Using Myers-Briggs Personality Type Indicators to Predict High School Student Performance in an Educational Video Game

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Educational video games have proven a useful tool for educators, offering experiential pedagogy in a variety of fields. Predicting the success of a video game in engaging students and motivating them to work with relevant material is problematic. One approach was attempted through administering the Myers-Briggs Personality Type Indicator to 42 high school students and observing subsequent voluntary performance on a popular mathematics video game throughout one semester. Game dynamics matching certain personality elements of the students generally correlated between learning preferences in the classroom and in the online gaming environment. Students who enjoyed group dynamics in classroom settings likewise indicated enthusiasm for the group dynamics in game play. Those students preferring structured learning environments may prefer less open ended virtual learning gaming environments. Since the game incorporated multiple choice questions and rewarded correct choices made quickly, those students with personality styles in which questions are carefully considered before answering suffered in points scored compared to those used to making fast intuitive choices in exam settings. Additional studies, including those with larger populations and different types of video games, are needed for more definite conclusions.
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CHAPTER 1 INTRODUCTION

Video games attract users, as evidenced by dollars spent and time documented playing. Surveys consistently indicate high school students derive high entertainment value from playing video games, and that almost all (97%) of American teenagers play video games of some kind (Lenhart, Kahne, Middaugh, MacGill, Evans, and Vitak, 2008). Efforts to incorporate educational elements into video games for school use are ongoing, however research into predictive elements concerning which children might benefit the most from different kinds of instructional video games is sadly lacking.

I propose herein to inquire into the possibility that personality preference may help predict a student’s inclination to benefit from instruction offered through the medium of an educational video game. In particular, I offered the Myers-Briggs Type Indicator (MBTI) to a selection of high school students, and through analysis of variance comparing their personality indicators to data generated in the game, determined if any particular indicator holds significance with the performance in a voluntarily offered, educational video game centered on high school math instruction.

The experiment could be replicated elsewhere and expanded upon over time by others, and with larger datasets possibly lead to increased understanding and prediction of the appropriateness of instructional video game interventions among certain segments of student populations, based on their personality preferences.
Many educators seem to intuitively feel video games would be ideal platforms for learning. Complicating the research into this intuitive notion is a variety of ever changing game platforms, as well as different types of games that may allow useful content to be incorporated. Further complicating matters are choices into how the learning content should be incorporated.

At the simplest level, a video game can make rote learning more interactive. With a bit more complexity, video games can be used to rehearse skill sets such as reading comprehension, often within a virtual environment that offers a different level of engagement than traditional books. At the highest level, gaming can key into higher level thought processes, offering opportunities for rational decision making scenarios using incomplete data (Gee, 2003).

Many high school educators may be interested in interventions that can assist students in high stakes exams. Such educators may wish for a computer mediated intervention in which the teacher stands as coach and mentor rather than a direct instructor; one offering students challenging yet engaging material, the frequent exercise of which will assist students in skills and/or knowledge which are tested by the state; one which offers teachers good feedback on student progress and pinpoints needy areas requiring further instruction. It is within this set of ideals in which certain video games may fit the bill, and for the sake of this study, a math instructional video games was used.

A wide variety of video games exist in the marketplace, with a large subset falling loosely under the title of educational. Within these, multiple target audiences from Kindergarten through collegiate levels are addressed, as well as a wide range of subject matter. For the sake of this study, a junior high to high school level mathematics game from a major educational title company was chosen as the focus game of choice: DimensionM, from the
gaming company DimensionU, Inc. (formerly Tabula Digita during the time this study took place).

The reasoning behind this choice was the title has been the subject of prior study showing its effectiveness in encouraging math practice, corresponding with increased exam scores. In addition, the game was initially designed with academic input, primarily from educators at University of Central Florida. For-profit, large scale educational video games that can be quickly placed within a majority of classrooms throughout the country, if effective in raising statewide test scores, may be worth the investment by schools facing tight budgets. Since this particular title is a for-profit, large scale educational video game with research showing corresponding improvement in test scores, it seemed a natural choice for the study.

History of Educational Video Gaming

Games have been studied in the modern era beginning notably with ethnologist R. Stewart Culin, who published treatises on tribal gaming in Africa and popular Asian games in the late 1800s. Later, his work on games of the North American Indians showed similarities of purpose and style across 130 tribes scattered throughout the continent (Culin, 1907/1992). This series of anthropological studies for the Smithsonian lent an academic imprimatur to the study of gaming.

Following World War II, many business schools adopted a game developed by the American Management Association, Top Management Decision Game, introduced in 1956. This was a codified effort at using gaming and role play techniques to demonstrate varied outcomes based on choices made in the game, leading to better decision making skills for team players.
The technique caught on quickly in business circles, and by the 1970s, hundreds of similar games were offered as teaching tools in business, government, and education (Naylor, 1971).

Development of video games, when defined as mating the screen output of a computer to an entertainment program, dates to 1958 when a computer at Brookhaven National Laboratory was programmed to play a type of virtual tennis game via an oscilloscope (Flatow, 1992). Text-based output was also used in subsequent years, but the cathode-ray monitor on the DEC PDP-1 led to development of Spacewar by a programming team at Massachusetts Institute of Technology in 1962, which marked the first popular graphical video game (Juul, 1999). Home and arcade units featuring assorted titles soon followed.

With the introduction of the personal computer in the 1970s, schools soon began deploying them in the classroom. The Minnesota Educational Computing Consortium (MECC) quickly adopted the Apple II for Minnesota schools, and translated their software library to Apple BASIC. By 1980, MECC supplied schools nationwide with educational games and courseware, including popular titles such as Oregon Trail and Math Munchers. Educational software companies such as Mindscape and Davidson soon formed and flourished, offering their own titles (O’Neill, 1995).

At the turn of the millennium, video games continued to be an enormous revenue source for large entertainment companies, with home console titles, Internet-based games, handheld gaming devices, gaming apps, and traditional PC games all competing for entertainment time and dollars. From 1998 to 2008, the Entertainment Software Association estimated with private data firm The NPD Group that consoles and software titles grew in sales from $4.8 billion to $11.7 billion (Entertainment Software Association, 2010).
Academic interest grew as well as sales in the early part of the 21st century. Studies involving video games as the central focus ranged from practical solutions for integrating off the shelf software titles in the classroom (Charsky and Mims, 2008), to those examining the relationship video games have with children diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) (Farrace-Di Zinno, Douglas, Houghton, Lawrence, West, and Whiting, 2001), to medical explorