologies most often used in game research have not considered surveying a compilation of game experience over a broad range of game types which could facilitate developing this type of taxonomy. To avoid confusion I will refer to classifications found in the literature according to how I

have defined genres, typologies, and taxonomies here; even though an author might have referred to the categorization otherwise in his or her article.

Game genres. The first set of video-game genres that is commonly referenced by game researchers was created by Chris Crawford (2011), a prominent and prolific video-games designer. He used a top-level organizing principle to distinguish between strategy and action games, based on whether a game required mainly cognitive abilities or mainly perceptual and motor skills, respectively. He identified six genres of strategy games: adventures, dungeons and dragons (i.e., role playing), war, chance, educational and children's, and interpersonal; and six genres of action games: combat, maze, sports, paddle, race, and a final catchall category of miscellaneous.

Since Crawford's set of genres, others have been proposed. Herz (1997) proposed a set based on arcade games (see Table 1), but the set has become recognized as a general set of game genres and has been commonly cited for categorizing video games (Prensky, 2001a). A very large set of game genres was created by Wolf (2002); he proposed a set of 42. His goal was to be sufficiently comprehensive such that most any video game at the time could be best categorized with one of his genres. However, Wolf's set was too large to be used for purposes of analysis. All of the genres would need to be kept in mind for categorization purposes, rather than a small set that a person's mind could reasonably handle.

Table 1

Herz' Set of Video-Game Genres

Genre	Description (from Herz, 1997; Prensky, 2001a; Joseph, 2005)	Example Games (from Prensky, 2001a)
Strategy	Players use long-term and short-term strategies to develop and/or manage a complex entity, for example, an army, a city, a civilization, an anthill, a business, etc.	Civilization, Roller Coaster Tycoon
Simulation	Players must succeed in a simplified, modeled reality of a system, ranging from a simple machine to a complex universe.	Flying or driving things or building worlds such as Sim City and the Sims
Role-playing	Players assume characteristics of some person or creature type and act within character. Characters have traits or powers that grow or diminish based on gameplay.	EverQuest
Adventure	Players explore an unknown world and find objects and treasures and solve puzzles.	Zork, Myst, Riven
Puzzle	Players solve simple, generally visually-based problems, without any story involved.	Tetris, Devil Dice
Sports	This is the one category in this set of genre which is determined by a particular content.	Action games based on baseball, football, soccer, etc. Also, more statistics-oriented sports games like fantasy baseball.
Action	Players mainly utilize perceptual and reaction capabilities, although short-term (tactical) decisions may be required.	Super Mario, PacMan, Doom, Quake, Unreal Tournament
Fighting	Players fight computer-controlled characters or those controlled by other players.	Mortal Kombat, Virtual Fighter MMMCIII

Note. This table was based on the information in (Herz, 1997; Prensky, 2001a; Joseph, 2005).

As Järvinen noted (2008), genres are not static and they evolve and change as the literary form (i.e., video games) evolves and changes. Also, genres die out. According to Bowen (2003), puzzles are a dying game genre and many elements of adventure games, both text and graphics, have been absorbed into other genres.

An alternative method to provide finer distinction between games that a person could reasonably handle would be to define subgenres for each of a small set of primary genres. Järvinen specified seven primary genres (similar to Herz' set, Table 1) and subgenres for each (2008). His set, with the subgenres in parentheses, included: (a) action games (combat, space, adventure, rhythm), (b) game-simulations (management, transport, social, sports), (c) games of chance (draw, betting), (d) puzzle games (movement and arrangement, mechanical and assembly, adventure), (e) role-playing games (tabletop, live-action, digital), (f) sports games (race, comparison), and (g) strategy games (race, space, chase, displace, outplay, exchange, comparison).

Educational-game genres. There are several specific genres that are not identified in the compilations above that should be mentioned in this discussion because of their historical significance relevant to education. Those genres include edutainment, serious games, and immersive learning simulations. The edutainment genre grew out of the early efforts of companies to develop games specifically for education. Many of these games were skill-and-practice programs that incorporated gaming aspects, but did not provide good gameplay, that is, the enjoyable experience of playing a game (Egenfeldt-Nielsen, 2007). This genre developed a negative reputation, and companies stopped marketing educational games as edutainment (2005).

"Serious games" is a more recent genre which signifies games that are not only fun but also serve a serious purpose such as education or public advocacy. The Serious Games Initiative was founded to promote this genre and has worked to establish it as a stable sector of the video-game industry (Wilson Center, n.d.). Because of its purpose as well as the industry, government, and academic support it has garnered, it is reasonable to expect that it should have strong principles of learning purposely incorporated into it. However, at the Serious Games Summit in 2006, a panel of games' experts questioned the strength of this sector and suggested that these games do not compare well in gameplay to commercial games (Terdiman, 2006).

The eLearning Guild (Wexler, et al., 2007) has promoted a new term for educational games, immersive learning simulations. This genre has been proposed for several reasons. First of all, previous genres that specifically targeted the educational market, such as edutainment and serious games, have been "stuck" with derogatory connotations. Also this term does not specifically reference a "game," which was anticipated to improve its marketability to industry executives (2007). There are critics who have claimed that there is not definitive proof that games are an improvement or even equal to traditional educational strategies. However, it has been generally conceded that simulations are useful educational tools (Cannon-Bowers, 2006, as cited in Blunt, 2006).

Massively, multiplayer online games (MMOGs). Many casual games (as well as classic games, such as chess, poker, and bridge) can be played online. These online games are often supported by communication facilities, so that the players can chat with

each other outside the gameplay. These online games have become extremely popular and have spawned online communities with many players as interested in the player interactions as the gameplay itself, or even more so. These types of games are not MMOGs.

MMOGs trace their origin to adventure games and multi-user dungeons (MUDs) implemented on university computers. An adventure game enables a player to solve puzzles in order to explore a virtual world and score points by finding treasures; or, in some games, win by accomplishing a theme-based goal situated in the game. The "world" is comprised of a network of connected "rooms," each separately and perhaps elaborately portrayed. The first multi-user adventure game was created and written by Roy Trubshaw and Richard Bartle at Essex University in the UK (Bartle, 1999). They named their creation MUD out of respect for the popular Dungeons and Dragons game that originated the adventure game genre, originally implemented as a tabletop game. Trubshaw and Bartle as well as others continued development of the original MUD as well as new MUDs based on different themes.

The first MUDs were text based; later, two dimensional (2D) and then three dimensional (3D) graphical representations were created. These virtual worlds were persistent, meaning that the state of the virtual world and the characters in it would remain in the same state while individual players might leave temporarily and come back later. Furthermore, there was no overall end state, in which winners could be declared. Still, game goals could be provided within the game to provide challenges for the players.

The initial MUD included combat facilities and was clearly a game. However, other MUDs were created that did not include combat, so they were actually virtual worlds in which players could interact with each other. The evolution of this latter path has led to social spaces such as Second Life. The line between games and social spaces has not always been clear. However, this study was concerned with activities that are mainly games rather than social spaces. Over time, the MUD technology was improved, and games based on this technology were commercialized. Eventually, thousands of people could play simultaneously. These games became known as MMOGs, although the number of players that would distinguish MMOGs from multiplayer games has never been specified.

MMOGs are important because millions of people play them. In addition, many people can play the same MMOG simultaneously with the possibility of interacting with others individually or as teams. The different types of interactions that occur should likewise have different impacts on players' cognitive and metacognitive processing.

The most popular MMOG, the World of Warcraft, attained over nine million subscribers in 2007 (Gamasutra, 2007). The MMOG technology limits the ability for all subscribers to interact with each other simultaneously. The solution is to use separate servers, each supporting a portion of the subscribers who are playing at any given time, and limiting their interactions to others on the same server. Some games have provided the ability for players to cross over to other servers, perhaps dividing the universe into separate worlds, each on its own server. One MMORPG, Eve Online, hosted 41,690 simultaneous users (i.e., on a single server) on December 9, 2007 (Eve Online, 2007)

Other types of games have been played online in large communities with the possibility of players interacting with others within or outside the game. These games have included the "classics" such as chess, bridge, poker, etc. in which the interactions within the game itself are limited to a small number of players. However, interactions among players in the community (which might provide different types of relatively "casual" games) are much more widespread. The distinguishing characteristics of MMOGs are that many players can play them simultaneously and interact with other players with the games; the games are played in virtual worlds or universes that are persistent, and the games are rarely reset; there is in-game support for clans and guilds (i.e., groups of players who want to play together within the game); and the games never reach a clear end point as are single-player games.

Game-study typologies. Using the industry-based genres as identified above might not be the wisest choice to compile an assessment of a person's game experience for this study. It would be more desirable to use a relatively small set of organizing principles that were clearly defined and orthogonal to one another. The principles selected would also need to have an anticipated effect on metacognitive awareness, and they would need to be convertible to reasonable survey questions.

Researchers in game studies have recognized the need for a framework and common terminology for analyzing and discussing the structure of existing games as well as new game designs (e.g., Kreimeier, 2002; Björk & Holopainen, 2003; Klabbers, 2003; Lindley, 2003). Based on such a framework and terminology, high-level game classification systems with orthogonal categories have also been needed (Lindley, 2003).

With such a system a game could be specified by a collection of variables, not just fit into a single genre category. In answer to these needs, a variety of different frameworks and classification systems have been proposed. These ideas were considered for distinguishing game types and are discussed below.

Caillois' typology. When researchers discuss game classifications, they usually begin with the work of Roger Caillois, a French psychological anthropologist. Caillois characterized all of the world's "games," which he considered in the broadest sense of pleasurable activities, by two dimensions: the type of activity and how it is played (Caillois, 2001). He categorized the type into four classes, which he named: (a) *agon* (competition), (b) *alea* (chance), (c) ilinx (vertigo), and (d) *mimcry* (simulation or make-believe). The class agon represents activities with competition as the main feature and would include most sports and athletic events as well as any type of strategy game. Alea is the class for any activity primarily based on chance. Ilinx includes any activities that alters consciousness, for example, riding a merry-go-round or skydiving. Finally, mimcry includes activities that are based on alternate realities, such as dance, theater, and the arts. Any game could be characterized by one of these classes, based on the dominant nature of the game. However, a game will often contain characteristics of more than one class. For example, a role playing game (mimcry) such as Dungeons and Dragons is also a competition (agon) and also contains chance (alea). A racing game (ilinx) is also a competition (agon) and could include chance (alea).

Caillois' second dimension characterized how an activity is engaged, either as ludus (requiring effort, patience, and skill) or paidea (characterized by carefree gaiety and

free improvisation). Ludus is most characteristic of playing a game whereas paidea is most characteristic of playing with a toy. Game researchers often make the distinction between a game and a toy, and this is one of the earliest ideas that inform that distinction.

Caillois' typology includes the type of organizing principles that game studies will provide. However, the Caillois principles do not provide sufficient resolution to distinguish types of games by their anticipated effects on metacognitive awareness.

Juul's typology. Video games are half real in that they are based on rules, and they are half fiction in that they may represent a world that is created on an audio visual display (Juul, 2005). Juul created a typology of games that is useful in representing the dichotomies that exist based on these ideas (see Table 2). As mentioned in Chapter 1, I have used Juul's description of coherent world games to identify the type of games that would most likely foster metacognitive awareness.

Aarseth's typology. Aarseth, Sunnanå, and Smedstad (2003) created a typology of games based on a systematic methodology. They compared two similar games to each other in order to find a principle difference between them, with a separate value assigned to each game. Next, they tried to apply the principle to other games. If another game would not fit either value of the proposed principle, they would introduce a third value. If that wasn't possible, the principle (i.e., dimension) would be rejected as too arbitrary. They continued this analysis iteratively until they reached what they considered a suitable list of dimensions and values, which became the typology. The resulting dimensions were intended as sufficiently general to apply across all types of games that are based on spatial movement, including video games, non-electronic games, and even athletic

games. As an example of Aarseth's typology, four of its dimensions are shown in Table 3.

Table 2

Juul's Video-Game Typology

Type	Description	Example Games
Abstract	The game in its entirety or separate pieces doesn't represent any reality other than what is constituted by the rules.	Checkers, Tetris
Iconic	Individual parts have meaning in reality but the context or world is abstract.	A deck of cards in which the Jack, Queen, and King each conveys a real entity, but usually within an abstract context
Incoherent world	Game is based in a fictional world[a] created by rules and representations, but it has significant discontinuities from reality that prevents suspension of disbelief.	Donkey Kong in which Mario has three lives by the rules, which is not supported by a plausible rationale within the fictional world
Coherent world	Game is based in a fictional world created by rules and representations, and suspension of disbelief may be continuously maintained.	Strategy, simulation, adventure, or role-playing games; all as defined by Herz (1997) in Table 1
Staged	Special case in which a game on the abstract-side of this "scale" is played in a fictional world.	"Shenmue (Sega-AM2 2000) where protagonist can play games on in-game arcade machines" (Juul, 2005, p. 133)

Note. This table was based on Juul's description of his typology (2005, pp. 131-133).
[a]A "fictional world" refers to a world based in fantasy or reality.

Table 3

Aarseth's Partial Game Typology

Dimension	Value	Comments
Perspective	Omni-present	Can view the entire field of play
	Vagrant	Perspective follows a main character (i.e., an avatar)
Player Structure	Single player	Single player against computer
	Two player	Playing against each other or each independently against the computer
	Multiplayer	All independent from each other
	Single team	At least two players on one team
	Two team	Playing against each other
	Multi-team	Play as a team against other teams or against the computer
Mutability	Static	Player's character does not change during game
	Power-ups	A temporary increase in one or more of a character's traits
	Experience-leveling	A permanent increase in one or more of a character's traits
Savability	Non-saving	Game cannot be saved; cannot be restored to earlier position
	Unlimited	Game can be saved at any point and restored to that point later
	Conditional	Can store game at certain points during game

Note. This table was based on the information in (Aarseth, Sunnanå, & Smedstad, 2003).

The typology developed is broad and comprehensive, and the dimensions can be logically linked to varying potential impacts on metacognitive awareness. For example, consider the savability and mutability dimensions. Whether a game can be saved or not could have an impact on the level of risk that a player perceives in considering novel strategies. The mutability dimension affects whether and how a player's character can change as a result of playing the game. A game with more mutability might encourage more immersion of a player into his or her character and intensify the experience of that perspective. More important is the player-structure dimension, which has a large impact with how players interact with each other (or with no one else in a single player game).

Lindley's organizing principles. Another interesting game-categorization system was created by Lindley (2003) and his colleagues at the Zero Game Studio of the Interactive Institute in Sweden. This system "locates" a particular game or type of game within a design space created by a small set of orthogonal dimensions that represent fundamental characteristics of games. Four of the characteristics include ludology (gameplay), narratology (telling a story), simulation (modeling the subject content), and gambling (chance). In this system, ludology refers to how the game can be played as established by the rules, which is a broader range of play than the actual intent of the rules. Ludology, narratology, and simulation can be combined to form a game space that is represented by a triangle, with each of these characteristics as points. This construction yields three edges, referred to as dimensions. A point within the space represents the relative importance of each of these characteristics of a particular game or type of game. For example, chess would be located near the ludology vertex. A role-playing game

would be located near the center of the triangle because that type of game could combine substantial amounts of gameplay, simulation, and a story. Chance adds a fourth vertex to the game space, which can thus be represented as a tetrad. A game of pure strategy, such as chess, would remain on the ludology-narratology-simulation triangle. However, chance could be introduced into a role-playing game, which would place this game type within the tetrad volume.

Lindley (2003) identifies two more important dimensions for classifying games, the game's authenticity (fiction or non-fiction) and the game's "virtuality" (virtual or non-virtual). A virtual game is played within "computer space;" a non-virtual game is played in physical space (e.g., on a board, as a card game, or out in the actual world). A particular game can be located at any point along each of these two dimensions. For example, the "disease-simulation game" was developed at MIT for students to learn how disease is spread based on a "participatory simulation" (Colella, 2000). This game is based on a model that is intended to approximate reality, so it would be located on the non-fiction side of the authenticity dimension. However, the game would be located in the middle of the virtuality dimension because it is played on a mobile device as well as in physical space. Players move in physical space and interact with other players to find the source of an epidemiological infection. Each player has a mobile device that maintains contact with other players' devices and keeps track of the local and global game spaces.

For each of the two dimensions, authenticity and virtuality, it may be useful to show the game space of the ludology-narratology-simulation triangle extruded along the

corresponding dimension. The "Lindley system" is useful to consider because it can represent an important and high-level perspective of the entire game space with relatively few organizing principles.

Järvinen's List of Themes. I anticipate that metacognitive awareness may be positively correlated with the breadth of themes in a person's game experience. Game themes can be as numerous as there are subject domains. However, to get an idea of the types of game themes, I turned to Järvinen's list based on his study of over 100 games (2008). His list of themes included: abstract, arts, athletics, cartoon, chance, conquest, contest, crime, dance, dining, drawing, fantasy, geopolitics, horror, hunting, literature, medieval colonies, martial arts, music, nature, pets, physics, science fiction, society, space travel, travel, treasure hunt, trivia, urban real estate, verbal communication, war, war (science fiction), wealth, winter sports, and words. Playing games with a wide variety of themes could enhance transferability potential and thus enhance the potential to foster general metacognitive processes.

Gamer motivations. Although a game could have the potential to foster metacognitive awareness, the extent that it will is dependent on how a person plays the game. For example, in an MMORPG game, some players might play it to succeed based on the goals of the game while others might be using the game space mainly as an excuse to socialize. Both would be playing the same game, but they would each be experiencing it differently. Consequently, any impact of the game on their metacognitive awareness could be different as well.

Motivations versus behaviors. The literature on the motivations for playing games is intertwined with the literature on playing styles. That makes sense because a person's motivations for playing games should reasonably translate to the types of games played and how they were played. Considering that the range of different types of games is so immense and that the same game can be played differently by different people, a person's motivations could be satisfied if desired. Furthermore, considering the huge investment in time that many people put into playing these games, particularly MMORPGs, it would seem that people would play in a way to satisfy their motivations for playing. This section will discuss the literature that references motivations and playing styles (and other synonomous terms such as playing behaviors which is often used as a synonym for playing styles). However, the case will be made in Chapter 3 that the GEQ should assess players' motivations rather than behaviors, because the assessment of motivations is anticipated to be more valid and reliable based on a survey.

Early Studies of Gamer Motivations. One of the main reasons that educational researchers were originally interested in studying games was their observation that students were highly motivated to "work" hard in playing the games, and they did appear to be learning something, whether what they were learning was educationally valuable or not (Egenfeldt-Nielsen, 2007). Consequently, researchers began studying why games were so engaging and motivating. The seminal research in this area was done by Thomas Malone (1980a). Malone surveyed the video-game preferences of 65 elementary-school students. He also studied the students while they each played multiple versions of particular video games. In each version, a particular feature of the game would be

changed to study its effect on the appeal of the game to the students. Malone determined that the main characteristics that motivated students to play video games were challenge, fantasy, and curiosity (1980a, 1980b). In further study Malone and Lepper determined that control and interpersonal interactions were additional motivators (1987).

In discussing the intrinsic motivation of games it is also essential to discuss the concept of flow, a term coined by Mihaly Csikszentmihalyi (1990). Flow is the state that produces the optimal experience and is the greatest source of happiness for a person. The eight characteristics that are associated with the flow state are: (a) clear goals, (b) clear feedback on goal progress, (c) optimized challenge, (d) feeling of complete control, (e) free from worries because so absorbing, (f) disappearance of self consciousness, (g) time forgotten, and (h) completely absorbed attention. The first four of these characteristics can be considered to facilitate flow because they are coincident with conditions that can be designed into an activity to help produce flow. The last four characteristics are coincident with the whole experience of being in the flow state and would be difficult to enable directly by specific design specifications. Flow is so important because it produces an intense focus on the task at hand. Increasing focus should amplify any cognitive effect produced by an activity.

The structure of video games facilitates flow (Bowman, 1982, as cited in Egenfeldt-Nielsen, 2007). In a study based on player interviews, Bowman identified the reasons: “clarity of task, choice in problem-solving strategy, possibility for self-improvement, balance between skills and challenges, clear feedback, enjoyment while learning and lack of fear of failure” (2005, p. 83). Jones (1998) described how each of

the eight characteristics of flow is manifested in video games, and how that understanding can be used to design more effective learning environments. He noted Rieber's description of these endogenous environments in which the content and structure are so intertwined that "one cannot tell where the content stops and the game begins" (1996, as cited in Jones, 1998, p. 6). To create these types of integrated environments "one must consider carefully an integration of the content, the controls, and the patterns of interaction" (Jones, 1998, p. 9).

As mentioned above, Malone and Lepper added interpersonal interactions (i.e., cooperation, competition, and recognition) to his list of motivators in a later extension to their research (1987). That addition came about after games evolved to be playable online with many people interacting with each other within the game space.

Qualitative analysis of playing styles. Bartle (2003) intended the first MUD as a game and as a space to explore identities. As an administrator of the MUD, he started an online debate among the "wizzes" (highly experienced players) with the question, "What do people want out of a MUD?" The debate continued over a six-month period and contained several hundred postings, some lengthy. Fifteen wizzes contributed regularly and another 15 contributed now and then. Bartle analyzed the rich archive of information to discover what people most liked to do in MUDs. He found four patterns that were constantly repeated. He named the types achievers, killers, socializers, and explorers. Achievers are focused on the goal and want to gain points and succeed in quests. Killers like to pester other players and sometimes "kill" them. Socializers use the game space more as a place to socialize than play the game. Explorers are interested in knowing

everything they can discover about the virtual world as well as its underlying mechanics. Bartle found that any person would be a composite of the four types but would show predominance for one of the types (Bartle, 1996).

On further analysis Bartle determined that the four types could be represented by two dimensions (1996). The first dimension is a focus on the world versus a focus on the players. The second is a focus on action as opposed to interaction. In other words, would the player rather cause an effect on another player or on the world, or rather, would the player interact with the world or with a player to learn more about them? In a subsequent paper, Bartle (2003) introduced another dimension that he had found in the original data. That third dimension was implicit versus explicit. Would a person take action without thinking about it first or use forethought in taking actions? With these three dimensions, Bartle identified eight types (2003). The types he found for two and three dimensions are shown in Table 4. For example, as shown in the table for the 2D model, socializers interact with players. In the 3D model, friends interact with players without forethought and networkers interact with players with forethought.

Table 4

Bartle's Gamer Types in Two and Three Dimensions

Type (for 2D)	First and Second Dimensions		Type (for 3D)	Third Dimension
Achievers	Acting	World	Opportunists	Implicit
			Planners	Explicit
Killers	Acting	Players	Griefers (i.e., give grief to)	Implicit
			Politicians	Explicit
Explorers	Interacting	World	Hackers	Implicit
			Scientists	Explicit
Socializers	Interacting	Players	Friends	Implicit
			Networkers	Explicit

Note. This table was based on the information in (Bartle, 2003).

Bartle (2003) observed that players did not remain the same type throughout their game-playing experience. He found that many players progressed from killer to explorer to achiever to socializer (in the 2D model). With the greater resolution offered in the 3D model, refined descriptions of the trajectories found (i.e., the "player-development tracks") could be made. He found four trajectories by empirical observation which he named and described as follows:

1. Main (the most common): Griefer (see Table 4) to scientist to planner to friend;
2. Socializer: Griefer to networker to politician to friend;
3. Explorer: Opportunist to scientist to planner to hacker; and

4. Minor: Opportunist to networker to planner to friend.

Interestingly, each sequence begins as implicit, goes explicit, and returns to implicit. This basic sequence reflects a learning cycle described by Bartle (2003) as:

1. Locate: "Find what you can do—your primitive actions;"
2. Discover: "Seek out meaningful combinations of these actions;"
3. Apply: "Perform these combinations until they become second nature to you;"
4. Internalize: so that these combinations "become primitive actions for you."

This sequence also generally corresponds to a progression of greater immersion in the world. Game challenges cause changes in a person's real-world identity and projective identities so that they drift toward each other and align.

Aarseth, a prominent game-studies' researcher (and a games player for over 25 years), noted that the four Bartle types (in the 2D model) seemed intuitively correct to him. Furthermore he believed that those types would be representative of those in any game in which there were interactions among participants within an online community. However, he thought that one more type should be added, namely the cheater (Aarseth, 2003). This type uses "cheat codes" or "walk-throughs" that might be available or discoverable outside the normal game space, for example, in online fan discussions, to avoid working through problems as intended by the game. This type could be arguably absorbed by Bartle's explorer, but in Aarseth's usage the Explorer type discovers the game's secrets within the context of playing the game.

Factor analysis of playing styles. More recent research into the motivations of why people play MMORPGs reference Bartle's work as a starting point, but they

advocate an empirical approach based on a survey methodology and factor analysis (Alix, 2005; Yee, 2006). The first step in this approach is to come up with as complete a list of motivations as possible. Next, the respondents are solicited to rate how important the possible motivations are to them. These responses are then fed into the statistical analysis which divides the possible motivations into separate groups, termed factors. The motivations comprising each factor are those that are best correlated with each other insofar as most responses for that factor, but the factors are orthogonal to each other. In other words, given that each respondent represents a composite of a certain amount of each motivator, the set of factors found will provide the best odds that each respondent will be most compatible with one of the factors. The next step in this process is to label each factor based on its composite of motivators. The beginning and end of this process are clearly subjective. In other words, the list of initial motivations used is dependent on the effort and bias and methods used by the researcher. The factors determined will be based on those and not any that have been unidentified. Likewise, the labels given to each ultimate factor are also subjective.

Alix (2005) and Yee (2006) conducted separate and independent studies using factor analysis to determine the playing motivations of online gamers. Their target populations were MMOG and MMORPG gamers, respectively. Alix anticipated that his population was biased towards "dedicated and expressive gamers in the West." Yee's population was biased towards Everquest players (i.e., 82% of the responses).

Both researchers began with Bartle's four types to brainstorm a more comprehensive list of motivators. Each used separate methods from that point to come

up with their final set of factors. Alix referred to his final four factors as behaviors. Yee was adamant that his factors were motivators and not behaviors; and, strictly speaking, he was correct. In fact, both wrote that they were determining the motivations of gamers with their questionnaires. However, as I described above, motivations and behaviors insofar as playing video games are intertwined. Alix's assumption that motivations can predict the behaviors of gamers is not an unreasonable estimate.

Both researchers implemented their surveys on the web. The respondents were self selected, and neither study used a sample frame and random sampling to collect their data. It is true as Yee mentioned that a relatively small sample can represent a large population. In fact, there are millions of MMORPG gamers. Yee collected 6700 responses (2006), and there are additional steps he took that could arguably reduce the coverage and sampling errors. Alix collected 1178 responses (2005). However, there is no denying the fact that both surveys were statistically invalid for representing the target populations. Dillman, an expert in survey methodology, compared survey results that were generated with self selection and with random sampling (2007). The results were qualitatively different. The results using random sampling from a proper sample frame were proven correct, based on the results of a subsequent marketing campaign, even though the self-selected sample was much larger than the random sample. In considering Yee and Alix's studies, it is possible that certain gamer archetypes might have characteristics that would preclude them from volunteering for a survey. This is particularly a concern because the studies were investigating gamer motivations. I

believe that these studies were useful, but they should be considered exploratory rather than confirmatory.

Alix determined that there were four archetypes that he labeled: (a) warriors, (b) narrators, (c) strategists, and (d) interactors (in order of distinctiveness in the factor analysis). Yee's analysis resulted in ten motivators that he further organized under three overarching categories. Those three categories with their respective subordinates in parentheses are: (a) achievement (advancement, mechanics, competition), (b) social (socializing, relationship, teamwork), and (c) immersion (discovery, role-playing, customization, escapism).

This preceding background on player motivations and playing styles was used to inform the development of the playing-style dimension of the GEQ as discussed in Chapter 3.

Demographics and Preferences

For this study, it was important to understand gamer demographics and how gamer preferences varied across those demographics. This understanding was necessary to choose a suitable target population, to improve understanding of the results, and to predict whether the results could be generalized to other populations.

As video gaming has infused our culture, gamer demographics have become more representative of the general population (Fattah & Paul, 2002). In 2007, the Entertainment Software Association sponsored its yearly survey of video-gamer demographics and preferences (2007). The survey gathered data from "1,200 nationally representative households" that were identified as owning a console or computer used to

play video games. The survey found that 67% of American heads of households played video games. Adult gamers had been playing for an average of 13 years. The average age of gamers was 33 years; 28% were under 18, 48% were 18 to 49, and 24% were over 50 (2007). This last figure represented a dramatic change. In 1999, only 9% of gamers were over 50 (Entertainment Software Association, 2005).

In addition to who plays, it was also important in this study to estimate how often they played. In 2006, the Associated Press and AOL sponsored a survey of 3024 adults, of which 1206 (40%) said they were gamers (Gamasutra, 2006). Of the gamers, 32% played less than an hour a week, 34% played 1 to 3 hours, 23% played 4 to 10 hours, and 10% played 10 hours or more.

Genre preferences. In the Associated Press and AOL survey (Gamasutra, 2006), the gamers indicated their genre preferences: 37% played action, sports, or shooter games; 31% played strategy, adventure, role-playing or simulation games; and 29% played casual games (e.g., card or board games converted to video games). Also, 28% of the gamers played with others, 63% played only alone, and 8% played equally with others or alone (2006).

RPGnet, an independent website for tabletop (or paper-based) role-playing games, sponsored a survey for the markets of tabletop role-playing games (TRPGs), computer-based role-playing games (CRPGs), and miniatures wargames (MWG) in 1999 (Dancey, 2000). The survey implementation was designed to provide a representative sample of the national profile of their gamer market for the age range of 12 to 35 years (truncated to 35 for a more manageable analysis). (It should also be noted that more than half the

market was found to be older than 19 years.) The most notable result was that gamers would mostly or exclusively play a single genre, whether it was RPG, CRPG, or MWG. The markets for these three genres were estimated to be about 2.25 million, 4.5 million, and 3.7 million people, respectively, for those who played monthly. These three game genres were each cognitively intense, were either non-electronic or video-game based, and comprised three mainly distinct populations of gamers. One final finding was that it took about five years for a player to master the role-playing genre and to know the type of character that the player would most like to play.

College students. Prensky has argued that those who have grown up with computers, the new multimedia, and video games think and process information differently than those who were in older generations and were first introduced to computers as adults (2001a). He pointed to research that the brains of this newer generation showed important differences than those of older generations (Prensky, 2001b). Prensky referred to the former group as natives and to the latter group as immigrants. For those older adults who still felt alienated to computers, he referred to as aliens. It is likely that basic game preferences and playing styles would be different among those different groups.

Although many adults of all ages now play video games, today's college students have stood out. A comprehensive study of college students' video-gaming behavior was reported by Jones (2003). That study relied on surveys, observations by graduate student researchers, and materials from previous studies. The study was conducted at 27 colleges and universities, and 1,162 surveys were returned. The results showed that 65% of

students were occasional or regular game players. Perhaps the most interesting result they found was that video gaming was integrated into student life, unlike older adults who compartmentalized their leisure activities. The researchers found that students often played video games while multitasking with other activities, including studying. Thirty-two percent played games during class. Clearly, college students would fit Prensky's category of "natives."

Selecting the target population. Gaining access to a suitable population was considered a major challenge. The target population was intended to have a wide range of video-game experience, from those with little or no video-game experience to those with substantial experience of the type most anticipated to foster metacognitive awareness. Furthermore, the population selected should be expected to respond fully and honestly to the survey. The full criteria used in selecting the target population are summarized in Table 5.

With the selection criteria set, potential populations were identified and evaluated against the criteria. Two basic types of populations were considered—populations of gamers and populations without regard to particular game ties. The latter type of population could be considered because gamers now represent a substantial portion of the population, and they have become increasingly representative of the general demographics. Thus, a suitable general population would be anticipated to have sufficient gamers for the study.

Table 5

Criteria for Selecting the Target Population

Criteria	Explanation and Comments
Adults over 18	My personal interest concerns adult learners. Furthermore, this will avoid the consent issue for minors.
Good anticipated response rate	Special influence is available, for example, access to an influential member or leader who could appeal to members on my behalf.
Quality sample frame anticipated to be available	Access to population is sufficient to draw a quality sample frame.
Good sensitivity expected to MA stimuli	MA stimuli are anticipated to register a measurable MA increase.
Good distribution of game experience in type and extent	Population members represent a wide variation of different types and amounts of game experience, including those with little or none.
Minimal effects expected from confounding variables	Confounding variables can be accounted for or controlled sufficiently so that effects of variables studied can be detected.
Minimal budget needed for survey implementation	Limits on the above criteria based on practicality and feasibility will be necessary.

The populations I considered included players of World of Warcraft (a particular video game); players of massively, multiplayer role-playing games (a particular video-game genre); employees of a government agency (e.g., the National Institute of Standards and Technology); students of the Defense Acquisition University; and college students from George Mason University (GMU).

I decided that first and second-year students from 18 to 21 years old from GMU would best meet my criteria. Based on video-gamer demographics, this group was likely to have a large percentage of gamers who would be active in gaming (Jones, 2003). Furthermore, their gaming experience would likely vary widely across the group in the types of games they played, how they played, and how much they played (2003). Metacognitive awareness should continue to develop for these students during their college years and throughout adulthood (e.g., Rasnak, 1995; Schraw, 1998a; Schraw, 1998b; Papaleontiou-Louca, 2003; Cooper, 2005; Vukman, 2005).

Consequently, I expected that they would be receptive to the types of stimuli that should foster their metacognitive awareness. Also, because they were traditional-age college students, confounding effects based on age and work activities should have been relatively similar across the population (compared to populations with broader demographics). I chose to focus on first and second-year courses because I expected to find larger classes of students than in upper level courses, which would make surveying them easier. Finally, I expected that my status as a GMU doctoral student would provide me good access to that population.

Chapter 3: Conceptual Framework

I used the IDEF0 methodology[11] to think through, develop and present my thought process for creating the GEQ. An IDEF0 diagram shows the activities and data flows of a process. Figure 1 provides a brief summary of the conventions used in the process diagrams presented in this study.

Figure 2 presents my belief for how playing games could foster metacognitive awareness. The particular game that a person selects to play is of a particular type and has a particular set of game behaviors that are possible for that game. For example, if a person decides to play chess, it is possible to create complex strategies, but it is not possible to engage in role playing. The player might have the available games at home, or perhaps would browse a video-game store or an online catalog to rent or buy the game desired. After playing a game, the player assesses the enjoyment of the experience and gains further knowledge of the types of behaviors that are possible in that game. Those two outputs provide feedback to the player for selecting future games and game behaviors.

[11] The Integrated DEFinition Language (IDEF) is a methodology that uses a graphical-representation scheme to model the activities, information flows, and dynamics of a complex system or enterprise; it was developed for the U.S. Air Force (USAF, 1981). IDEF0 refers to the component of IDEF that is used for activity modeling. Because the data flows are named inputs, controls, outputs, and mechanisms (in clockwise order), IDEF0 diagrams are also referred to as ICOM diagrams.

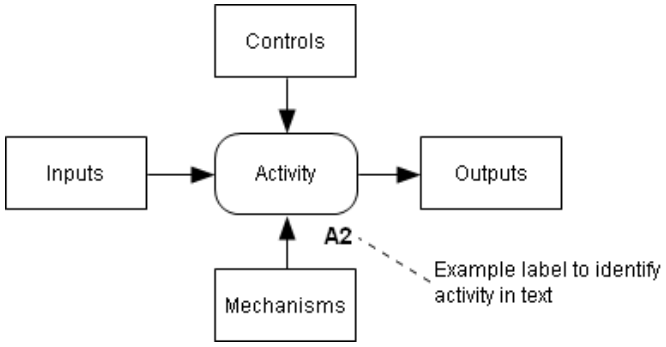

Figure 1. Summary representation of an IDEF0 process diagram. The diagram uses customized conventions to facilitate my creation of it with common computer-graphics programs. An IDEF0 diagram should contain three to seven activities and the associated data flows among them. The rounded rectangle represents an activity (or process); the rectangles represent data; and the arrows represent the directions of data flow. The data denote physical and abstract "object" representations, not the objects themselves. Inputs are used by the activity, and the activity generates outputs; controls represent constraints or drivers of the activity; and mechanisms provide the capabilities used to operate the activity. Mechanisms could include a person with particular capabilities or perhaps a software application. It is important to note that an IDEF0 diagram does not indicate the timing of activities. In fact, the activities shown in an IDEF0 diagram could all be concurrent.

Based on my beliefs, informed by the literature, and informed by the process represented in Figure 2, I created the GEQ based on the process represented in Figure 3.

The data acquired from the GEQ was analyzed in two phases. Phase 1 was used to address the study's main research questions; Phase 2 was used to draw further insight and possible new discovery of relationships between game playing and metacognitive variables. Furthermore, Phase 2 enabled the collection of additional data which could be used in case the Phase 1 criteria for categorizing games did not enable a sufficient distribution across game types for a valid statistical analysis.

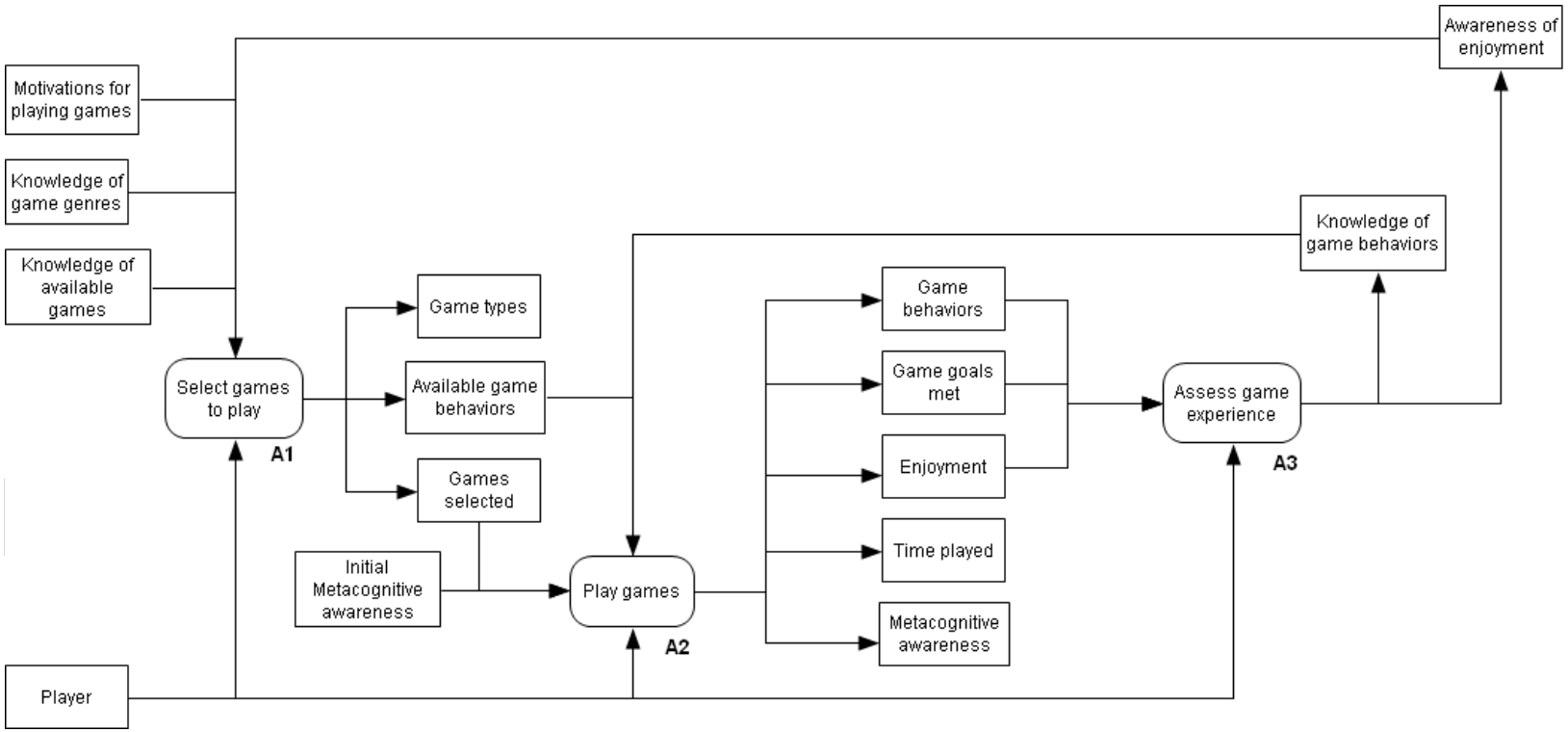

Figure 2. Process diagram for fostering one's metacognitive awareness by playing video and non-electronic games. Rounded-corner rectangles denote activities; A1 to A3 are activity labels; rectangles denote data; and arrowed lines denote data-flow directions.

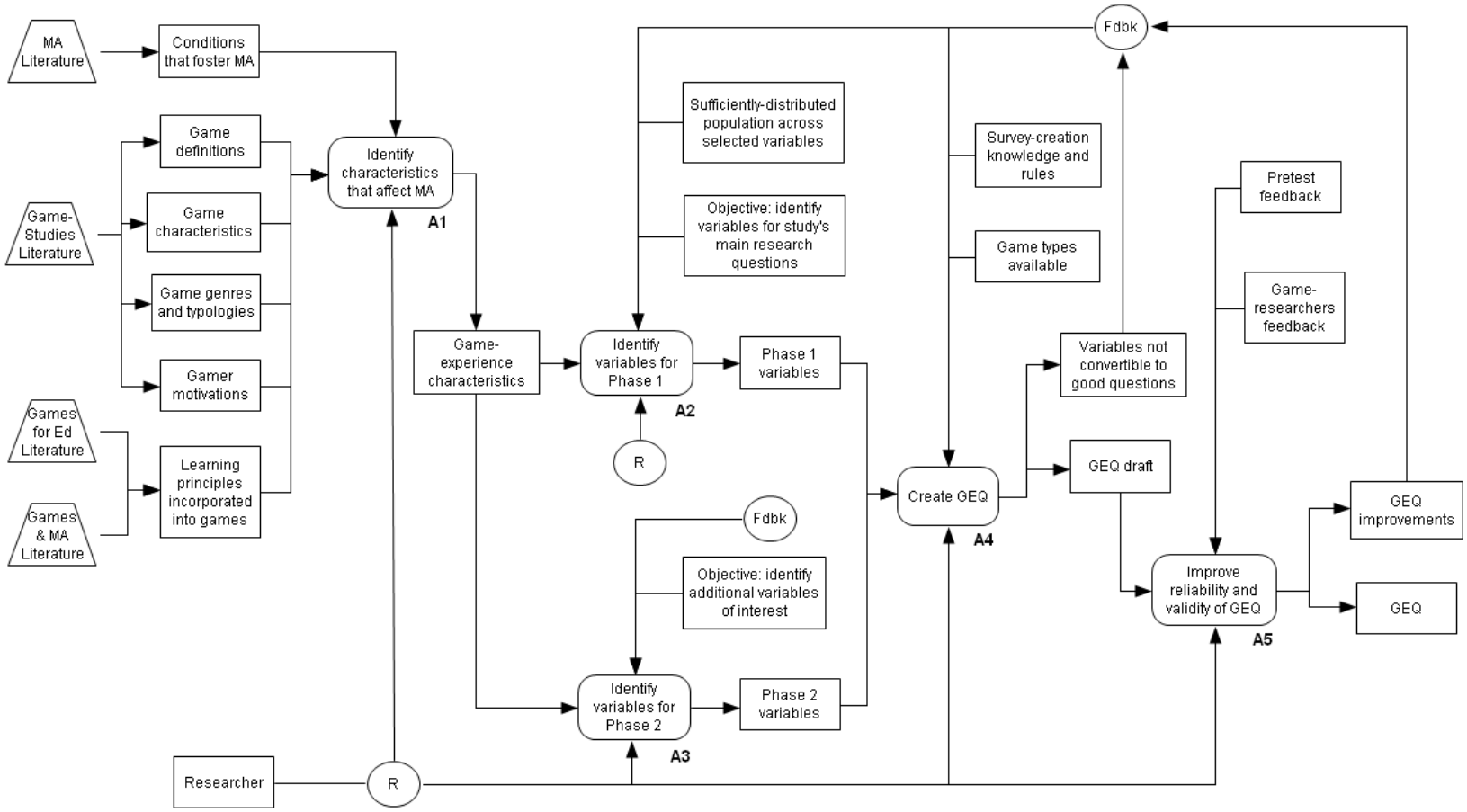

Figure 3. Process diagram for developing the game-experience questionnaire (GEQ). Phase 1 and Phase 2 refer to the study's two phases of data analysis. Rounded-corner rectangles denote activities; A1 to A5 are activity labels; rectangles denote data; trapezoids denote information sources; arrowed lines denote data-flow directions; and circles denote connectors to simplify the diagram. MA = metacognitive awareness; Ed = education; Fdbk = feedback.

The primary objective was to determine whether people who played certain types of games had a higher metacognitive awareness than those with less of that experience. That objective was represented as a constraint on A2 (in Figure 3) to identify appropriate variables for Phase 1. A second constraint was applied to A2 to limit the variables selected for an estimated respondent distribution across the variables for a valid statistical analysis. Other game-experience variables were identified in A3 to provide further insight, perhaps, into the Phase 1 objective as well as insight to inform future studies.

The GEQ was created to acquire data and assign values to the constructs to represent the Phase 1 and Phase 2 variables. Knowledge for creating a proper survey was used as a constraint. However, that constraint was compromised to allow the full range of video and non-electronic games to be considered by respondents. The variables ultimately used to create the GEQ were further filtered and modified based on feedback from A4 and A5.

Assumptions

Theoretically, the compilation of game experience should be summed over a person's entire lifetime and include the types of games played and the times spent playing those different types. Practically speaking, that is impossible. Assumptions were necessary to reduce what needed to be assessed, so that game experience could be operationalized to constructs that would satisfy the main goals of the study and were convertible to survey questions that could provide reliable and accurate measurements of those constructs.

Based on the theoretical and empirical literature, there are a number of game characteristics that could affect metacognitive awareness. Some characteristics might affect people similarly across a general population. Other characteristics might have an effect that is dependent on a person's particular learning preferences. In this study, I collected data for game characteristics that were anticipated to affect metacognitive awareness no matter how it might affect different population members.

In addition, some game characteristics might foster metacognitive awareness directly, whereas others might amplify that direct effect. The latter type includes a gamer's motivations. There are intrinsic characteristics of games that motivate people to play. If a person is immersed in the game experience, the person could enter the flow state in which attention was focused on the task at hand. Thus, any game characteristic that fostered metacognitive awareness could be amplified by the game characteristics that foster motivation and engagement.

The characteristics that motivate a specific individual will vary with the individual. For example, the particular fantasy and curiosity that would motivate an individual would likely be dependent on the particular subject content of the game, one of interest and relevance to the individual. In addition to the amplification effect, it is possible that motivation could foster metacognitive awareness directly. For example, setting a relevant challenge for an individual at the proper difficulty level to be challenging but not frustrating would motivate an individual. However, a suitable challenge would also elicit cognitive and metacognitive behaviors that could foster metacognitive awareness directly.

I believe that a video game is more likely to engage a player than a non-electronic game, because the fantasy and curiosity factors are likely to be more compelling, the challenge could be more authentic and thus more relevant, and consequently, the player is likely to be more emotionally attached to the outcome. However, I see a notable exception with non-electronic role-playing games with a facilitator. For example, Dungeons and Dragons, facilitated by a Dungeon Master to resolve conflicts and provide additional information as needed, can be addictive and may arguably foster metacognitive processes as much as its video-game counterpart. In the non-electronic version, the players' imaginations substitute for the visual imagery that the video-game version presents. However, I expect that first and second-year college students, the target population for this study, would be much more likely to play the video-game versions of games rather than their non-electronic game counterparts.

Since there are so many video games available, I assume that an individual would choose to play games that were most motivating and engaging to that individual. Since the proper level of challenge is a motivator to play games (Malone, 1980b), the games that different individuals play will likely be at the proper level of challenge for them in their overall game experience. In other words, two individuals might play strategy games of the same basic type, but at different levels of challenge. However, my assumption is that both individuals could benefit insofar as metacognitive awareness, because each would be choosing to play games that were at the proper level of challenge for each.

Game Types

I assumed that video games could be divided into two types: strategy games and action games (Crawford, 2011). Strategy games emphasize planning and decision making abilities whereas action games emphasize perception and reaction abilities (1982). Either type of game could require skills of the other, although to a lesser extent. However, strategy games should more likely foster metacognitive awareness than action games, because the former emphasizes cognitive abilities rather than physical abilities emphasized by the latter.

As discussed in Chapter 1, I believe that CWGs are the type of game most likely to foster metacognitive awareness. I have referred to other types of strategy games as NCWGs. CWGs would generally include the strategy, simulation, role-playing, and adventure-game genres as defined by Herz (1997) and shown in Table 1 (Chapter 2).

I further categorized NCWGs into three subtypes: minimal strategy, moderate strategy, and high strategy. My distinctions between the three NCWG types are subjective, and I will include examples of each type to help clarify them. My examples are based on games that are considered classic and should be familiar to most people. Minimal-strategy games include word puzzles, visually-based puzzles, and other similarly simple games. Examples include crossword puzzles, hangman, solitaire, Trivial Pursuit, Jeopardy, Scrabble, and Tetris. Minimal strategy games require thinking but require little or no planning, which is an important basis for strategy.

Moderate-strategy games introduce a distinctly higher level of strategy. Examples of these games include checkers, poker, and backgammon. High-strategy

games can require intensive thinking and strategizing. Examples of these games include bridge, chess, and go. Although my distinctions between these three types are not sharply focused, I believe they would be sufficient for respondents to associate a particular NCWG with one of the three types.

I believe that minimal-strategy games would not be effective in fostering metacognitive awareness, whereas moderate- and high-strategy games could be effective. Actually, the different level of impact between moderate and high-strategy NCWGs on metacognitive awareness is debatable. For example, Professor Charles Nesson, a Harvard Law School professor, offered a course using online poker to teach strategy (2008, January 24). I have included all three subtypes in Phase 1 to qualify more survey participants as gamers, and to avoid problems for the participants in distinguishing between the relatively subjective differences I have specified.

In identifying strategy games, it must be acknowledged that games are transmedic (Antonietti & Mellone, 2003; Juul, 2005), and non-electronic strategy games may foster similar effects on metacognitive awareness as video strategy games. Thus, non-electronic strategy games present a confounding variable. Unfortunately, if you consider non-electronic games as part of a respondent's game experience, then the time spent playing non-electronic games should be added to time spent playing video games for a consistent analysis. Without knowing the game experience of the target population in advance, fully considering non-electronic games in the analysis would add further complication that could make the study intractable. Thus, the effects of non-electronic games were not considered in Phase 1.

Table 6 summarizes the differences between the three game types for Phase 1.

Table 6

Video-Game Types as Specified by Game Characteristics

	Video-Game Types		
		Strategy Game Types	
Game Characteristics	Action Game	Non-Coherent World Game	Coherent World Game
player capabilities required	emphasizes perception and reaction capabilities; may still require short-term strategy and tactics	emphasizes planning and decision-making abilities	
examples	Space Invaders, Super Mario, PacMan, Mortal Kombat, Doom, Quake, Unreal Tournament	3 strategy levels (subjective): - minimal (e.g., puzzle or simple word games) - moderate (e.g., checkers) - high (e.g., chess)	games in which a complex entity is developed, or operated, or both; or solving challenges in an elaborate world, particularly when role playing

Gamer Types

The three types of video games were used to categorize the respondents into separate groups. It was likely that respondents would have played video games of more than one of these three types over their prior two years. Furthermore, it was likely that some respondents never or rarely played video games in that period. Classifying those

latter respondents based on the video games they played would not make a lot of sense. Thus, categorizing respondents into groups had to take account of these issues.

I defined three types of video gamers based on the three types of games they play, recognizing that they will not play one of those types exclusively. In addition, some games (e.g., CWGs) could contain substantial amounts of both strategy and action. The three types of gamers will be called ACTG gamers, NCWG gamers, and CWG gamers. In addition, those who rarely or never played video games over the prior two years will be referred to as non-gamers.

The process for labeling each respondent as one of the four types (including the non-gamers as the fourth group) is presented in Chapter 4.

Gamer Motivations

The types of games that people play are dependent on their motivations for playing, and their motivations determine how they would most likely play those games. In playing games, players would be most engaged in types of activities they are most interested in doing. Those activities would be most likely to encourage the flow state in which the players' attention would be most focused on those tasks. Thus, even though they might spend more time in other required activities in the game, they would accrue the most learning benefits in the activities they most enjoyed.

In analyzing the main studies cited here for player motivations and behaviors (Malone, 1980b; Malone & Lepper, 1987; Bartle, 1999, 2003; Alix, 2005; Yee, 2006), there are several key points to mention. First of all, only Bartle and Alix indicated that they were studying behaviors rather than motivations. However, Alix's questionnaire

asks respondents for their motivations, not behaviors, as is the case in the studies by Malone (1980b) and Yee (2006). Bartle's qualitative approach was based both on motivations and behaviors (1997).

Second, Alix (2005) and Yee (2006) both criticized the validity of Bartle's studies because of their qualitative nature. However, Bartle drew observations from most of the experts who played the MUD he managed (1997), and he also studied archives of player behaviors for his analysis. On the other hand, Alix (2005) and Yee (2006) designed their study on self-selected populations which therefore were statistically invalid for the more general target population. Malone's study (1980a) used children for the target population, whereas the other studies used a target population with a broad range of ages.

Collectively, the studies showed important similarities in some results but variations in others. Motivations to overcome difficult but not frustrating challenges to succeed in game goals were supported from all of these studies. Similarly, the motivation for interacting with others was supported by the studies. There was mixed support to separate personal interactions into pure socializing and collaborating. However, that differentiation would be useful in analyzing differences in associations with metacognitive awareness. I have discussed how role playing could have powerful impacts on metacognitive awareness. However, Yee (2006) included role playing within his immersion factor that also included interest in exploring (the world), storylines, and characters; which also found support in the other studies. Finally, competition through dominating, imposing on, or winning over others could be found in all the studies analyzed.

Based on my analysis, I decided that five motivations would be useful to include in my study (see Table 7), namely achievement, socializing, collaboration, immersion, and competition. In determining these factors, an important difference in my study relative to the others should be mentioned. The other studies were investigating the distribution in motivation types throughout the target population. My goal was to collect players with certain motivations into separate groups and then study the variation of metacognitive awareness among the groups.

The Ideal Game-Experience Profile

I would like to propose a hypothetical person's game-experience profile that maximizes the potential to foster metacognitive awareness. This profile is an ideal, and it is not expected that even a single player would realize the full profile. From this perspective, the ideal gamer has spent a substantial amount of time playing strategy video games. That compilation of games would include the construction of virtual objects, the probative cycle, resource management, assessment of value systems, and role playing while solving problems. Playing different types of characters in different sessions would enable thinking through the subject and problem space in multiple perspectives. In addition, the games played would include a variety of subject themes. The greater the variety of cognitive processes and themes in the games played the greater the likelihood that metacognition learned in a specific subject domain would be generalized to multiple domains and evolve to a general capability.

Table 7

Motivations for Playing Games that are Anticipated to Affect Metacognitive Awareness based on Analysis of Prior Studies

Proposed Motivation	Motivation Characteristics[a]	Motivations for Playing Games Determined in Prior Studies			
		Malone & Lepper (1987)	Bartle (1997)	Alix (2005)	Yee (2006)[b]
achievement	enjoy mental challenges, complex strategies, difficult to master	challenge	achiever	strategist	achievement (advancement)
socializing	enjoy friendly chats with other players, help others, make friends	not applicable[c]	socializer	interactor	social (socializing and relationship)
collaboration	work with other players to solve challenges together, enjoy group achievements	cooperation	socializer	interactor	social (teamwork)
immersion	enjoy role playing, exploring and learning about a complex world or system, feeling "inside the game" (i.e., "suspending disbelief")	fantasy, curiosity	explorer	narrator	immersion (discovery, role-playing, and escapism)
competition	dominate, impose on, or achieve over other players	competition	killer	warrior	achievement (competition)

[a]These characteristics were informed by the studies identified in the four columns to the right. The terms used in the four column are from the referenced studies. [b]Terms in parentheses are sub-factors. [c]None of the Malone and Lepper motivations were related to socializing as identified by the "Motivation Characteristics."

This effect would be further enhanced if the game world and simulations involved were detailed, complex, authentic, and consistent to the subject domain involved. Also, games that included both virtual and physical embodiments, for example, the disease-simulation game (Colella, 2000) would also encourage transfer.

The potential of fostering metacognitive awareness would be increased with outside activity associated with the games played. Discussing the validity of the underlying models of the games with other players in person or on fan discussion groups would be beneficial. Designing a game, particularly design that required knowledge of the gameplay and underlying game logic, would also be conducive to fostering one's metacognitive awareness. Similarly, modding activities (i.e., altering parts of the game permitted by users) might also foster metacognitive awareness, particularly if the modding involved aspects of the game's underlying logic or gameplay.

The compilation of games played would be predominantly comprised of the following game structures and characteristics. They would be endogenous rather than exogenous, so that reasoning within the subject content would be necessary to satisfy the games' goals. The main goals of the games would be allotelic, meaning that they were established by the rules, but intermediate goals would be frequently autotelic, meaning that the players would often create or identify intermediate goals. The profile painted would be a constructivist orientation that would foster the ability to think and reason independently within the subject domain. Furthermore, emergent games would enable greater flexibility in creating strategies than progressive games.

The compilation would feature substantial experience in multiplayer games, particularly in rich, immersive worlds with complex and ill-structured challenges. Other players would be a factor in increasing one's motivation. More importantly, the presence of other players would help produce a mastery environment. Discussing strategy in collaboration with other players would help the player reflect on nuances and deeper meanings within the subject domain. The other players' support and teamwork would encourage risk taking and persistence to succeed in difficult challenges. To realize the potential in playing multiplayer games, the playing behaviors adopted would be based on achievement first, but collaboration and immersion would be important; although, as indirect effects, socializing could lead to collaboration and competition could enhance achievement (Table 7). The compilation would also include single-player games which would encourage independent thinking and acting. Games played in that mode would have "save and restore" functions to encourage risk taking.

Chapter Wrap-up

This chapter has described game structures and gamer motivations that I believe would affect the potential to foster metacognitive awareness. These ideas will be used in Chapter 4 to describe the research design and methodology for this study. Figure 4 shows an overview of the independent variables (and attributes) considered for the study, as well as confounding variables that might affect the results. Data were collected to estimate values for the game-playing variables shown. These variables were anticipated to affect metacognitive awareness, but they were not necessarily included in the Phase 1 design.

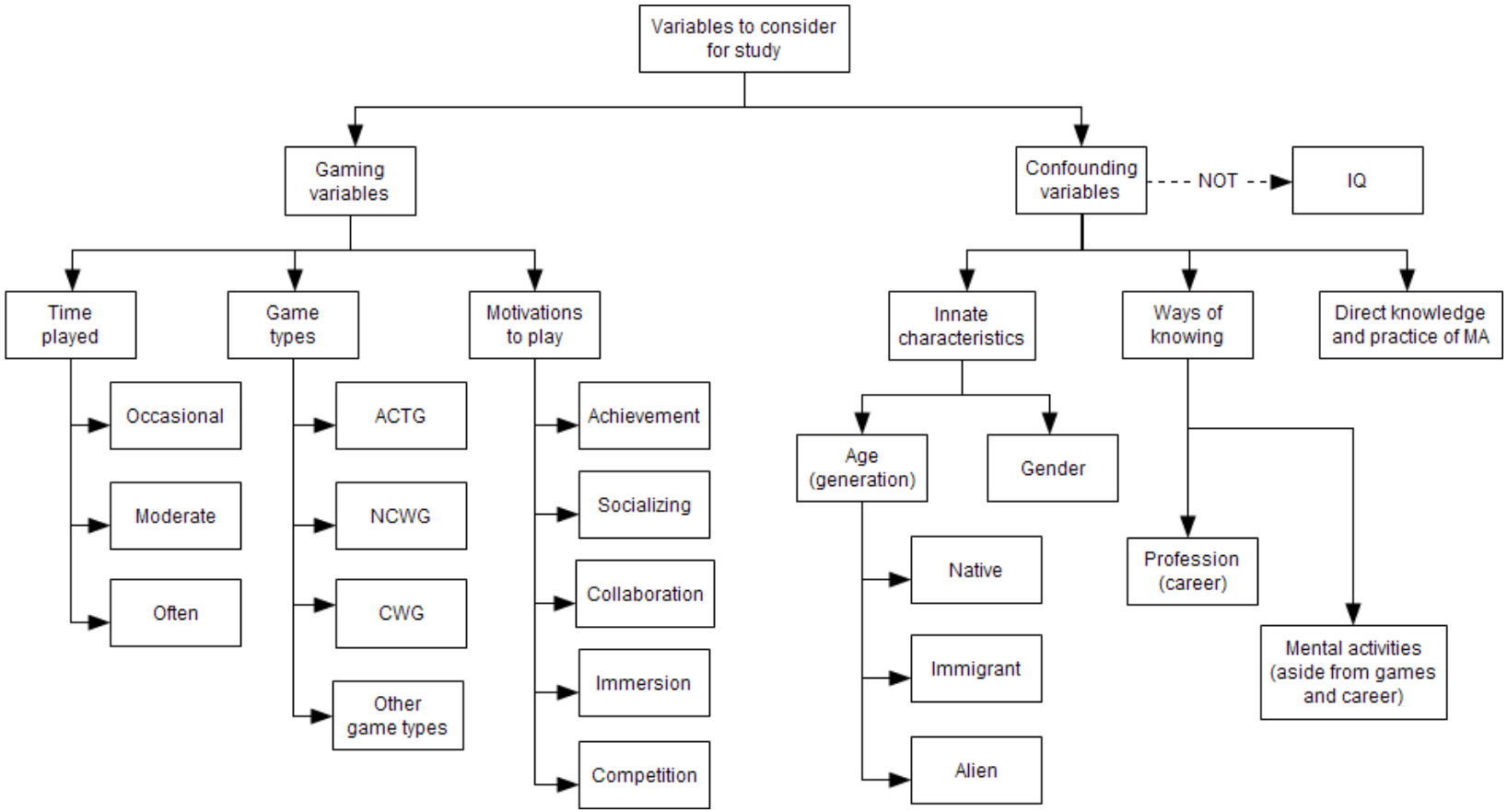

Figure 4. Variables anticipated to affect metacognitive awareness. MA = metacognitive awareness; ACTG = action game; NCWG = non-concurrent world game; CWG = concurrent world game.

Chapter 4: Methodology

Research Design

This study employed a quantitative, survey methodology to collect and analyze data to investigate associations between game experience and metacognitive awareness. The analysis was conducted in two phases. Phase 1 addressed the study's main research questions, satisfying the study's main requirements. The analysis intended was a 3 (time played) x 3 (gamer type) analysis of variance (ANOVA). However, the data needed recoding, and the final design was a 2 (time played) x 3 (gamer type) ANOVA.

Phase 2 enabled further exploration of the data that mitigated problems in Phase 1 and enabled further analysis of the data.

Participants

The target population for the overall study was the population of undergraduate students at GMU. For Phase 1, the target population was the population of first and second-year students at GMU who were video gamers and aged 18 to 21 years. Video gamers were defined in this study as those who played video games for an average of two hours a month for the two years prior to being surveyed. The sample frame for Phase 1 was estimated based on the population of students who were distributed surveys (as described in the Data Collection section in the Distributing and collecting surveys sub-section). The estimation included the consequence (i.e., the response rate) based on

screening out those who were not in the Phase 1 age range or class-year range and were not video gamers. For Phase 2, all of the respondents were eligible based on the particular analyses done. Further discussion of the sample frame that was used in Phase 1 is presented in the Study Limitations sections (in particular, in the Survey errors sub-section concerning coverage errors).

Determining the sample size required was an issue for this study, because the effect size necessary could not be determined until data analysis. In lieu of estimating a pre-survey sample size, the survey was continued until a minimum of 135 students and a maximum of 1000 students were surveyed.[12] The details of the sample size and the associated issues are discussed in the Data Analysis section.

Study Variables

Two main variables were used in this study, metacognitive awareness and game experience. In addition, a small number of demographic variables were used.

Dependent variable. The dependent variable was metacognitive awareness and was operationalized as MAI. It was represented as an interval variable with a single, numeric value.

Independent variables. The independent variables were demographic and game-experience variables.

Demographic variables. The demographic variables included *gender*, *age*, *class year*, and *subject major*. Class year was an ordinal variable with values: *First year*, *Sophomore*, *Junior* and *Senior*. Subject major was a nominal variable that ranged from

[12] The initial proposal called for a maximum of 500 students to be surveyed. However, during the survey the GMU's Human Subjects Research Board (HSRB) allowed an extension to 1000 students.

the pure arts to the pure sciences. Specific values, and examples for each, were: (a) *The Arts* (e.g., music, painting, or performance), (b) *Social Sciences* (e.g., sociology, education, history, or government), (c) *Applied Sciences* (e.g., engineering, software, or architecture), and (d) *Pure Sciences* (e.g., mathematics, physics, chemistry, or biology).

Game-Experience Variables. Game experience was based on three separate dimensions—time played, game type, and gamer behavior. For Phase 1, game experience was operationalized to satisfy two criteria: (a) enable a limited number of basic distinctions that were anticipated to affect metacognitive awareness and (b) enable a sufficient distribution of those distinctions across the sample frame for a reasonable statistical analysis (as discussed in the Data Analysis section). For Phase 2, the data were explored to identify "variables of opportunity" that represented aspects of the three dimensions of game experience to spot potential trends for how metacognitive awareness might vary with those variables.

Time played represented the total amount of time that a respondent played games over the prior two years. Data were collected for both the time spent playing video games and the time spent playing non-electronic games. For the most part, time played was based on the time spent playing video games only. However, the time spent playing non-electronic games was collected to investigate possible confounding effects on the results obtained.

For Phase 1, the time played for video gamers was structured as an ordinal variable that was based on dividing the time played over the prior two years into three equal ranges, identified as Occasional, Moderate, and Often. As mentioned above, a

video gamer was defined as a respondent who played video games for at least 48 hours over the two years prior to being surveyed. This value represented an average of two hours a month, which is an estimate based on prior surveys. For example, in a nationwide survey of adults who played video games, 68% played one or more hours a week (Ipsos, 2006). In a second example, 60% of MIT students played video games one or more hours a week (Squire & Jenkins, 2003). I decided that requiring video-game play of at least one hour every two weeks over the prior two years was a reasonable minimum for a respondent to be considered a video gamer for this study and provide valid answers on the GEQ. However, two years was operationalized as 100 weeks to ease the respondent's ability to estimate time played. By using 100 weeks, a respondent could approximate the number of weeks played over the prior two years by estimating the percentage of weeks played in that period.

Game type represented the proportion of time that games with certain structures or characteristics were played by a gamer over the prior two years. For Phase 1, game type was represented as a nominal variable with three possible values. The three game types were identified as ACTG, NCWG, and CWG. The basic characteristics for the three types were designated as shown in Table 6 in Chapter 3. The game types were used to separate the video gamers in the sample frame into three types of gamers, based on the proportions of the different game types they played. The criteria for that separation are provided in the Data Analysis section.

Game behavior represented the way a gamer played games over the prior two years. I assumed that players tried to invoke behaviors that reflected their motivations for

playing; and they were likely to focus their attention more intensely on those behaviors. Thus, I assumed that game behaviors were directly reflective of gamers' motivations for playing games. I labeled the behaviors by the motivations they reflected, namely: *Achievement*, *Socializing*, *Collaboration*, *Immersion*, and *Competition* (see Table 7).

To simplify game-experience distinctions in Phase 1, the variables used were limited to time played and gamer type. Phase 2 included a wider range of game characteristics. In addition it included gamer motivations and demographic variables.

Measures

All data were collected by a survey, comprised of the two self-assessment instruments described below.

Metacognitive awareness index.

The instrument used to measure metacognitive awareness in this study was named the Measurement of Adaptive Cognition, or simply, the MAC (Haynie & Shepherd, 2009). The MAC consists of 36 items on a Likert scale, ranging from 1 (*not very much like me*) to 5 (*very much like me*); it yields an overall index based on an average of the 36 items. The MAC was proven reliable (α = .885) and structurally and nomologically valid (as described in Chapter 2). The instrument is shown in Appendix A.[13]

The MAC measures the strength of five metacognitive processes in support of adaptive problem-solving and decision making in a dynamic and uncertain environment. As argued in Chapter 2, it is appropriate for this study to refer to the score returned by the MAC as the MAI.

[13] J. M. Haynie provided me permission to use the MAC instrument for this dissertation (personal communication, June 9, 2008).

Game-experience questionnaire. The game-experience questionnaire is shown in Appendix B. For convenience, the questions related to demographics were included in the GEQ.

The GEQ was comprised of a variety of question types: numeric, single-response multiple-choice, and open-ended. The multiple-choice questions included those with discrete alternative answers and those based on a scale.

The first question of the GEQ was designed to appeal to all respondents and to help engage their interest, encouraging them to complete it.[14] Accordingly, the first question in the GEQ was a question to query the respondent's general attitude towards video games. The response might also be useful for further interpretation of the data.

The four numeric questions that followed were used to collect data for estimating time played for video and non-electronic games. The multiple-choice questions with alternative answers were used to collect the four demographics data items, as well as the first question described above, and for one question concerning game themes.

About two thirds of the questionnaire was based on a linear, numeric scale. Most of the scale's items were used to assess proportions of time played (video or non-electronic games) that a respondent has played games with certain characteristics or structures. This scale type was also used to assess the importance to respondents of various motivations for playing games. A verbal-frequency scale was used for assessing behaviors related to video gaming but conducted outside of the game, for example, discussing games on a website for fans. Behaviors outside the game would not take place

[14] This design feature was based on survey research (Dillman, 2007).

within a "time-played context," and would be more difficult to assess on a time-based proportionate scale.

Finally, the open-ended questions at the end of the survey were intended for further interpretation and insight of the previous data.

The GEQ was assessed by two evaluators to provide feedback and qualify its use for this study. That process will be described in the Pretesting Subsection.

Data Collection

The survey package for each subject consisted of hard copies of: (a) an informed consent form, (b) instructions for filling out the questionnaires, and (c) the MAC and GEQ questionnaires. Each survey package had a four-digit serial number that was printed at the bottom of the last page of the survey. This number was unique for each survey. The serial numbers improved my ability to keep track of the number of surveys distributed and returned.

Pretesting. The MAC was already a tested and valid instrument. Nevertheless, it was included in the pretesting to ensure that there were no problems in responding to it and to estimate the time required to complete the entire survey.

The GEQ has not been tested for validity and reliability. Instead, two evaluators who were knowledgeable about a games' potential for education assessed the instrument for its main objective. The main objective was to assess a respondent's game experience for the types of games played for the two years prior to the survey. The evaluators recorded their own responses for the GEQ. In addition they provided feedback on any issues they found. I incorporated the evaluators' feedback to improve the GEQ. In

general, however, both evaluators believed that the GEQ was satisfactory to determine a person's game experience over the prior two years based on game characteristics. (See Appendix C for an overview of the evaluators' feedback and the changes made to the GEQ to accommodate it.)

In addition, I ran a pretest of the entire survey package with four representative students. All four students took less than 30 minutes to complete the survey. Three of the students did not report any problems with the survey, and the fourth reported several minor issues with the GEQ, which I used to improve it.

Distributing and collecting surveys. My key concern was to obtain a sufficient number of respondents and a sufficient response rate so that statistically valid results could be achieved. I decided that the best chance to obtain such a sample was to persuade GMU professors (and instructors) to allow me to present my survey to their classes and ask students to return them at their class a week later. The professors were highly accommodating.

At the beginning of class, I presented the survey using a script that was pre-approved by the HSRB. I told the students that the survey was completely voluntary but that they should read the informed consent form (included in the survey package) before deciding to respond to the survey. [15] The surveys would be due back at the same class a week later. With the exception of those who had already received a survey package in another class, everyone in each class was requested to take a survey whether they planned to fill it out or not. Anyone receiving the survey package was invited to email me to

[15] The HSRB approved this study without the requirement of a signature on the informed consent form.

request an overview after the study was completed. I have maintained a list of those email addresses and will delete them after the overviews are sent out (after approval of my study by my dissertation committee).

A day or two before the surveys were due back for a class, I sent an email to the professor who forwarded it to his students as a reminder that the surveys would be collected at their next class. The following week, I collected the surveys at the beginning of class and distributed additional surveys to students who were absent when the surveys were first distributed. I made arrangements with the professor to collect the surveys from the absent students and the students who wanted to return surveys but forgot. I continued surveying classes until I met the criteria specified in the Data Analysis Section.

Data Analysis

As the surveys were collected, the data were stored in appropriately-formatted files for ready-entry into the PASW® Statistics Package.

Phase 1. Two of the research questions addressed associations between metacognitive awareness and each of the two independent variables, time played and game type. The third research question addressed the association between metacognitive awareness and the interaction of these two variables. To address these research questions a two-way ANOVA with disproportionate cell frequency (Hinkle, Wiersma, & Jurs, 2003) was conducted. Because time played and game type each had three possible values, the original design planned was a 3 (time played) x 3 (gamer type) factorial.

Estimating time played. Two questions in the GEQ were used to estimate the time spent playing video games over the prior two years. The first question asked for an

estimate of the number of weeks spent playing video games over the last 100 weeks. The second question asked for an estimate of the hours spent playing video games in a typical week. Multiplying weeks played by hours played per week was assumed to provide a reasonable estimate of the hours played over the prior two years. This method allowed leeway for sporadic play over the prior two years, because the GEQ described to the respondents how the total hours played over the last 100 weeks would be calculated.

Identifying gamer type. If a respondent played video games for less than 48 hours over the prior two years, then the respondent was considered a non-gamer, and the gamer type was not identified for this study. Otherwise the respondent was considered a gamer, and the gamer type was identified as described below.

Five items in the GEQ, namely items 12, 13, 14, 18, and 19 were used to identify each respondent's gamer type. The scale used for these items was a five-point linear, numeric scale with anchors at 1 (*seldom or never*) and 5 (*mostly or always*). Identifying the type of gamer was a three-step process. The first step determined whether the gamer was an action gamer or a strategy gamer, based on the heuristics shown in Table 8. Recall from Chapter 3 that minimal-strategy games (i.e., simple word and visual puzzle games) were considered NCWGs.

Table 8

Heuristic to Distinguish between Action and Strategy Gamers

	GEQ Question Number		
Gamer Type	12: Puzzle games	13: Action games	14: Strategy games
Action gamer	1 or 2	3, 4, or 5	1 or 2
Strategy gamer	1, 2, or 3	1, 2, or 3	Ans[14] + Ans[12] > 3

Note. The GEQ questions in this table refer to video games. The heuristics were based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years. Ans = respondent answer to GEQ question number (in brackets).

If the gamer was identified as a strategy gamer, then the second step was used to determine whether the gamer was an NCWG or a CWG gamer, based on the heuristics shown in Table 9.

The gamer type was not identified for every gamer in the first two steps. The intent of the third step was to review the entire surveys of the unidentified gamers to make reasonable identifications of them. Unfortunately, the results showed that there was too large a percentage of unidentified gamers after the first two steps that precluded a reasonably objective identification based on the criteria used. The handling of this problem is described in Chapter 6.

Table 9

Heuristic to Distinguish between NCWG and CWG Gamers

	GEQ Question Number		
Gamer Type	12: Puzzle games	19: Abstract strategy games	18: CWGs
NCWG gamer	Any	Ans[19] + Ans[12] > 3	1 or 2
CWG gamer	1, 2, or 3	Ans[19] + Ans[12] <= 4	3, 4, or 5

Note. The GEQ questions in this table refer to video games. The heuristics were based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years. Ans = respondent answer to GEQ question number (in brackets); NCWG = non-coherent world game; CWG = coherent world game.

The heuristics were subjective. For example, I slanted gamer identification towards CWG gamers over both NCWG gamers and action gamers. My main goal was to determine whether people with substantial experience playing CWGs games would have a higher metacognitive awareness than those with less of that experience. Thus, a gamer who recorded at least a 3 for playing CWGs will be considered a CWG gamer, regardless of whether that gamer played other types of strategy games as often. Finally, notice that I have not used the level of NCWGs (i.e., minimal, moderate, or high) to distinguish among NCWG gamers for Phase 1. However, the GEQ collected data to determine that distinction among respondents and it could be explored in Phase 2.

Determining sample size needed. Providing an optimal number of students to use for the sample was a challenge. There are four interactive parameters that must be

considered in designing a statistical study: significance criterion, effect size, sample size, and power. Knowing any three of these, the fourth can be calculated (Cohen, 1988). It is possible to set the effect size small enough to meet the significance criterion within the power specified for a large enough sample size that can be calculated. However, setting a meaningful effect size may be impossible (Weiss, 2006, p. 130). If the research study is closely modeling a previous study, determining a meaningful effect size is possible. However, the current study was unique and estimating a meaningful effect size before data analysis was not feasible. In this case, an intuitive estimate based on surveying and statistical experience should be used. Based on an experienced researcher's opinion, I determined a minimum number of 15 subjects per data cell for my study.[16] Based on that number, a minimum of 135 subjects would be required for a 3 x 3 ANOVA (i.e., 9 data cells). However, that would assume that all 135 respondents were gamers and evenly distributed among the data cells. In light of the issues discussed, it was decided that surveying would continue until at least 15 subjects filled each data cell, or as many surveys were distributed as practical, up to a limit of 1000 surveys.

Recoding. In conducting surveys it is common for groups of respondents, distinguished by certain characteristics within the sample population, to be of unequal sizes. This is not a problem for ANOVA as long as the ratio between the smallest and largest group is less than about 4 or 5 percent (Alreck & Settle, 1995, p. 295). However, the absolute number of respondents in any group should not be too small; else the results will not be meaningful for that group or its comparison with others.

[16] This estimate was based on the opinion of Anastasia Kitsantas, a member of my dissertation committee and an expert in statistical analysis.

It is standard practice to recode survey data into new categories during data analysis to produce a better distribution of respondents across data cells (Alreck & Settle, 1995). The recoding might merge categories together to obtain a sufficient number of respondents per cell. The recoding is subject to several rules: (a) The categories must be all inclusive (i.e., there should be a category for every data point); (b) they must be mutually exclusive; and (c) they must be meaningful, implying that there should be more variation in the thing being measured between categories than within them (1995, pp. 260-261).

I distributed 759 surveys throughout the spring semester of 2010. I started my analysis at that point. The results are presented in Chapter 5.

Phase 2. In this phase, variables were selected based on the anticipation that they might affect metacognitive awareness and could provide further insight into relationships between playing games and metacognitive awareness. In fact, the data collected to support Phase 2 were used to mitigate the problem that was discovered in the Phase 1 analysis in identifying the gamer types.

Study Limitations

The limitations of this study are described below. They are divided into four categories: (a) approximation of game experience, (b) confounding variables, (c) cause and effect, and (d) survey errors.

Approximation of game experience. The GEQ was used to tag each respondent with a nominal value that represented the respondent's game experience for the two years prior to the survey. I never expected the assessment to be precise. The accuracy only

needed to be sufficient to assign each respondent to the proper gamer type with reasonable validity. I expected that respondents' recall of past events would be less accurate the further back in time that the events occurred. Thus, I designed the questions with linear, numeric scales and verbal-frequency scales, intended to minimally tax respondents' memories and provide reasonable accuracy for the two-year period assessed.

If playing video games could foster metacognitive awareness, it would be possible that video games played before two years ago could also contribute to a person's metacognitive awareness. However, I believed it was impractical to expect accurate recall of game experience prior to the two years assessed.

Confounding variables. The main confounding variables I considered were age and cognitive-intensive activities other than playing video games. Research studies have shown that metacognitive awareness increased with age (in years) at least through the late 40s (Rasnak, 1995; Cooper, 2005; Vukman, 2005). Furthermore, age could influence how a person related to and was affected by video games (Prensky, 2001a). In addition to age, any activity that encouraged cognitive and metacognitive behaviors could foster metacognitive awareness, for example, education, work, volunteerism, etc. More directly, non-electronic games that were based on strategy could have similar impacts as some video games.

Effects from confounding variables were partially mitigated by selecting traditional-aged undergraduate students for the target population. I expected that the confounding effects due to age and cognitive-intensive activities would be lower with this

population than for a more general population. In addition, questions were included in the GEQ that might provide insights on the effects of age, class year, college major, and non-electronic games during the Phase 2 analysis.

Cause and effect. Four conditions are necessary for a study to prove a cause and effect relationship: (a) An association between the cause and the effect is found, (b) the cause precedes the effect, (c) a cause mechanism is identified, and (d) viable alternatives are ruled out (Weisberg, Krosnick, & Bowen, 1996).

In this study, condition (a) was tested by design. Condition (c) could be satisfied by a number of cause mechanisms that were described in Chapters 2 and 3. For condition (d), the primary alternative explanation considered (assuming an association was found) was that respondents with higher metacognitive awareness demonstrated a greater preference for CWGs than respondents with lower metacognitive awareness. Data analysis might suggest that the alternative was possible, but similar to the cause and effect possibility, neither explanation could be proven. In either case, the study was not designed to test for condition (b), thus negating the possibility that a cause and effect relationship could be proven.

Survey errors. There are four sources of errors in a survey methodology: measurement, sampling , coverage, and nonresponse. All four must be minimized to obtain the most accurate results. "As of yet there is no accepted way of providing a meaningful combined measure of the effect of these four sources of error on overall accuracy" (Dillman, 2007, p. 198).

Measurement error. Measurement errors could be made intentionally or unintentionally. Because the target population was comprised of GMU students, I assumed they were honor-bound to answer the questions truthfully. Unintentional errors could occur if the respondents did not correctly understand the questions or the possible responses. To mitigate the risk, I used the feedback on the GEQ from two experts to improve the questionnaire. In addition, I used the feedback from four representative subjects to improve the questionnaire further to ensure it was understandable by members of the target population.

Sampling error. Sampling errors occur if only a portion, rather than all of the members of the sample frame, return completed surveys. The error is calculated based on the particular statistical analysis that was used to determine a result. The calculation assumes that a randomized sample was extracted from the sample frame. Since the sample in this study was equivalent to the sample frame, the sample could be considered a randomized sample.

Coverage error. A coverage error occurs if the sample frame is not fully representative of the target population. It occurs if particular subgroups are missed as a consequence of the method used to extract the frame.

As described in the Data Collection section, I requested that everyone in the classes surveyed take a survey, whether they intended to fill it out or not (assuming they hadn't already received a survey in another class). I assumed that coverage error would occur if the classes surveyed were not representative of the classes across the target population. To partially mitigate that risk I surveyed classes across a variety of subject

areas. Furthermore, I assumed that students who missed class when the surveys were distributed would not reflect any significant subgroup's characteristics.

However, the main issues concerning coverage error involved the confounding variables of age and class year. For the Phase 1 analysis, the sample frame was based on undergraduate gamers, aged 18 to 21 years, and taking first and second-year courses; thus, juniors and seniors could also be included. The latter were allowed in the sample frame to mitigate the risk that there would not be enough respondents for analysis if they were excluded. Conversely, students who were aged 22 and older were excluded from the sample frame, even though their surveys could be used in the Phase 2 analysis.

Nonresponse error. A nonresponse error occurs if the respondents do not fairly represent all segments of the sample that are relevant to the study. A self-selected sample is particularly vulnerable to this type of error. Dillman presented a case study with a target population of nearly 80,000 that used three simultaneous implementation methods (2007, pp. 257-259). The first used a self-selected sample and the other two used randomized samples from quality sample frames. In the self-selected sample, there were 474 respondents, a 0.6% response rate, compared to 265 and 264 in the other two out of sample frames of 400 each, a response rate of 66% for each. The self-selected sample missed significant segments of the population and the results were significantly different from the other two. The results of the other two were similar.

Even with a quality sample frame, nonresponse has been a common problem. It "has been growing in recent years and is increasingly a consideration in the interpretation of reported results" (Scheuren, 2004, p. 66). A high response rate will lower the risk of a

nonresponse error, although it doesn't guarantee that relevant population segments were sufficiently represented.

I considered a low response rate to be a major risk. Consequently, I put major emphasis on the selection of a target population that I could easily access. More importantly, I planned to design a survey implementation informed by Dillman's Tailored Design Method (2007). Dillman found that the survey implementation design was much more important than the survey design to achieve a high response rate. Furthermore, he proved his method was successful by continually achieving high response rates in his survey studies (2007). The core of his method was based on establishing a trust relationship with the sample surveyed during the implementation.

Unfortunately, I discovered that approvals were needed from administrators of multiple departments as well as from each class instructor for the classes I surveyed. I realized based on practicality that I could not design a survey implementation that could be uniformly used across classes. Thus, I took the core idea of Dillman's method and tried to establish trust by visiting every class and personally presenting and distributing my survey. The characteristics of my presentation that I hoped would garner trust included sincerity, a description of how anonymity would be protected, acknowledgment of the time required (under 30 minutes anticipated), and a good rationale for the importance of the study.

Chapter 5: Results

I conducted the survey during the 2010 spring semester, from February 2 to May 5, and distributed 759 surveys in 29 classes. I expected that I could obtain large numbers of students by surveying large classes (in the neighborhood of 100 students) taking first and second-year classes. However, I discovered that the response rate was low in those classes and surveying smaller classes attained a better response rate, although still lower than I had expected. The survey of large classes was also impeded by over a week of school shutdowns due to snow storms during the initial data collection. Based on my early data-collection experience, I believed that I could better engage students and attain a greater response rate in smaller classes, even though my script to describe the survey was the same.

Classes with mainly first-year students were easy to find; however, I relied on instructors' recommendations for classes that had mostly (or at least a majority) of sophomore students. In the "sophomore" classes that I surveyed, I found that a sizable number of respondents were older students or juniors and seniors.

The sample frame was specified as the population of students who were distributed surveys in the classes surveyed. Therefore, the sample was identical to the sample frame. Out of 759 surveys distributed, only 175 substantially-completed surveys

were returned.[17] Issues in the survey implementation along with the low response rate had consequences on the quality of the sample frame and the generalizability of the results. Those issues and consequences will be discussed in Chapter 6.

Categorizing Respondents for Data Analysis

Screening participants. The sample obtained was screened by age range, class year, and level of video-game play (specified as gamer or non-gamer) for the Phase 1 analysis (Figure 5). The 80 eligible gamers will be referred to as the video-gamer sample of undergraduates, aged 18 to 21 years; or VG21 for simplicity.

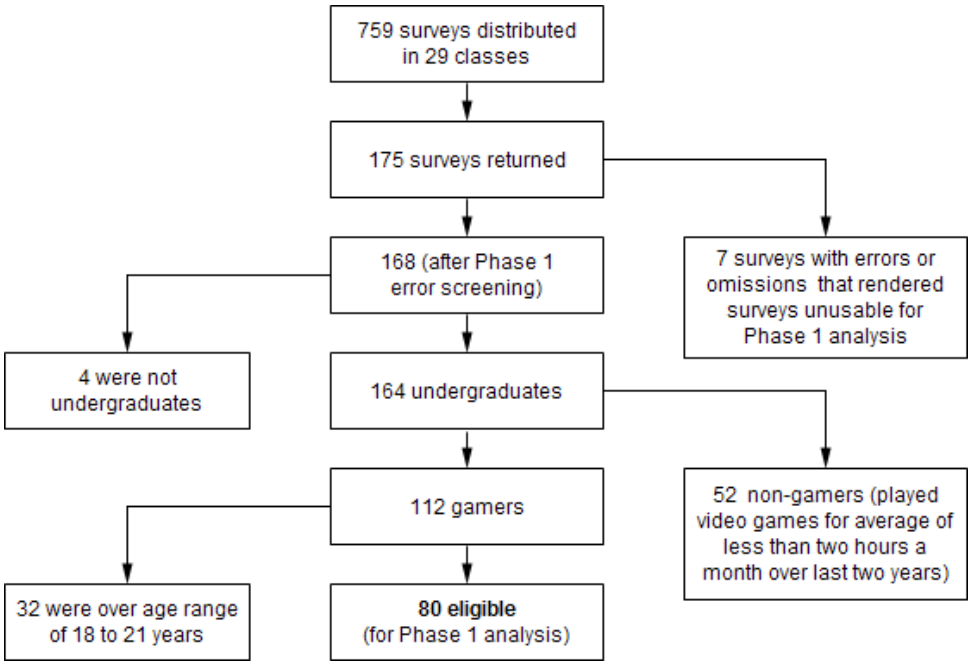

Figure 5. Screening participants for Phase 1 analysis. The analysis for this study was done in 2 phases (Phase 1 and Phase 2).

[17] Surveys that were returned blank or nearly so were repaired as needed and were returned to be recycled to other students. The 759 represents the number of students who received new or recycled (blank) surveys.

Categorizing Phase 1 gamers using pre-survey criteria. Three steps were specified in Chapter 4 to sort the gamers into three groups for the Phase 1 analysis: ACTG, NCWG, and CWG gamers. To briefly recap, the first step used a heuristic, specified in Table 8, to identify action and strategy gamers; the second step used a heuristic, specified in Table 9, to identify NCWG and CWG gamers from the strategy gamers; and the third step used a "best effort" to identify the gamers not yet identified in the first two steps by a full review of their surveys. I strove to specify the heuristics in the first two steps to identify most of the gamers. However, the data showed that I was unsuccessful in that attempt. Only 18 out of the 80 eligible respondents could be identified using the heuristics. (The 18 were identified as 15 ACTG gamers, 1 NCWG gamer and 1 CWG gamer.) The remaining 62 represented too large a percentage of the eligible sample to enable a reasonably objective categorization. Further review of the data reinforced my conclusion that my initial categorization criteria were not effective for this study. That review and a new set of criteria for gamer categorization are described below.

Establishing new criteria for Phase 1. Below is my analysis of the original criteria, followed by my analysis leading up to the new criteria. Hereafter, the original criteria will be referred to as the pre-survey criteria. The new criteria will be referred to as the post-hoc criteria (shortened from the term post-hoc survey criteria for simplicity).

Strategy versus action gamers. Distinguishing between action gamers and strategy gamers was problematic. The cross-tabulation of the VG21 sample shown in Table 10 indicated that 58 out of 80 gamers showed a behavior-based preference of 4 or 5

(out of 5) for playing action games. However, the gamers' preference for playing strategy games was much more balanced. Furthermore, the data indicated that a sizable proportion of the sample played games that contained both substantial action and strategy (with preferences of 4 or 5 for both). That finding is not inconsistent, because many games played today contain both action and strategy (e.g., many MMORPGs). I concluded that the sample gamers could not be objectively separated into action and strategy gamers.

Table 10

Cross-tabulation of Preference Frequencies for Action and Strategy Games[a]

	Preference for Strategy Games					
Preference for Action Games	1	2	3	4	5	Total
1	0	0	0	0	0	0
2	2	1	0	2	4	9
3	2	3	6	1	1	13
4	2	7	7	12	3	31
5	2	5	6	7	7	27
Total	8	16	19	22	15	80

Note. The table is based on VG21, the sample of respondents who were undergraduate video gamers, aged 18 to 21 years. The preferences are based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years.
[a]Video games often blend action and strategy into the same game

Note that I originally included puzzle games in counting towards strategy games that gamers played. I did not expect that puzzle games would have a large impact on

fostering metacognitive awareness. However, I added that type because I was concerned that I could not identify enough strategy gamers for the Phase 1 analysis without including them. However, the result described above overshadows this concern, and the conclusion determined above still stands.

Categorizing strategy gamers. I further reviewed the data to determine whether the gamers could be categorized in a logical way that was true to the main goal of my study and as similar to the research questions as originally conceived. To that end, I studied the responses for items 15 to 19 in the GEQ. Those items are reproduced in Table 11

As stated previously, I have referred to the type of games that I believed would best foster metacognitive awareness as CWGs. Furthermore I believed that the games that fit this category were the two types of games described by Gee (2003) and quoted in Chapter 1. The two types of games are those specified in items 15 and 16. I'll refer to those types as entity-development games (EDG) and role-playing games (RPG). Item 18 was a catchall for CWGs, which included entity-development games, role-playing games, and adventure games as well. Adventure games (item 17) have similarities to RPGs but are of a different sort as will be discussed shortly. I included adventure games (ADGs) as part of the CWG type, because I was concerned that there would not be a sufficient number of CWG gamers for the Phase 1 analysis without including ADGs as well. The data showed that that was a misplaced fear.

Table 11

Items Duplicated from the Game-Experience Questionnaire (GEQ)

Game Type	Game-Type Description
15. ___ Strategy games in which you develop and/or operate a complex entity	A complex entity could include a business, an army, a city, a civilization, a system, etc. Game examples include military and business games, SimCity, etc.
16. ___ Role-playing games	These take place in a fictional world in which you solve challenges through the character you play. (**A fictional world in a game may be based on fantasy or reality**.) Examples include Everquest, World of Warcraft, etc.
17. ___ Adventure games	Explore a fictional world and solve puzzles to gain points, treasures, tools, etc. Might be based on a story with only one or a few possible endings.
18. ___ Games based on a fictional world, story, or complex entity	They include any games in type 15, 16, or 17 above.
19. ___ Abstract strategy games	NOT based on a fictional world, story, or complex entity. Examples include Poker, Checkers, Chess, Bridge, etc. Do not include games in type 12 above.

Note. The GEQ was created for this study to estimate how often the survey respondents played various types of games. The game types in this table refer to video games. Respondent answers were based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years.

The frequencies of the VG21 gamers' preferences are shown in Table 12. Sixty of the 80 gamers showed a preference of only 1 or 2 for playing abstract-strategy games. On the other hand, 54 out of 80 gamers preferred CWGs at a 4 or 5 level. I concluded that CWG based on item 18 was not suitable to distinguish gamer types. To design a

Table 12.

Tabulation of Preference Frequencies for Game Types

	Preference					
Game Type	1	2	3	4	5	Total
EDG	21	16	14	15	14	80
RPG	19	6	11	19	25	80
ADG	11	10	9	21	29	80
CWG	13	5	8	18	36	80
ASG	31	29	8	7	5	80

Note. The table is based on VG21, the sample of respondents who were undergraduate video gamers, aged 18 to 21 years. The preferences are based on a self-reported Likert scale, ranging from 1 (rarely or never played) to 5 (regularly or always played) over the prior two years. EDG = entity-development games; RPG = role-playing games; ADG = adventure games; CWG = coherent-world games, which included any of the types: EDG, RPG or ADG; ASG = abstract-strategy games.

useful analysis, I decided to look more closely at the deconstruction of the CWG type, namely EDG, RPG, and ADG.

I did not expect that ADGs would have the same impact as EDGs or RPGs to foster metacognitive awareness. ADGs are progressive rather than emergent; they are acquisition based rather than interactive based; they are much more allotelic rather than autotelic. EDGs and RPGs are the opposite from ADGs in these respects. As explained in Chapter 3, the latter game structures (emergent, interactive, and autotelic) should foster metacognitive awareness more than the former. In addition, EDGs and RPGs cover the broad range of CWG types and are orthogonal in their coverage of CWG aspects. ADGs

may overlap in coverage and may also be confused with RPGs. Finally, the preference levels in Table 12 show that EDGs and RPGs were reasonably distributed.

New categorization for gamer types. Consequently, I wondered whether I could separate the gamers into three types: NCWG, EDG, and RPG. Table 13 shows a cross-tabulation of the gamers' EDG and RPG preferences.

Table 13

Cross-tabulation of Preference Frequencies for Entity-Development Games (EDGs) and Role-Playing Games (RPGs)

	Preference for EDGs					
Preference for RPGs	1	2	3	4	5	Total
1	13	3	1	1	1	19
2	0	0	5	0	1	6
3	1	3	3	2	2	11
4	4	5	2	6	2	19
5	3	5	3	6	8	25
Total	21	16	14	15	14	80

Note. The table is based on VG21, the sample of respondents who were undergraduate video gamers, aged 18 to 21 years. The preferences are based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years.

I decided that the gamers could be categorized based on their EDG and RPG preferences as shown in Table 14. A more complete and clearer categorization of the gamer types is shown in Table 15. In the case of ties between RPG and EDG in which both values equaled 4 or 5, I favored EDG gamers to improve the distribution for the

Phase 1 analysis. Fortunately, the results that the two-way ANOVA yielded allowed further analysis to investigate any bias introduced by the specific categorization; those results will be presented as well.

Table 14

Heuristic Used to Categorize Gamers into Three Types

Gamer Type	Game-Type Preference Shown Over Prior Two Years			*n*
NCWG	RPG <= 3	AND	EDG <= 3	29
RPG	RPG >= 4	AND	RPG > EDG	28
EDG	EDG >= 4	AND	RPG <= EDG	23
Total				80

Note. The table is based on VG21, the sample of respondents who were undergraduate video gamers, aged 18 to 21 years. The preferences are based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years. NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game.

Table 15

Gamer Categorization based on a Cross-Tabulation of Preference Frequencies for Entity-Development Games (EDGs) and Role-Playing Games (RPGs)

	Preference for EDGs				
Preference for RPGs	1	2	3	4	5
	NCWG Gamers			EDG Gamers	
1	13	3	1	1	1
2	0	0	5	0	1
3	1	3	3	2	2
	RPG Gamers				
4	4	5	2	6	2
5	3	5	3	6	8

Note. The table is based on VG21, the sample of respondents who were undergraduate video gamers, aged 18 to 21 years. The preferences are based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years. NCWG = non-coherent world game.

Phase 1 Analysis

Two-way ANOVA for MAI as a function of time played and gamer type.

Recoding. Although 759 surveys were distributed, there was not a sufficient response to perform a 3 x 3 ANOVA for the screened sample of 80 video gamers. Therefore, I recoded the data and reduced the number of cells to enable a 2 x 3 ANOVA to be performed, with two levels of time played and three types of gamer. The recoding satisfied the recoding requirements: (a) all eligible surveys were included; (b) the

categories were mutually exclusive; and (c) the category distinctions were meaningful. Table 16 presents the results.

Table 16

Cross-tabulation for Gamer Type and Time Played

	Gamer Type			
Time Played	NCWG	RPG	EDG	Total
Low	19	10	11	40
High	10	18	12	40
Total	29	28	23	80

Note. The table is based on VG21, the sample of respondents who were undergraduate video gamers, aged 18 to 21 years. Low represents 48 to 750 hours of time spent playing video games over the prior two years and High represents greater than 750 hours in that same time span. NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game.

Post hoc research questions. The reconstituted research questions are presented below. The questions are similar to the original questions, excepting their revision to re-categorize gamers based on the data collected as well as the recoding necessary for analysis. Two years were operationalized as 100 weeks.

RQ1. Do first and second-year college students, aged 18 to 21 years, differ on their metacognitive awareness based on the level of time (Low or High) that they spent playing video games over the prior two years?

RQ2. Do first and second-year college students, aged 18 to 21 years differ, on their metacognitive awareness based on the type of video games (NCWG, RPG, or EDG) that they played over the prior two years?

RQ3. Do first and second-year college students, aged 18 to 21 years differ, on their metacognitive awareness based on the interaction of the time that they spent playing video games and the types of video games that they played over the prior two years?

H3a. The EDG and RPG video gamers who played video games at a High level of time over the prior two years will have a higher metacognitive awareness than the NCWG video gamers who played video games at any level of time.

H3b. The EDG and RPG video gamers who played video games at a High level of time over the prior two years will have a higher metacognitive awareness than the EDG and RPG video gamers, respectively, who played video games at a Low level of time over the prior two years

ANOVA requirements. The three requirements for using ANOVA were satisfied. All observations were independent; that is, all 80 data points were based on measurements of different gamers. Second, a box plot for the two-way ANOVA (Figure 6) indicated that there were no outliers or extreme values for the six data cells identified, and the distributions did not appear overly skewed. A Q-Q test as well as the Komogorov-Smirnov and Shapiro-Wilk tests provided further evidence that all six groups satisfied the normal-distribution requirement. Third, the Levine test for equality of error

variances showed the null hypothesis was not indicated at the .05 level; thus, homogeneity of variance was confirmed.

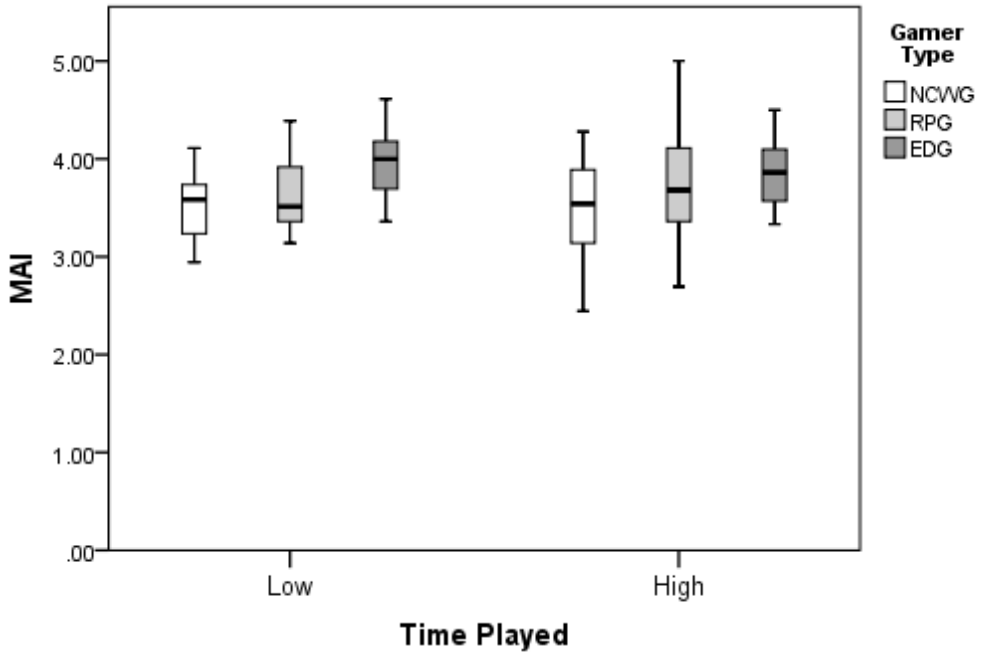

Figure 6. Box plot for MAI as a function of time played and gamer type. MAI = metacognitive awareness index; Low represents 48 to 750 hours of time spent playing video games over the prior two years and High represents greater than 750 hours in that same time span. NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game.

Results of the two-way ANOVA.

Table 17

Descriptive Statistics for MAI as a Function of Time Played and Gamer Type

Gamer type	Low time played			High time played			Total		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
NCWG	19	3.54	.35	10	3.49	.60	29	3.52	.44
RPG	10	3.61	.38	18	3.72	.61	28	3.69	.53
EDG	11	3.95	.37	12	3.86	.36	23	3.90	.36
Total	40	3.67	.40	40	3.71	.55	80	3.69	.48

Note. MAI = metacognitive awareness index; Low represents 48 to 750 hours of time spent playing video games over the prior two years and High represents greater than 750 hours in that same time span. NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game.

The gamer-type factor had a significant main effect: $F(2, 74) = 4.46$; $p = .015$; partial $\eta^2 = .11$, a "medium" effect; and power = .75, slightly less than .8, a "large" power.[18] The time-played factor did not have a significant main effect ($p = .95$). Furthermore, there was not an interaction effect between the gamer-type and time-played factors ($p = .70$). Post-hoc analysis based on Fisher's Least Significant Difference

[18] The values .01, .06, and .14 roughly correspond to a small, medium, and large effect size, based on partial η^2 (Stern, p. 296). A power of at least .8 is generally considered a large power.

(LSD)[19] test showed that EDG had a significantly higher MAI than NCWG. Figure 7 provides visual support of these results.

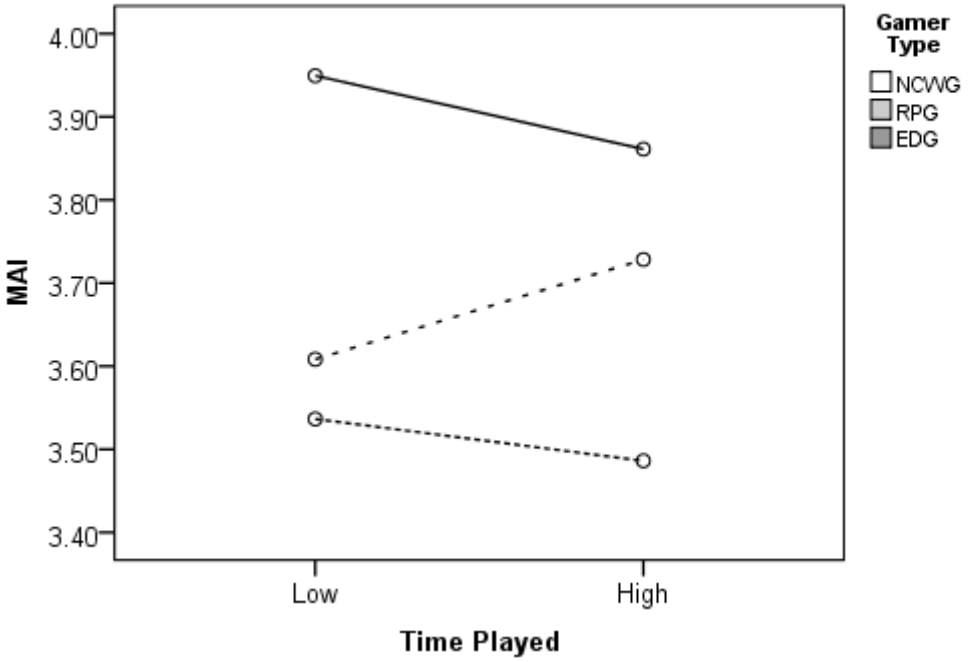

Figure 7. Plot of MAI as a function of time played and gamer type. MAI = metacognitive awareness index; Low represents 48 to 750 hours of time spent playing video games over the prior two years and High represents greater than 750 hours in that same time span. NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game.

The next section investigates any bias in the categorization of gamer types used in the preceding analysis. Consequently, the response to the research questions is shown at the end of the Phase 1 Analysis section.

[19] The Fisher's LSD test was used because it was recommended when exactly three groups are compared (Cardinal & Aitken, 2006).

One-way ANOVAs for MAI as function of gamer-type. Because my categorization of gamers was biased towards EDG gamers (by identifying ties between playing RPG and EDG gamers in favor of EDG gamers), I wondered if that bias had a significant effect. Because time played was not a significant factor, I could test that bias by running three one-way ANOVAs for gamer type as the single factor. The sets of gamer types used for each of the three analyses were referred to as gamer types A, B, and C.

All three analyses satisfied the ANOVA requirements of independent observations, sufficiently equal variances, and normal distributions. The gamer types A used the same gamer types as specified in Table 15 and used in the two-way ANOVA above.

Gamer types A. The results of the analysis are shown below.

Table 18

Descriptive Statistics for MAI as a Function of Gamer Types A

Gamer Type	*n*	*M*	*SD*
NCWG	29	3.52	.44
RPG	28	3.69	.53
EDG	23	3.90	.36
Total	80	3.69	.48

Note. MAI = metacognitive awareness index; NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game.

The gamer-type factor had a significant effect: $F(2, 77) = 4.55$; $p = .014$; partial $\eta^2 = .11$, a medium effect; and power = .76. Post-hoc analysis based on Fisher's LSD test showed that EDG gamers had a significantly higher MAI than NCWG gamers. There was no significant difference for MAI with RPG gamers between the NCWG or EDG gamers.

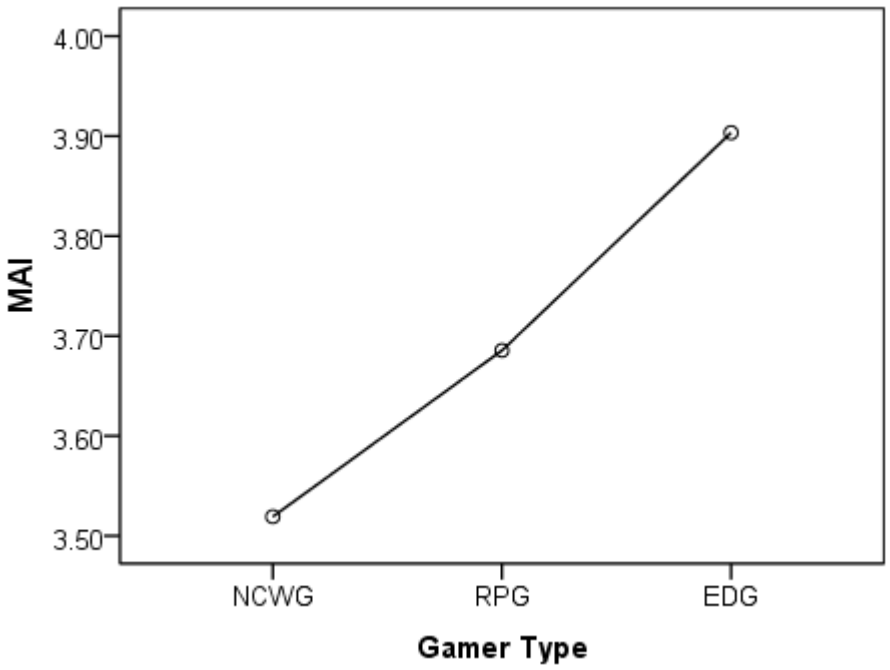

Figure 8. Plot of MAI as a function of gamer types A. MAI = metacognitive awareness index; NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game.

Gamer types B. An alternative categorization of gamer types is shown in Table 19. The type defined by both RPG and EDG preferences as 4 or 5 is referred to as CWG, because that type has the strongest combination of RPG and EDG preferences.

The box plot revealed that there was an outlier, and it was excluded from the analysis. (The outlier showed RPG and EDG preferences of 5 and 3, respectively, and is not included in Table 19.)

Table 19

Gamer Types B Categorization (excluding one outlier) based on a Cross-Tabulation of Preference Frequencies for Entity-Development Games (EDGs) and Role-Playing Games (RPGs)

	Preferences for EDGs				
Preference for RPGs	1	2	3	4	5
	NCWG Gamers			EDG Gamers	
1	13	3	1	1	1
2	0	0	5	0	1
3	1	3	3	2	2
	RPG Gamers			CWG Gamers	
4	4	5	2	6	2
5	3	5	2	6	8

Note. The table is based on VG21, the sample of respondents who were undergraduate video gamers, aged 18 to 21 years. The preferences are based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years. NCWG = non-coherent world game. CWG = coherent world game.

The results of the analysis are shown below.

Table 20

Descriptive Statistics for MAI as a Function of Gamer Types B (excluding one outlier)

Gamer Type	*n*	*M*	*SD*
NCWG	29	3.52	.44
RPG	21	3.59	.47
EDG	7	3.91	.44
CWG	22	3.87	.37
Total	79	3.69	.46

Note. MAI = metacognitive awareness index; NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game; CWG = coherent-word game.

The gamer-type factor had a significant effect: $F(3, 75) = 3.71$, $p = .015$; partial $\eta^2 = .13$, a medium effect; and power = .79. Post-hoc analysis based on the Šidák test[20] showed that CWG gamers had a significantly higher MAI than NCWG gamers. There was no significant difference of MAI with RPG or EDG gamers between any other gamer type. A plot of the means is shown in Figure 9.

[20] The Šidák test was used because it was recommended when more than three groups were compared (Cardinal & Aitken, 2006).

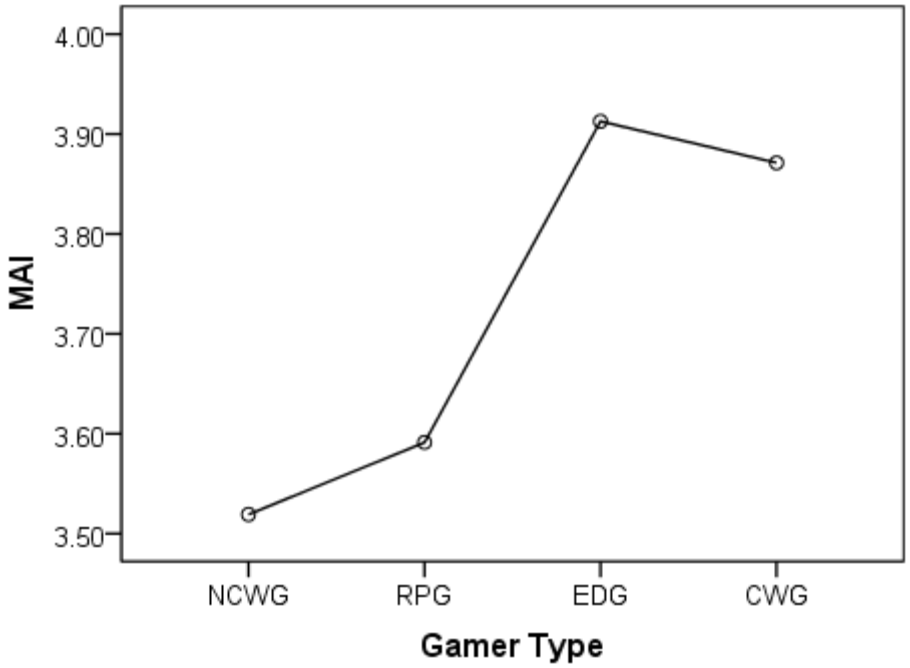

Figure 9. Plot of MAI as a function of gamer types B, excluding one outlier. MAI = metacognitive awareness index; NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game; CWG = coherent-word game.

With the outlier included, the results are shown below.

Table 21

Descriptive Statistics for MAI as a Function of Gamer Types B

Gamer Type	*n*	*M*	*SD*
NCWG	29	3.52	.44
RPG	22	3.66	.55
EDG	7	3.91	.44
CWG	22	3.87	.37
Total	80 [a]	3.69	.48

Note. MAI = metacognitive awareness index; NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game; CWG = coherent-word game.
[a]The total number of gamers includes an outlier for the gamer type RPG.

The gamer-type factor had a significant main effect: $F(3, 76) = 3.08$, $p = .032$; partial $\eta^2 = .11$, a medium effect; and power = .70. Post-hoc analysis based on pair-wise comparisons (*t* tests) with a Šidák correction showed that CWG gamers had a significantly higher MAI than NCWG gamers. There was no significant difference of MAI between any other pair of gamer types. A plot of the means is shown in Figure 10

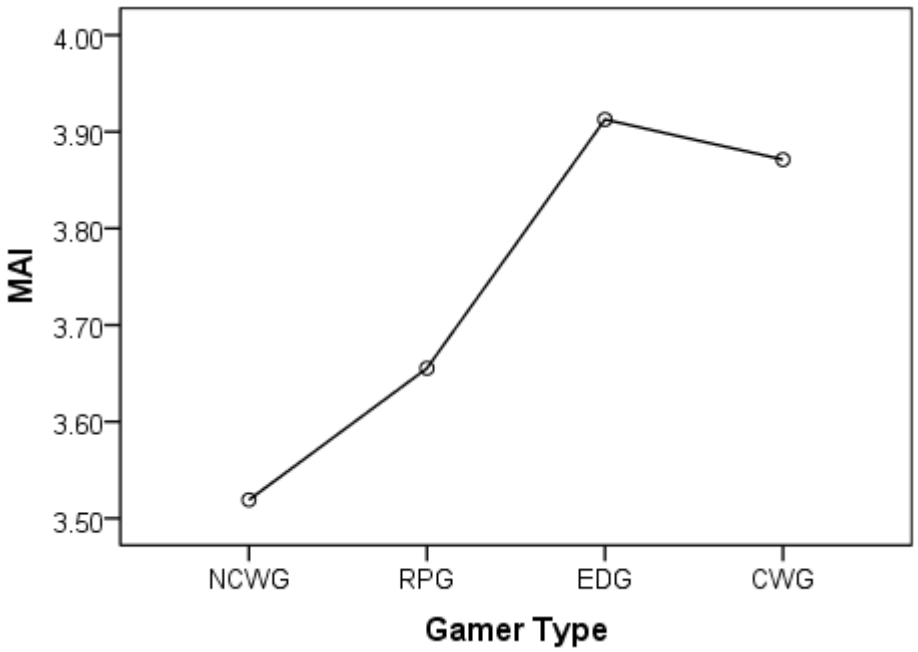

Figure 10. Plot of MAI as a function of gamer types B. MAI = metacognitive awareness index; NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game; CWG = coherent-word game.

Gamer types C. The third categorization of gamer type analyzed is shown in Table 22.

Table 22

Gamer Types C Categorization based on a Cross-Tabulation of Preference Frequencies for Entity-Development Games (EDGs) and Role-Playing Games (RPGs)

	Preference for EDGs				
Preference for RPGs	1	2	3	4	5
	NCWG Gamers		EDG Gamers		
1	13	3	1	1	1
2	0	0	5	0	1
	RPG Gamers		CWG Gamers		
3	1	3	3	2	2
4	4	5	2	6	2
5	3	5	3	6	8

Note. The table is based on VG21, the sample of respondents who were undergraduate video gamers, aged 18 to 21 years. The preferences are based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years. NCWG = non-coherent world game. CWG = coherent world game.

The results of the analysis are shown below.

Table 23

Descriptive Statistics for MAI as a Function of Gamer Types C

Gamer Type	*n*	*M*	*SD*
NCWG	16	3.44	.39
RPG	21	3.67	.45
EDG	9	3.56	.56
CWG	34	3.85	.46
Total	80	3.69	.48

Note. MAI = metacognitive awareness index; NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game; CWG = coherent-word game.

The gamer-type factor had a significant main effect: $F(3, 76) = 3.23$, $p = .027$. Partial $\eta^2 = .11$, a medium effect; and power = .72. Post-hoc analysis based on pair-wise comparisons (*t* tests) with a Šidák correction showed that CWG gamers had a significantly higher MAI than NCWG gamers. There was no significant difference for MAI with RPG gamer type between the NCWG or EDG gamer type. A plot of the means is shown in Figure 11.

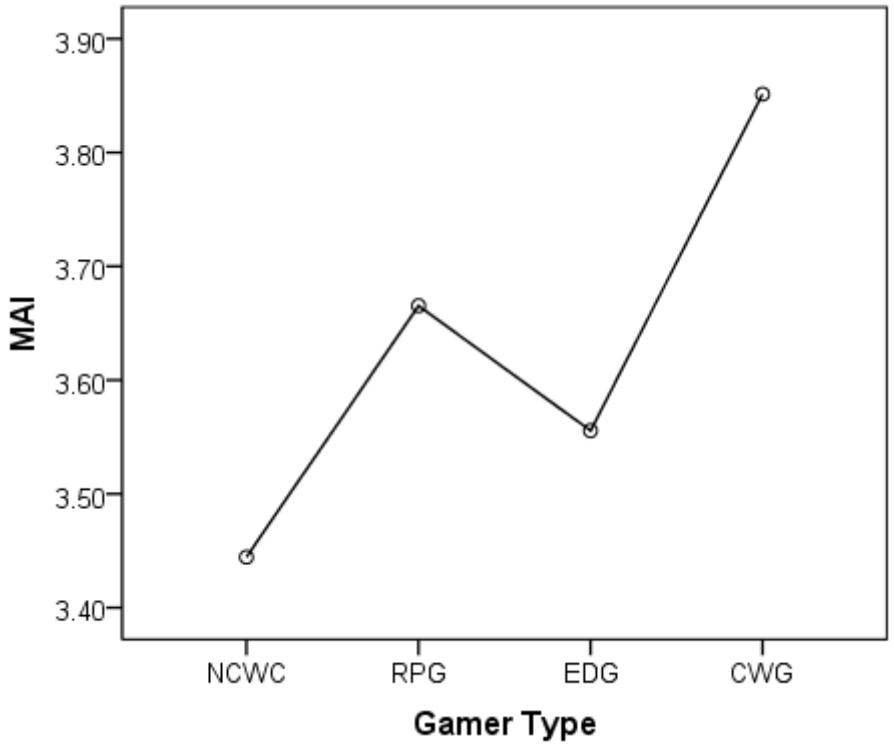

Figure 11. Plot of MAI as a function of gamer types C. MAI = metacognitive awareness index; NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game; CWG = coherent-word game.

Response to research questions. The post-hoc research questions were similar to the original research questions, except for their revision to re-categorize gamers based on the data collected and for the recoding necessary for analysis. The new hypotheses were similar as well. As before, I did not provide hypotheses for RQ1 and RQ2, and I provided two hypotheses for RQ3.

The answers to the research questions are briefly stated below. (The questions were based on the VG21 sample.)

RQ1. The result of the two-way ANOVA indicated that the level of time spent playing video games (Low or High) over the prior two years was not associated with a significant difference for gamers' MAI.

RQ2. In considering the one-way ANOVAs in addition to the two-way ANOVA, CWG gamers (characterized by high values for both EDG and RPG) were associated with a significantly higher MAI than NCWG gamers. The results for EDG gamers were inconclusive; the results for RPG gamers were not significant.

RQ3. There was not a significant interaction effect between time played and gamer type that was associated with MAI. This result did not support my hypotheses.

The interpretation of these results will be discussed in Chapter 6.

Phase 2 Analysis

The Phase 2 analysis was used to provide further insight into the relationship of playing video games and metacognitive awareness. In addition, the extra data collected was used in the Phase 1 analysis to create the post-hoc criteria that proved necessary.

Impact of age and class year. The sample frame was an issue in this study because of two confounding variables, namely age and class year, which represented a second issue. To shed further light on these issues, I considered five samples that were screened by age and class year from the surveys collected. Table 24 shows the sample breakdowns before screening out the non-gamers for analysis. Note that the 80 gamers in the UG21 sample comprised the VG21 sample that was used in Phase 1.

Table 24

Samples Screened for Age and Class Year from the Surveys Collected

Sample Name	Description	Gamers	Non-Gamers	Total
FS21	first and second-year students, aged 18 to 21 years	64	27	91
UG21	undergraduates, aged 18 to 21 years (this distribution was used in the main text)	80	34	114
UG24	undergraduates, aged 18 to 24 years	97	38	135
UG99	undergraduates, aged 18 to 99 years (i.e., all ages)	112	51	163
ALL99	all respondents (any age, any year, i.e., First year to Senior plus Other)	114	54	168

Note. Seven surveys out of the 175 collected were not usable in the analysis

I decided to do a comparative analysis with three additional gamer samples, namely the gamers in FS21, UG24, and UG99; referred to as the VGFS, VG24, and VG99 samples, respectively. The analysis was based on a one-way ANOVA for MAI with gamer type as the independent variable for each of the VGFS, VG24, and VG99 samples. In addition, I included the results for the VG21 sample from the analysis in Phase 1.

I chose to use the gamer types B criteria (Table 25) over the A and C criteria. The A criteria subjectively favored EDG gamers over RPG gamers in cases of ties in preferences for EDGs and RPGs. The C criteria led to gamer type distributions that were less evenly distributed (Table 26), particularly between NCWG and CWG gamers, the two types that I considered most important in the analysis. Finally, the B criteria

established CWG gamers as strong in both EDG and RPG (with Likert scores of 4 and 5's), which clearly distinguished CWG gamers from the other types.

Table 25

Heuristic Used to Categorize Gamers into Four Types

Gamer Type	Game-Type Preference Shown Over Prior Two Years		
NCWG	RPG <= 3	AND	EDG <= 3
RPG	RPG >= 4	AND	EDG <= 3
EDG	EDG <= 3	AND	RPG <= 3
CWG	EDG >= 4	AND	RPG >= 4

Note. The table is based on VG21, the sample of respondents who were undergraduate video gamers, aged 18 to 21 years. The preferences are based on a self-reported Likert scale, ranging from 1 (*rarely or never played*) to 5 (*regularly or always played*) over the prior two years. NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game. CWG = coherent world game.

Table 26

Gamer-Types B and C Frequencies for Sample Respondents

Sample Name	Set	NCWG	RPG	EDG	CWG
VGFS	B	23	19	6	16
	C	13	18	8	25
VG21	B	29	22	7	22
	C	16	21	9	34
VG24	B	32	25	10	30
	C	17	25	12	43
VG99	B	38	32	11	31
	C	22	31	13	46

Note. VGFS comprises first and second-year student gamers, aged 18 to 21 years. VG21, VG24, and VG99 comprise undergraduate gamers, with the following age restrictions: 18 to 21 years for VG21, 18 to 24 years for VG24, and aged 18 years and over for VG99. NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game. CWG = coherent world game.

After excluding outliers using box plots, the three additional samples were determined to have normal distributions and satisfied the Levine test for homogeneity of variance. The ANOVA results for the four samples are summarized in Table 27 and Figure 12.

Table 27

ANOVA Results for MAI as a Function of Gamer Type for Four Survey Samples

Sample Name	*n*	*df*	*F*	*p*	Partial η^2	Power	Main Effects based on Šidák Post-Hoc Test
VGFS	64	3, 60	4.29	.01**	.18	.84	(CWG, EDG) > NCWG[a]
VG21	79[b]	3, 75	3.71	.02*	.13	.79	CWG > NCWG
VG24	96[b]	3, 92	4.00	.01*	.12	.82	(CWG, EDG) > NCWG[a] also, CWG > RPG
VG99	112	3, 108	2.80	.04*	.07	.66	CWG > NCWG

Note. All of the samples shown above were extracted from the overall sample frame of the study. They were all based on respondents who played video games for an estimated average of two hours a month over the prior two years. VGFS comprises first and second-year students, aged 18 to 21 years. VG21, VG24, and VG99 comprise undergraduates, with the following age restrictions: 18 to 21 years for VG21, 18 to 24 years for VG24, and aged 18 years and over for VG99; MAI = metacognitive awareness index.
[a]The expression, "(CWG, EDG) > NCWG," means that MAI for CWG and EDG gamer types were each significantly greater than the NCWG gamer type. [b]The number excludes one outlier removed from the RPG gamer type.
*$p < .05$. **$p < .01$.

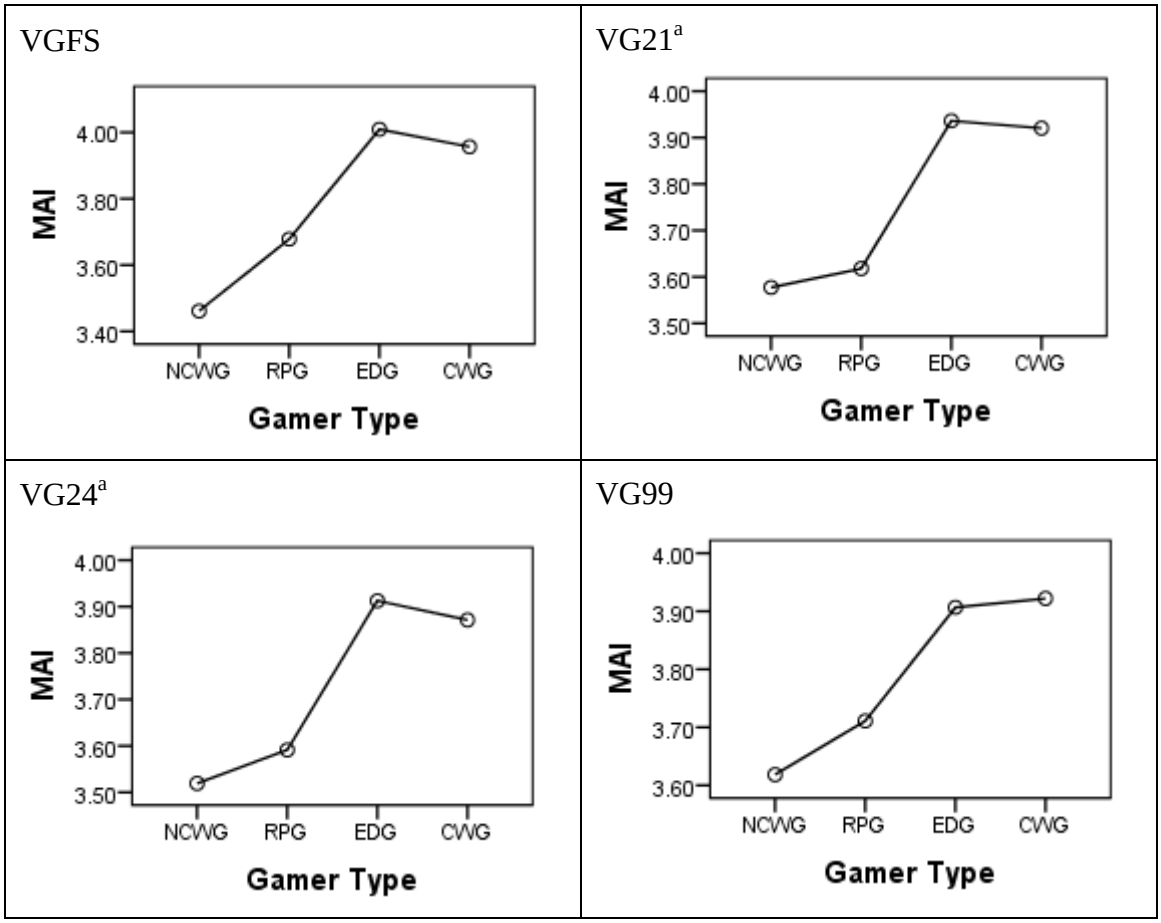

Figure 12. Plots of MAI for different samples. Note that the scale for MAI is different for each sample. VGFS comprises first and second-year students, aged 18 to 21 years. VG21, VG24, and VG99 comprise undergraduates, with the following age restrictions: 18 to 21 years for VG21, 18 to 24 years for VG24, and aged 18 years and over for VG99. MAI = metacognitive awareness index; NCWG = non-coherent world game; RPG = role-playing game; EDG = entity-development game; CWG = coherent world game.
[a]The sample excluded one outlier.

In reviewing Table 27, the results for a "purer" sample than VG21, namely VGFS which only included first and second-year students, showed a large effect size and a large power that were both greater than those for VG21. The results for VG24 were close to those of VG21 (excluding the additional result that CWG gamers had a significantly

higher MAI than RPG gamers). The results for VG99, aged 18 years and over, showed a substantially smaller effect size and power. In other words, the purer the sample was in terms of age range and class year, the greater the effect size and power that were computed. These results provide insight into the effect of the confounding variables of age and class year as well as the issue of the sample frame, and both will be discussed in Chapter 6.

Response rates. Before concluding this chapter, rough estimates for the response rates of the VGFS and VG21 samples can be calculated, based on the population breakdowns in Table 24. There were 759 surveys distributed, representing the sample frame for the overall study. Excluding "error surveys" in the calculations and extrapolating down from the ALL99 sample, there would be an estimated 515 surveys distributed to yield the UG21 sample. Extrapolating further to screen out the non-gamers would yield an estimated 361 surveys distributed to yield the VG21 sample. Finally, a response rate of 22% was estimated for the VG21 sample. Using similar calculations, a response rate of 40% was estimated for the VGFS sample.

Chapter 6: Discussion

Interpretation of the Results

To summarize the main findings, a positive association was found between first and second-year college students who were CWG gamers, aged 18 to 21 years, and metacognitive awareness. The effect size was .11, a medium effect, and the power was .75, a medium to large power. However, because of coverage error and a low response rate, 22%, the result could not be generalized to the target population. If the target population considered only first and second-year students, aged 18 to 21 years, the effect size was .18, a large effect, and the power was .84, a large power. Although the coverage and response rate were better, but at 40% the response rate was still low. The two main explanations considered for the associations found were that playing CWGs fostered metacognitive awareness or that those with a higher metacognitive awareness preferred CWGs. Neither possibility could be dismissed based on this study's design.

The research design was hindered by a "Catch 22." The three types of gamers originally conceived for Phase 1 were specified before collecting data. I expected that the gamer types could be objectively distinguished and sufficiently distributed to enable the data analysis intended.

In fact, initial analysis revealed that the gamer types specified were not suitable. In particular, action gamers and strategy gamers could not be objectively distinguished.

Consequently, the set of gamer types were revised in accordance with the main goal of the study and to enable post-hoc research questions that mirrored the original research questions and utilized the same method of analysis; the hypotheses mirrored the original hypotheses as well. From hereon, the discussion will refer to the post-hoc research questions and hypotheses, but the term, post-hoc, will be assumed.

The research questions (RQ1 to RQ3) and hypotheses (H3a and H3b) were presented in Chapter 5. I did not provide hypotheses for RQ1 and RQ2. However, the results did not support my hypotheses for RQ3 (i.e., H3a and H3b).

The result for RQ1 indicated that if the types of games played were not considered, the time played would not show a significant association with MAI. I did not provide a hypothesis for RQ1, because I could not dismiss the possibility that other types of games, even relatively simple games such as poker, could encourage a high-level of strategic thinking (Nesson, 2008) that might foster metacognitive awareness. In fact, any video game not based on pure chance would require some type of cognitive activity, although not necessarily accompanied by metacognitive activity. Alternatively, playing video games regularly for substantial time periods might distract from school work and metacognitive activities. The result for RQ1 indicated that any possible confounding effects were averaged out.

For RQ2, I wasn't sure if the way I distinguished between EDG and RPG gamers was biased. Because the result for RQ1 indicated that time played was not significant, I conducted three one-way ANOVAs for MAI as a function of gamer type. In doing so, I introduced a fourth gamer type (CWG) that showed strong preferences for both EDGs

and RPGs. The additional analyses provided important insight for interpreting the results. However, to apply that insight the research questions were considered in the context of all four gamer types.

The results for RQ2 showed that CWG gamers were associated with a significantly higher MAI then NCWG gamers. The results for RPG gamers were insignificant; the results for the EDG gamers were inconclusive. For gamer types B and C, there were relatively few EDG gamers compared to each of the other three types. Also, for gamer types C, there were only three gamers who recorded a 4 or 5 in their preference for EDGs. Thus, the inconsistent results for the EDG gamers were understandable. In conclusion, a strong preference for both EDGs and RPGs produced a significant and positive association with MAI in comparison with the NCWGs. For the two-way ANOVA the effect size was .11 (a medium effect) and the power was .75 (a medium to large power) at a confidence level of 95%.

The result provided credence for the alternative explanation that gamers who preferred CWG games had a higher MAI. However, previous research showed that adult gamers had been playing video games (as of 2007) for an average of 13 years (Entertainment Software Association, 2007). Thus, it was possible that CWG gamers had played CWGs for a substantial amount of time prior to the two-year period assessed in the survey; and that prior experience could have affected the result. In summary, neither of the explanations for the association found could be dismissed.

For RQ3, I expected that EDG and RPG gamers who played video games for a substantial amount of time would have a higher MAI than gamers with less of that

experience. However, the results showed that my hypotheses for that view were not supported. In this case, however, because the time played included all types of video games, apportioning the times played to different gamer types was questionable. Considering the results for RQ1 and RQ2, the result for RQ3 was not surprising.

In summary, CWG gamers were associated with a higher metacognitive awareness than NCWG gamers. The cause and effect relationship was not proven, but it could not be ruled out as well.

The epistemological theories presented in Chapter 2 explain why CWGs (including both RPGs and EDGs) can foster metacognitive awareness. Although RPGs usually have other real players (i.e., they might include only virtual players), EDGs often have other real players as well. CWGs provide a mastery environment that encourages and supports players to be persistent in overcoming challenges and to try different strategies without fear of actual risk. In addition, CWGs support active learning and situated meaning. The players explore, probe, reflect, and test hypotheses in a large, complex, and consistent world; in their quest to create meaning by interaction with the world and other players in order to reach their goals. In addition, players in CWGs form CoPs and operate in a semiotic domain. The players learn by observing and interacting with others in the CoP, then working to develop the practice. They develop tools, including semiotics that are unique to the game, and may be further unique to a particular CoP in the game. Thus, they think and act through a "language," foreign to their own, which provides another perspective then the one they normally use.

In EDGs, players develop, manage, and operate complex entities which require synthesis, design, and strategic planning. These are powerful learning activities. They incorporate the activities used in active learning and situated meaning described above. Although these activities may also be used in RPGs, they are used more and are more intensive in EDGs.

In RPGs, players reflect and act through their character's perspectives and values, while also interacting through their character with others in a community (i.e., a CoP) to develop shared perspectives and values. The multiple perspectives and values would broaden their outlook in the activities described in the epistemological theories described. The enhanced outlook would intensify their reflection in those activities and foster metacognitive awareness.

In summary, there is reason to understand that CWG gamers who demonstrated strong preferences for both EDGs and RPGs would have a higher metacognitive awareness due to playing those games.

Limitations of Findings

Approximation of game experience. The two variables used in the Phase 1 research questions, that is, the preferences demonstrated for EDGs and RPGs, were each based on the Likert score of single items in the GEQ. Because of the wide net cast on the types of games that the target population had played, I was limited in probing deeper into particular game types in order to limit the overall length of the GEQ. Even so, the length of the GEQ was longer than I had wanted. Nonetheless, considering that this study was taking a first look with a survey approach to detect a quantitative association between

playing games and metacognitive awareness, I believe that the measure used to separate the gamers ultimately into four groups was sufficient for this study.

Target population and sample frame. I suspected that age and class level were confounding variables that could have a significant impact on Phase 1. Thus, I believed that first and second-year students who were gamers, aged 18 to 21 years, would be the best target population for this study. However, for practicality sake, I had to survey classes that had "mostly" first and second-year students enrolled, realizing that the classes would contain juniors and seniors as well. To mitigate the risk of too few respondents for the Phase 1 analysis, I chose to include all gamers who were undergraduates and aged 18 to 21 years for Phase 1.

The results of the Phase 2 analysis (Chapter 5) confirmed my beliefs concerning age and class year. These results were based on one-way ANOVAs for MAI as a function of gamer type. The results for the smaller but "purer" sample of gamers who were first and second-year students (VGFS) showed a larger effect size and power than the VG21 sample. The effect size and power for VGFS were both large (i.e. .18 and .84, respectively), differing from the results for the VG21 sample, which showed a medium effect size and a medium to large power (i.e., .13 and .79, respectively). Conversely, when the sample included undergraduate gamers of any age (sample VG99), the effect size and power were much smaller (i.e., 07 and .66, respectively).

Survey errors. Survey errors included measurement, sampling , coverage, and nonresponse.

Measurement error. I reviewed the completed surveys to determine whether they appeared reasonable and consistent. I excluded seven surveys from the analyses due to errors that rendered them unusable. Of those, there were six surveys that had errors in the GEQ and one survey that was missing the MAI instrument. Only two items in the GEQ were ultimately used to determine gamer type. Although the Phase 1 analysis was confirmatory, because of the wide range of games included in the survey, I could not probe for details of particular game types. Thus, the study would be more accurately described as exploratory.

Sampling error. The sampling errors for the Phase 1 analyses were under 5%. The sampling errors for the Phase 2 analyses were under 5% as well; although the sampling error for the VGFS sample was under 1%.

Coverage error. The sample frame for the overall study was based on the students who were distributed surveys. I surveyed 29 first and second-year classes across the university. In each class, I requested that everyone take a survey, whether they were planning to complete it or not; unless they had already received a survey in another class. It appeared to me that my request was well honored.

The demographic results for the VG21 sample indicated that the respondents represented a reasonable distribution across broad categories of course major (e.g., the arts, social sciences, applied sciences, and pure sciences). Women represented 29% of the VG21 sample. This percentage contrasted to a 2007 nationwide study in which 38% of all gamers and 47% of online gamers were female (Entertainment Software

Association, 2007). Perhaps fewer women gamers responded to the survey than their proportion in the sample frame.

More importantly, in order to mitigate the risk of too few respondents for analysis, juniors and seniors were included in the VG21 sample frame, although only first and second-year classes were surveyed. Basically, one could consider that the sample frame represented a target population of undergraduate gamers, in which juniors and seniors were underrepresented, or that the sample frame represented a target population of first and second-year students who were gamers, in which juniors and seniors were polluting the sample frame. I chose the latter perspective because I thought it was a better representation of the target population.

Summing up, the coverage for the VG21 sample frame was poor, because it was compromised by the way it was specified. On the other hand, the coverage for the VGFS sample frame, restricted to first and second-year students who were gamers, aged 18 to 21 years, was reasonable.

Nonresponse error. The response rates for the VG21 and VGFS samples were 22% and 40% respectively (estimated at the end of Chapter 5). With these low response rates, I believe that a significant nonresponse error was likely.

Generalizability. In Phase 1, because of poor coverage and a low response rate, the results were not generalizable. In the Phase 2 analysis, the coverage of the VGFS sample frame was reasonable, but the response rate was still too low for comfort. Thus, the results were not generalizable.

Implications

Although previous studies have shown that playing games could elicit metacognitive behaviors (e.g., Antonietti & Mellone, 2003; Doolittle, 1995; Henderson, 2005; Hong & Liu, 2003; Horak, 1990; Ke, 2007; Pillay, Brownlee, & Wilss, 1999; Pillay, 2002), no previous studies have shown that playing games could directly and measurably improve metacognitive awareness. Whereas previous studies had used experiments involving only a few games and over a small time span (e.g., Ke, 2007), the survey approach used here enabled measurement of a compilation of game experience and over a much larger time span.

Although not generalizable, evidence was found that first and second-year students who were gamers (aged 18 to 21 years) who preferred playing CWGs were associated with a higher MAI than those who preferred playing NCWGs. Two main explanations for these results were considered: (a) playing CWGs fostered metacognitive awareness or (b) those with higher metacognitive awareness preferred to play CWGs. Neither possibility could be dismissed in this study.

My further-reaching goal was to assess the feasibility of developing an empirically-based taxonomy of game characteristics organized by their potential to foster metacognitive awareness. A good taxonomy would be valuable. It could be used to organize a database to consolidate research findings and facilitate access to them. The database could be used to identify gaps, conflicts, and redundancies in the research base. Egenfeldt-Nielsen (2007) claimed that research of the educational potential of games was fragmented. The key purpose of his dissertation was to provide a framework to

consolidate previous research and provide a means for a more efficient roadmap of the future research needed. Creating the taxonomy described could provide a rigorous and structured approach that could complement Egenfeldt-Nielsen's goal.

To prove feasibility for developing the taxonomy, evidence would first be needed that contrasting game experiences could be quantitatively associated with different MAIs. This study found an association. However, additional evidence would be needed that contrasting game experiences were the cause for different MAIs. To prove a cause and effect relationship with a survey methodology, a longitudinal survey approach would be necessary.

I believe that the methodology that I used for this study might be the study's most valuable contribution. In implementing the methodology I encountered many obstacles and pitfalls and many lessons were learned. I believe that the results and the knowledge amassed could warrant and inform future research.

Future Research

Future studies should be designed to test whether any associations found are based on cause and effect relationships. In particular, I would recommend a study with sufficient resources that, if successful, could make significant headway toward the long-term goal of developing a taxonomy. I have provided the guidelines and rationale for that study below.

Longitudinal approach. First of all, the study would employ a longitudinal survey methodology with two surveys, the second survey conducted at a suitable interval after the first; I would recommend an interval of at least one year. With this approach, a

cause and effect relationship could be tested. In addition, this approach would avoid the confounding effect that prior gaming experience might present.

Game tasks. I surveyed a population whose members played a wide range of game types so that a broader population could be included. The disadvantage was that I could not probe for details of specific game types. In addition, it was difficult to compose questions that asked about the types of games played instead of specific game tasks that gamers performed. I concluded that future research should be limited to at most a single genre, and preferably a single game, so that behavior-based preferences for specific game tasks could be queried. However, assuming that a single game was chosen, it should include specific tasks from both EDGs and RPGs that are anticipated to directly or indirectly affect metacognitive awareness.

The MMORPG genre. MMORPGs contain many of the characteristics that engage metacognitive behaviors. Because MMORPGs are large and complex, many people who play them might consume much or most of their game-playing time on those games. Millions of people play MMORPGs. Even so, those players would not represent a broad population of learners. However, for the purpose of studying game characteristics that could affect metacognitive awareness, the MMORPG population could be a good choice to study.

I would suggest using a single MMORPG because of the advantages. MMORPGs are extremely popular; even a single MMORPG might have millions of registered players. Furthermore, everyone in the target population would have played the same game, reducing the threat of an association between game preference and MAI.

Also, the survey could use the game's terminology, which would be familiar to the players. Thus, the survey could query the portion of time spent on particular game tasks. Certainly MMORPGs would contain tasks that would be characteristic of RPGs. However, the particular game chosen should also include game tasks that were significant in EDGs. Since the study would be based on a comparison of game tasks rather than game types, I believe that a study based on an MMORPG would be possible. The final advantage of using a specific game would be the greater facility to specify and access a quality sample frame.

Obtaining a quality sample frame. A quality sample frame is critical to obtain generalizable results. In gaming research concerning specific game behaviors in MMORPGs, survey studies have typically relied on self-selected surveys that have been conducted online (e.g., Yee, 2006; Beedle, 2005; Alix, 2005). However, a self-selected sample is not generalizable to the target population.

I can understand why the past studies cited relied on self-selected samples, because a quality sample frame for a significant population of gamers, particularly for an academic study, is not easy to obtain. However, for a study that could affect future education, generalizable results would be extremely important. I believe it is possible to obtain a quality sample frame and a sufficient response rate if the proper resources could be obtained. Foremost, the study would require a champion who could provide sufficient access to the target population to access the quality sample frame needed and enable a proper survey implementation. That champion would either have influence with the game distributor or would be the game distributor. In addition, resources would be

necessary to provide incentives to members of the sample frame. However, providing incentives to respondents doesn't generate significantly higher response rates (Dillman, 2007). Alternatively, providing a small incentive to all members of the sample frame is an important part of establishing the trust relationship that has succeeded in generating significantly higher response rates. I would think that the game distributor could provide a game-related incentive that would not be too expensive.

Because the study would require two surveys spaced sufficiently in time, the study would require more resources and would be more difficult to conduct than a single survey would. Thus, I believe that evidence that the study had a reasonable chance of success would be necessary to make the case to obtain the resources necessary. I believe that this study could be cited at least as partial evidence towards that goal.

Suggested research. After selecting the game for the study, the first step in the suggested research would be to develop a list of game tasks that would be appropriate for the study's objective. Because of the high cost anticipated for the study, it would be advantageous if more than one study could be conducted with the same survey data, although with the same ultimate objective in mind. For example, based on the list of game tasks compiled, different categories of gamer types could be determined pre-survey for a confirmatory analysis similar to the one done here. However, the analysis would use a repeated-measures ANOVA because of the longitudinal approach. Perhaps more than one list of gamer types might be used. .However, because of the problems I discussed in anticipating gamer-type distributions pre-survey, I believe that additional and perhaps more interesting studies could be conducted post survey.

I would suggest that an initial data analysis be done using an exploratory factor analysis to determine the latent variables (i.e., composites of game tasks representing different gamer types), similar to the gamer-motivation studies done by Alix (2005) and Yee (2006). However, the list of tasks generated pre-survey would be generated from an initial list of dimensions that were suitable for this study. Based on the latent variables determined and with suitable criteria, each respondent would be categorized as one of the gamer types. Then the repeated measures ANOVA would be conducted, similar to those done in the confirmatory analyses.

Appendices

Appendix A: The Generalized Measure of Adaptive Cognition (MAC)

The items for the MAC are listed below, categorized by its five dimensions. When this measure is converted to a questionnaire, the headings will be removed to avoid bias. However, the order of the items can be left the same (J. M. Haynie, personal communication, June 7, 2008).[21]

The scale used for the measure is shown below:

Scale

NOT Very Much Like Me 1 2 3 4 5 Very Much Like Me

Goal Orientation

I often define goals for myself.

I understand how accomplishment of a task relates to my goals.

I set specific goals before I begin a task.

I ask myself how well I've accomplished my goals once I've finished.

When performing a task, I frequently assess my progress against my objectives.

Metacognitive Knowledge

I think of several ways to solve a problem and choose the best one.

I challenge my own assumptions about a task before I begin.

[21] J. M. Haynie provided me permission to use his instrument for my dissertation (J. M. Haynie, personal communication, June 9, 2008).

I think about how others may react to my actions.

I find myself automatically employing strategies that have worked in the past.

I perform best when I already have knowledge of the task.

I create my own examples to make information more meaningful.

I try to use strategies that have worked in the past.

I ask myself questions about the task before I begin.

I try to translate new information into my own words.

I try to break problems down into smaller components.

I focus on the meaning and significance of new information.

Metacognitive Experience

I think about what I really need to accomplish before I begin a task.

I use different strategies depending on the situation.

I organize my time to best accomplish my goals.

I am good at organizing information.

I know what kind of information is most important to consider when faced with a problem.

I consciously focus my attention on important information.

My 'gut' tells me when a given strategy I use will be most effective.

I depend on my intuition to help me formulate strategies.

Metacognitive Choice

I ask myself if I have considered all the options when solving a problem.

I ask myself if there was an easier way to do things after I finish a task.

I ask myself if I have considered all the options after I solve a problem.

I re-evaluate my assumptions when I get confused.

I ask myself if I have learned as much as I could have when I finished the task.

Monitoring

I periodically review to help me understand important relationships.

I stop and go back over information that is not clear.

I am aware of what strategies I use when engaged in a given task.

I find myself analyzing the usefulness of a given strategy while engaged in a given task.

I find myself pausing regularly to check my comprehension of the problem or situation at hand.

I ask myself questions about how well I am doing while I am performing a novel task.

I stop and re-read when I get confused.

Appendix B: The Game Experience Questionnaire (GEQ)

The GEQ is shown on the following pages. It has been modified from the actual survey questionnaire to fit this document's margin requirements. In addition, the entire text is in black; minor instructions have been omitted; and the line and page spacing have been modified.

Instruction Sheet for Game-Experience Questionnaire[22]

This questionnaire is intended to get a general understanding of your game-playing preferences and habits (including video games and non-electronic games). So, estimate your answers as best as you can. (Write your answers directly on the questionnaire in the space provided for each question.)

Virtual worlds that are basically social spaces (for example, Second Life®) are not considered games for this survey, except for games played within those worlds or spaces.

Select only one answer for every question.

All questions are based on your game-playing experience **in the last 2 years** (going back from today), except for the last section.

Many questions will use the scale shown below:

Scale

Seldom (or Never)	1	2	3	4	5	Mostly (or Always)

Important: This is a continuous scale to show a rough **proportion of time** that you played particular types of games out of the total time that you played games.

The scale ranges from Seldom to Mostly. However, if your answer for a question is "never played," answer "1" in the space provided.

[22] The instruction sheet was two-sided and included the following page on the reverse side.

Assume that "**game**" is a broad term that ranges from simple puzzle games, such as crosswords, all the way to complex, multiplayer games that are played over many sessions.

A video game is played on an audiovisual device. The device can be an arcade system, a game console, a handheld device, a personal computer, a phone, etc.

A non-electronic game does not use any type of computing or audio-visual device. It is typically played with paper and pencil, cards, game boards, or with miniatures on a tabletop.

An athletic game is not considered here, unless it has been converted to a video game or non-electronic game. Hybrid games that combine video and non-electronic games, such as Wii, are included. Consider them **video games**.

Do not include games that are based mainly on chance rather than any capabilities or skills (for example, lotteries, slot machines, bingo, etc.).

SECTION 1 Interest in Games

Write your answers in the space provided after the question numbers.

1. ___ Select one statement below that represents your strongest opinion about **video games**.
    1. Video games are a waste of time.
    2. Video games provide an escape from reality.
    3. Video games are a worthwhile leisure activity.
    4. Video games are a worthwhile leisure activity and can be a useful learning experience.

2. _____ In the last 100 weeks (about 2 years), roughly estimate the number of weeks (0 to 100) in which you played video games.

3. _____ In a typical week when you played video games in the last 2 years, estimate the hours a week that you played.

4. _____ In the last 100 weeks (about 2 years), roughly estimate the number of weeks (0 to 100) in which you played non-electronic games.

5. _____ In a typical week when you played non-electronic games in the last 2 years, estimate the hours a week that you played.

Your answers (for questions 2 thru 5) will be used to estimate the number of hours that you played video games and non-electronic games in the last 100 weeks.

The number of weeks times the hours a week will provide rough estimates for those 2 times.

SECTION 2 Non-Electronic Games

During the time you played **non-electronic** games in the last 2 years, how much of that time did you play the types of games listed below? Pick a number from the scale.

Scale

Seldom (or Never) 1 2 3 4 5 Mostly (or Always)

Type of Games	Additional Information
6. ___ Puzzles and other simple games	Simple word and visual puzzles. Require thinking, but little or no strategy. Examples include Crossword puzzles, Trivial Pursuit, Jeopardy, Scrabble, Solitaire, etc.
7. ___ Games in which you develop and/or operate a complex entity	A complex entity could include a business, an army, a city, a civilization, a system, etc.
8. ___ Role-playing games	This type of game takes place in a fictional world in which you solve challenges through the character you play. A fictional world may be based on fantasy or reality.

SECTION 3 Abstract Strategy Games (includes video and non-electronic games)

During the time you played **video and non-electronic games** in the last 2 years, how much of that time did you play the type of game listed below?

Scale

Seldom (or Never) 1 2 3 4 5 Mostly (or Always)

9. ___ Abstract strategy games	NOT based on a fictional world, story, or complex entity. Examples include Poker, Checkers, Chess, Bridge, etc.

Of the time you played abstract strategy games, how much of that time did you play the following? (Use the scale above.)

10. ___ Easy-thinking games	Assume that games such as poker and checkers are easy-thinking games, relative to games such as chess and bridge which are intense-thinking games.
11. ___ Intense-thinking games	

SECTION 4 Video Games

If you rarely or never played video games in the last 2 years, skip to SECTION 7.

Else, during the time you played **video games** in the last 2 years, **how much of that time** did you play the types of games listed below? Pick a number from the scale.

Scale

Seldom (or Never) 1 2 3 4 5 Mostly (or Always)

12. ___ Puzzles and other simple games	Simple word and visual puzzles. Require thinking, but little or no strategy. Do not require quick reactions. Examples include crossword puzzles, Trivial Pursuit, Jeopardy, Scrabble, Solitaire, etc.
13. ___ Action games	These games require good perceptual abilities and quick reactions. Quick decision making is required.
14. ___ Strategy games	Strategy includes careful planning and decision making. Do not include games in type 12 above. (Strategy games may include action, but strategy is at least as important.)
15. ___ Strategy games in which you develop and/or operate a complex entity	A complex entity could include a business, an army, a city, a civilization, a system, etc. Game examples include military and business games, SimCity, etc.
16. ___ Role-playing games	These take place in a fictional world in which you solve challenges through the character you play. (**A fictional world in a game may be based on fantasy or reality**.) Examples include Everquest, World of Warcraft, etc.
17. ___ Adventure games	Explore a fictional world and solve puzzles to gain points, treasures, tools, etc. Might be based on a story with only one or a few possible endings.

18. ___	Games based on a fictional world, story, or complex entity	They include any games in type 15, 16, or 17 above.
19. ___	Abstract strategy games	NOT based on a fictional world, story, or complex entity. Examples include Poker, Checkers, Chess, Bridge, etc. Do not include games in type 12 above.
20. ___	Multiplayer games	These let you interact with many other players (assume over 50) within the gameplay itself.
21. ___	Games with persistent worlds	These take place in a fictional world. If you leave the game, the world and game will continue in your absence.

Strategy video games based on a fictional world, story, or complex entity use a particular subject theme. Theme examples include art, crime, geopolitics, literature, medieval colonies, nature, physics, science fiction, travel, real estate, war, wealth, etc.

22. ___When you played strategy video games based on themes, what best characterized your experience?
    1. Played games with mostly the same or similar themes
    2. Played games from a small range of themes
    3. Played games from a wide range of themes

SECTION 5 Motivations for Playing Video Games

Consider your motivations for playing **video games** in the last 2 years. Pick a number from the scale to show the importance to you of each motivation listed below.

Scale

Not at all important 1 2 3 4 5 Very Important

	Motivation	Examples for each motivation
23. ___	Achievement	feeling of accomplishment in solving game's challenges
24. ___	Socializing	friendly chats with players, helping others, or making friends
25. ___	Collaboration	working with other players to solve challenges or enjoy group achievement

26. ___ Immersion — role playing, exploring, feeling "inside the game," or escaping reality

27. ___ Competition — winning against, defeating, or imposing your will over other players

SECTION 6 Outside the Video Game

The questions in this section are based on your **video-gaming activities in the last 2 years.**

The worlds, characters, objects, and stories in video games may not accurately represent the reality that they portray. Or they may reflect a particular point of view. Gamers often discuss games outside the context of the game (e.g., in online chats, fan-club discussion groups, face to face, etc.)

28. ___ How often did you discuss the authenticity of the video games you played with other gamers?

1. Never 2. Rarely 3. Sometimes 4. Often 5. Regularly

29. ___ How often did you participate in the actual design of a new video game?

1. Never 2. Rarely 3. Sometimes 4. Often 5. Regularly

"Modding" is the practice of modifying an existing video game by programming or reprogramming certain aspects of it. This activity takes place outside the normal play of the game. (Often, game producers provide special tools for modding).

30. ___ How often did you participate in modding activities?

1. Never 2. Rarely 3. Sometimes 4. Often 5. Regularly

SECTION 7 Demographics and General Information

31. ___ What is your gender?

1. Male:
2. Female

32. ___ How old were you on your last birthday (in years)?

1. 18 to 21
2. 22 to 24
3. 25 to 34
4. 35 to 49
5. 50 or over

33. ___ What is your current class status (before you've started your next semester)?

1. Freshman
2. Sophomore
3. Junior
4. Senior
5. Other

34. ___ How would you best describe your college major?

1. The Arts (for example, music, painting, performance)
2. Social Sciences (for example, sociology, education, history, government)
3. Applied Sciences (for example, engineering, software, architecture)
4. Pure Sciences (for example, math, physics, chemistry, biology)
5. Other

SECTION 8 Finishing Up

If you rarely or never played games (neither video nor non-electronic games) in the last **4 years**, skip this section.

For questions 35 and 36, consider your game experience in the 2 years prior to the last 2 years (i.e., **3 and 4 years ago**). Use the following scale.

Scale

Much less than the last 2 years	1	2	3	4	5	Much more than the last 2 years

35. ___ How often did you play video games (3 and 4 years ago)?

36. ___ How often did you play non-electronic games (3 and 4 years ago)?

37. List the main characteristics of your favorite type of games **over the last 2 years**. Write your answer using a brief list of words and phrases, separated by commas, in the spaces below. (Use the following page if you need more space.)

38. List the main characteristics of your favorite type of games **over the 2 years prior to the last 2 years** (3 and 4 years ago). Write your answer using a brief list of words and phrases, separated by commas, in the spaces below. (Use the following page if you need more space.)

Please verify that you have answered all questions in both questionnaires. (Note: some questions in this Game-Experience Questionnaire may not apply to you if you don't play games, so leave those unanswered.) If you do not answer questions that apply, your survey data may not be usable.

Appendix C: Modifications to the GEQ Based on Evaluators' Feedback

I asked two experts with substantial knowledge in educational and gaming research to evaluate the GEQ. One is an expert gamer and manager of a learning technology laboratory. The other is the program director of an advanced learning laboratory.

I told the evaluators that the questionnaire was intended to determine their game experience over the prior two years. I asked them to respond to the questionnaire based on their own game experience, and to provide feedback on any problems with the questionnaire that they found.

Both evaluators thought the questionnaire was satisfactory. One said, "[o]verall it seems to be very well thought out." The other said, "[o]verall, I think this is ok." Based on their questionnaire responses and feedback, I listed issues that I inferred from their survey answers, their direct feedback, and additional issues in reflecting on the questionnaire in determining solutions during this exercise. The issues and solutions I incorporated are listed in Table 28.

Table 28

Issues based on GEQ Evaluators' Feedback and Solutions Incorporated

No.	Issue	Solution
1	Did games in GEQ include virtual worlds and social spaces (e.g., Second Life®)?	I included a note on the instruction page that virtual worlds and social spaces were not included, except for games played within those worlds or social spaces.
2	Questions for estimating time played were not clear; particularly that sporadic play was estimated in weeks played over prior two years.	I added the explanation for how total hours would be estimated.
3	It was not clear that lowest answer for scale items was 1, not 0, if never played type of game indicated by item.	I modified anchors from "Seldom" and "Mostly" to "Seldom (or Never)" and "Mostly (or Always)."
4	Gaming experience over the prior two years might be very different than prior game experience	I added three questions to the last section to obtain game-experience information for the two years prior to two years back (e.g., three and four years ago).
5	Motivations for playing games were not a complete set (Section 5).	The motivations in GEQ were not intended to be a complete set. However, I included a fuller explanation for each motivation. In addition, I changed the last motivation, "dominance," to "competition" to better represent the study's research and to be more inclusive to respondents.
6	It was not clear that the last GEQ question was asking a respondent to provide his or her own definition for a game.	I deleted the question; it was not necessary.

No.	Issue	Solution
7	It was not clear on questions for modding and designing games in Section 6 exactly what activities were included.	I deleted the words "and development" from "design and development." I added the sentence to end of the modding question that game producers often provide special tools for modding. This addition should have helped a gamer who was not involved in modding to realize that fact. Gamers who were involved in modding should have understood what the term meant.
8	It was not clear what turn-based and real-time games meant.	I deleted those two questions. I was not sure how to ask those questions and avoid confusion.
9	Answering class status (e.g., Freshman or Sophomore) might be confusing if student is between semesters.	I added the phrase "before you've started your next semester" to clarify the question's meaning.
10	Questions in Section 3 on abstract strategy games were confusing (mainly concerning proportions of what time should be considered).	I rewrote the questions to avoid the confusion.

References

References

Aarseth, E. (2001). Computer game studies, year one. *Game Studies. The International Journal of Computer Game Research, 1*(1). Retrieved from Game Studies website: http://www.gamestudies.org/0101/editorial.html

Aarseth, E. (2003). Playing research: Methodological approaches to game analysis. In Proceedings of DAC, Melbourne, Australia. Retrieved from http://hypertext.rmit.edu.au/dac/papers/Aarseth.pdf

Aarseth, E., Smedstad, S. M., & Sunnanå, L. (2003). A multi-dimensional typology of games. In *Proceedings of Level Up: Digital Games Research Conference, University of Utrecht, The Netherlands*, 48-53. Retrieved from Digital Games Research Association website: http://www.digra.org/dl/db/05163.52481

Alix, A. (2005). Beyond P-1: Who plays online? In *Proceedings of DiGRA 2005 Conference: Changing Views—Worlds in Play*. Retrieved from Digital Games Research Association website: http://www.digra.org/dl/db/06276.52412.pdf

Alreck, P. L., & Settle, R. B. (1995). The *survey research handbook* (2nd ed.). Boston: Irwin McGraw-Hill.

Ames, C. & Archer, J. (1988). Achievement in the classroom: Student learning strategies and motivational processes. *Journal of Educational Psychology, 80*, 260-267. doi:10.1037/0022-0663.80.3.260

Antonietti, A., & Mellone, R. (2003). The difference between playing games with and without the computer: A preliminary view. *Journal of Psychology, 137*(2), 133-144. doi:10.1080/00223980309600604

Bartle, R. A. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD Research (Online), 1*(1). Retrieved from http://www.mud.co.uk/richard/hcds.htm

Bartle, R. A. (1999). Early MUD history. Retrieved from http://www.mud.co.uk/richard/mudhist.htm

Bartle, R. A. (2003) A self of sense. Retrieved from http://www.mud.co.uk/richard/selfware.htm

Beedle, J. B. (2005). *What educators can learn from multiplayer computer gaming: A study of who is playing and their perceptions of learning* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3155858)

Bowman, R. F. (1982). A Pac-Man theory of motivation: Tactical implications for classroom instruction. *Educational Technology, 22*(9), 14-17.

Blunt, R. D. (2006). *A causal-comparative exploration of the relationship between game-based learning and academic achievement: Teaching management with video games* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3220391)

Bransford, J. D., Brown, A. L., & Cocking, R. R., Eds. (2000). *How people learn: Brain, mind, experience, and school* (expanded ed.). Washington, D.C.: National Academy Press.

Cacioppo, J. T., Petty, R. E., & Kao, C. F. (1984). The efficient assessment for need for cognition. *Journal of Personality Assessment, 48*, 306-307. doi:10.1207/s15327752jpa4803_13

Caillois, R. (2001). *Man, Play and Games*. Champaign, IL: University of Illinois Press.

Cannon-Bowers, J. (2006, March 7). *The state of gaming and simulation*. Paper presented at the Training 2006 Conference and Expo, Orlando, FL.

Chau, P. Y. K., & Tam, K. Y. (1997). Factors affecting the adoption of open systems: An exploratory study. *MIS Quarterly, 21*(1). doi:10.2307/249740

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Colella, V. (2000). Participatory simulations: Building collaborative understanding through immersive dynamic modeling. *Journal of the Learning Sciences, 9*(4), 471-500. doi:10.1207/S15327809JLS0904_4

Cooper, S. S. (2005, October). Metacognitive development in professional educators. Paper presented at the Northern Rocky Mountain Educational Research Association, Jackson Hole, Wyoming, October 2005. Retrieved from http://www.lifecircles-inc.com/Metacognition.html

Crawford, C. (2011). *The art of computer game design* [Kindle Edition version]. Retrieved from http://www.amazon.com (Original work published 1900)

Cromley, J. G. (2005). Metacognition, cognitive strategy instruction, and reading in adult literacy. In *Review of Adult Learning and Literacy, 5*, 187-220. Retrieved from National Center for the Study of Adult Learning and Literacy website: http://ncsall.net/fileadmin/resources/ann_rev/rall_v7_ch5.pdf

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience.* New York: Harper Perennial.

Dancey, R. S. (2000). Adventure game industry market research summary (RPGs). *RPGnet, 1.0.* Retrieved from RPG.net website: http://www.rpg.net/news+reviews/wotcdemo.html

Dillman, D. (2007). *Mail and internet surveys: The tailored design method* (2nd ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Doolittle, J. H. (1995). Using riddles and interactive computer games to teach problem-solving skills. *Teaching of Psychology, 22*(1), 33-36. Retrieved from Society for the Teaching of Psychology website: http://teachpsych.org/top/index.php

Egenfeldt-Nielsen, S. (2007). *Educational potential of computer games.* New York: Continuum International Publishing Group.

Entertainment Software Association. (2005). *Essential facts about the computer and video game industry: 2005 sales, demographic and usage data*. Retrieved from The NanoTechnology Group Inc, Consortium for Global Education website: http://www.tntg.org/documents/gamefacts.pdf

Entertainment Software Association. (2007). *Essential facts about the computer and video game industry: 2007 sales, demographic and usage data*. Retrieved from Entertainment Software Association website: http://www.theesa.com/facts/pdfs/ESA_EF_2007.pdf

Esposito, N. (2005). A short and simple definition of what a videogame is. In *Proceedings of DiGRA 2005 Conference: Changing Views—Worlds in Play*. Retrieved from Digital Games Research Association website: http://www.digra.org/dl/db/06278.37547.pdf

EVE Online. (2007, December 9). EVE online: Breaks the wall yet again! *Eve News*. Retrieved from EVE Online website: http://www.eve-online.com/news/newsOfEve.asp?newsID=505

Fattah, H., & Paul, P. (2002, May 1). Gaming gets serious. *American Demographics*. Retrieved from http://www.findarticles.com/p/articles/mi_m4021/is_2002_May_1/ai_88679445

Flavell, J. H. (1976). Metacognitive aspects of problem solving [Electronic version]. In L. B. Resnick (Ed.), *The nature of intelligence* (pp.231-236). Hillsdale, NJ: Erlbaum. Retrieved from http:/www.questia.com

Flavell, J. H. (1981). Cognitive monitoring. In W. P. Dickson (Ed.), *Children's oral communication skills* (pp.35 - 60). New York: Academic Press.

Flavell, J. H. (2004). Theory-of-mind development: Retrospect and prospect. *Merrill-Palmer Quarterly, 50*(3), 274-290. Detroit, MI: Wayne State University Press. doi:10.1353/mpq.2004.0018

Gamasutra. (2006). *Pre-E3: Poll: 40% of U.S. adults play video games*. Retrieved from Gamasutra website: http://www.gamasutra.com/php-bin/news_index.php?story=9220

Gamasutra. (2007). *Analyst talks World of Warcraft churn, monthly revenues*. Retrieved from Gamasutra website: http://www.gamasutra.com/php-bin/news_index.php?story=16519

Game Studies (2006, December). Our mission. *Game Studies. The International Journal of Computer Game Research, 6*(1). Retrieved from Game Studies website: http://gamestudies.org/0601

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York: PalGrave-McMillan.

Hacker, D. J. (1998). Definitions and empirical foundations. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 1-23). Hillsdale, NJ: Lawrence Erlbaum Associates.

Haynie, J. M. (2005). *Cognitive adaptability: The role of metacognition and feedback in entrepreneurial decision policies* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3178332)

Haynie, J. M., Grégorie, D., & Shepherd, D. A. (2005). Informing entrepreneurial cognition: The role of metacognition and analogical training in strategic decision-making. Retrieved from Babson College website: http://www.babson.edu/entrep/fer/FER_2004/web-content/Section%20XXII/P1/XXII-P1_Text.html

Haynie, J. M., & Shepherd, D. A. (2009). A measure of adaptive cognition for entrepreneurship research. *Entrepreneurship Theory & Practice, 33*(3), 695-714). doi 10.1111/j.1540-6520.2009.00322.x

Henderson, L. (2005). Video games: A significant cognitive artifact of contemporary youth culture. In *Proceedings of DiGRA 2005 Conference: Changing Views—Worlds in Play*. Retrieved from Digital Games Research Association website: http://www.digra.org/dl/db/06276.11341.pdf

Herz, J. C. (1997). *Joystick nation: How video games ate our quarters, won our hearts and rewired our minds*. Boston: Little, Brown

Hinkle, D.E., Wiersma, W., & Jurs, S. G. (2003). *Applied statistics for the behavioral sciences*. Boston: Houghton Mifflin Company.

Holopainen, J., & Björk, S. (n.d.). Game design patterns. Retrieved from Nokia Research Center website: http://www.nokia.com/library/files/docs/Game_Design_Patterns.pdf

Hong, J., & Liu, M. (2003). A study on thinking strategy between experts and novices of computer games. *Computers in Human Behavior, 19*(2), 245-258. doi:10.1016/S0747-5632(02)00013-4

Horak, V. (1990). Students' cognitive styles and their use of problem-solving heuristics and metacognitive processes. Retrieved from http://www.eric.ed.gov/

Huggins, J. R. (2001). *A qualitative investigation into the metacognitive processes of adult learners in an online distance learning program* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3026616)

Ipsos. (2006). The Associated Press/AOL poll: Games study. DC: Ipsos Public Affairs. Retrieved from The Free Library by Farlex website: http://www.thefreelibrary.com/AP-AOL+Games+Poll+Reveals+Surprising+Profile+of+Gamers%3B+Urbanites...-a0145465576

Järvinen, A. (2008). *Games without frontiers: Theories and methods for game studies and design*. (Doctoral dissertation, University of Tampere, Finland). Retrieved from http://acta.uta.fi/pdf/978-951-44-7252-7.pdf

Jones, M. G. (1998). *Creating engagement in computer-based learning environments.* In *Proceedings of ITForum*. Retrieved from University of Georgia, College of Education website: http://it.coe.uga.edu/itforum/paper30/paper30.html

Jones, S. (2003). *Let the games begin: Gaming technology and entertainment among college students*. Retrieved from Pew Internet website: http://www.pewinternet.org/~/media//Files/Reports/2003/PIP_College_Gaming_Reporta.pdf.pdf

Joseph, D. R. D. (2005). *Middle school children's game playing preferences: Case studies of children's experiences* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3177481)

Justice, E. M., & Dornan, T. M. (2001). Metacognitive differences between traditional-age and nontraditional-age college students. *Adult Education Quarterly, 51*(3), 236-249. doi:10.1177/074171360105100305

Juul, J. (2005). *Half-real: Video games between real rules and fictional worlds*. Cambridge, MA: MIT Press.

Ke, F. (2007). *Computer-based game playing within alternative classroom goal structures on fifth-graders' math learning outcomes: Cognitive, metacognitive, and affective evaluation and interpretation* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3229015)

Klabbers, J. (2003).The gaming landscape: A taxonomy for classifying games and simulations. In *Proceedings of Level Up: Digital Games Research Conference, University of Utrecht, The Netherlands*, 54-67. Retrieved from Digital Games Research Association website: http://digra.org:8080/Plone/dl/db/05163.55012.pdf

Kluwe, R. H. (1982). Cognitive knowledge and executive control: Metacognition. In D. R. Griffin (Ed.), *Animal Mind-Human Mind* (pp. 201-224). New York: Springer-Verlag.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Lambert, S. (2006, June 5-7). A business model research schema. In *Proceedings of the 19th Bled eConference, Bled, Slovenia*. Retrieved from Univerza V Mariboru website: http://ecom.fov.uni-mb.si/proceedings.nsf/0/c6cc94943a84a8a4c125718000319598/$FILE/20_Lambert.pdf

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.

Lindley, C. (2003). Game taxonomies: A high level framework for game analysis and design. *Gamasutra*. Retrieved from Gamasutra website: http://www.gamasutra.com/features/20031003/lindley_01.shtml

Livingston, J. A. (1997). *Metacognition: An overview.* Retrieved from University of Buffalo, Graduate School of Education website: http://www.gse.buffalo.edu/fas/shuell/CEP564/Metacog.htm

Malone, T. W. (1980a). *What makes things fun to learn? A study of intrinsically motivating computer games* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 8024707)

Malone, T. W. (1980b). What makes things fun to learn? Heuristics for designing instructional computer games. In *Proceedings of the 3rd ACM SIGSMALL Symposium, Palo Alto, California*, 162-169. Retrieved July, 28, 2007, from ACM database. doi:10.1145/800088.802839

Malone, T. W., & Lepper, M. R. (1987). Making learning fun: A taxonomy of intrinsic motivations for learning. In R.E. Snow & M.J. Farr (Eds.), *Aptitude, learning, and ,instruction, III: Cognitive and affective process analysis* (pp. 223-253). Hillsdale, NJ: Lawrence Erlbaum Associates. Retrieved from http:/www.questia.com

Mehrabian, A. (1996). Relations among political attitudes, personality, and psychopathology assessed with new measures of libertarianism and conservatism. *Basic and Applied Social Psychology, 18*(4), 469-491. doi:10.1207/s15324834basp1804_7

Merriam-Webster Online Dictionary. (n.d.). Retrieved from Merriam-Webster website: http://www.merriam-webster.com/dictionary/genre

Mokhtari, K., & Reichard, C. A. (2002). Assessing students' metacognitive awareness of reading strategies. *Journal of Educational Psychology, 94*(2), 249-259. doi:10.1037/0022-0663.94.2.249

Munby, H., Versnel, J., Hutchinson, N. L., Chin, P., & Berg, D. H. (2003). Workplace learning and the metacognitive functions of routines. *Journal of Workplace Learning, 15*(3), 94-104. Retrieved from Association for Educational Communications and Technology website: www.aect.org/

Nesson, C. (2008, January 24). Retrieved from Colbert Nation website: http://www.colbertnation.com/the-colbert-report-videos/148413/january-24-2008/charles-nesson

Pahl, R., H. (1991). Finally, a good way to teach city government! A review of the computer simulation game SimCity. *Social Studies, 82*(4), 165-166. Retrieved from Taylor & Francis Group website: http://www.taylorandfrancisgroup.com/

Papaleontiou-Louca, E. (2003). The concept of instruction of metacognition. *Teacher Development 7*(1), 9-30. doi:10.1080/13664530300200184

Pillay, H. (2002). An investigation of cognitive processes engaged in by recreational computer game players: Implications for skills of the future. *Journal of Research on Technology in Education, 34*(3), 336-350. Retrieved from http://search.ebscohost.com

Pillay, H., & Brownlee, J., & Wilss, L. (1999). Cognition and recreational computer games: Implications for educational technology. *Journal of Research on Computing in Education, 32*(1), 203-216. Retrieved from http://search.ebscohost.com

Prensky, M. (2001a). *Digital Game-Based Learning*. New York: McGraw-Hill.

Prensky, M. (2001b). Digital natives, digital immigrants, part II: Do they really think differently? *On the Horizon, 9*(6), 1-6. Retrieved from http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part2.pdf

Randel, J. M., Morris, B. A., Wetzel, C. D., & Whitehill, B. V. (1992). The effectiveness of games for educational purposes: A review of recent research. *Simulation & Gaming, 23*(3), 261-276. doi:10.1177/1046878192233001

Rasnak, M. A. (1995). *Metacognitive dimensions of the selection and use of learning strategies by adult college students and traditional-age college students* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 9536727)

Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research & Development, 44*(2), 43-58. Retrieved from http://search.ebscohost.com

Scheuren, F. (2004). What is a survey? (2nd ed.). Retrieved from http://client.norc.org/whatisasurvey/

Schneider, W. (1985). Developmental trends in the metamemory-memory behavior relationship: An integrative review. In D. L. Forrest-Pressley, G. E. MacKinnon, & T. G. Waller (Eds.), *Metacognition, cognition, and human performance, 1*, 57-109. New York: Academic.

Schraw, G. (1998a). On the development of adult metacognition. In M. C. Smith & T. Pourchot (Eds.), *Adult learning and development perspectives from educational psychology* (pp. 89-106). Hillsdale, NJ: Erlbaum. Retrieved from http:/www.questia.com

Schraw, G. (1998b). Promoting general metacognitive awareness. *Contemporary Instructional Science 26,* 113-125. Retrieved from http://search.ebscohost.com

Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19*(4), 460-475. doi:10.1006/ceps.1994.1033

Schraw, G., & Moshman, D. (1995). Metacognitive theories. *Educational Psychology Review, 7*(4), 351-371. Retrieved from http://search.ebscohost.com

Squire, K. D. (2005, February). Game-based learning: Present and future state of the field. *eLearning Consortium, Masie Center*. Retrieved from The Masie Center website: http://masieweb.com/dmdocuments/Game-Based_Learning.pdf

Squire, K. D., & Jenkins, H. (2003). Harnessing the power of games in education *Insight 3*(1), 5-33. Retrieved from University of Wisconsin, School of Education website: http://website.education.wisc.edu/kdsquire/manuscripts/insight.pdf

Sperling, R., Howard, L., Miller, L., & Murphy, C. (2002). Measures of children´s knowledge and regulation of cognition. *Contemporary Educational Psychology, 27*(1), 51-79. doi:10.1006/ceps.2001.1091

Swanson, H. L. (1990). Influence of metacognitive knowledge and aptitude on problem solving. *Journal of Educational Psychology 82,* 306-314. doi:10.1037/0022-0663.82.2.306

Terdiman, D. (2006, March 6). What's wrong with serious games? *CNET Networks, Inc*. Retrieved from CNET, News website: http://news.cnet.com/Whats-wrong-with-serious-games/2100-1043_3-6052346.html

USAF. (1981). *Function modeling manual (IDEF0)*. Integrated computer-aided manufacturing (ICAM) architecture, Part II, Volume IV. (Report No. AFWAL-TR-81-4023). Wright-Patterson Air Force Base, Ohio: Materials Laboratory, Air Force Wright Aeronautical Laboratories, Air Force Systems Command.

Vandergrift (2006). The metacognitive awareness listening questionnaire: Development and validation. *Language Learning, 56*(3), 431-462. doi:10.1111/j.1467-9922.2006.00373.x

Vukman, K. B. (2005). Developmental differences in metacognition and their connections with cognitive development in adulthood. *Journal of Adult Development, 12*(4), 211-221. doi:10.1007/s10804-005-7089-6

Weisberg, H. F., Krosnick, J. A., & Bowen, B. D. (1996). *An introduction to survey research, polling, and data analysis* (3rd ed.). London: Sage Publications.

Weiss, D. J. (2006). *Analysis of variance and functional measurement: A practical guide, Volume 1*. New York: Oxford University Press.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge, MA: Cambridge University Press.

Wexler, S., Aldrich, A., Johannigman, J., Oehlert, M., Quinn, C., & Barneveld, A. (2007). *Immersive learning simulations: The demand for, and demands of, simulations, scenarios, and serious games*. Santa Rosa, CA: The eLearning Guild.

Wilson Center (n.d.). Serious games initiative. Retrieved from Woodrow Wilson Center for International Scholars website: http://seriousgames.org/about2.html

Wolf, M. (2002). Genre and the video game. In M.Wolf (Ed.), *The medium of the video game* (Chapter 6, pp. 113-134), TX: University of Texas Press.

Yee, N. (2006). Motivations for play in online games. *CyberPsychology & Behavior, 9*(6), 772-775. doi:10.1089/cpb.2006.9.772

Curriculum Vitae

Howard T. Moncarz received a Bachelor of Science in Engineering Physics from Cornell University in 1970. He received a Master of Science in Aerospace Engineering from University of Maryland in 1972. Afterwards, he worked for over 30 years as a research and development engineer in industry, government, and academia. His work spanned a wide variety of industries and disciplines, ranging from apparel manufacturing to vehicle dynamics to training and education applications.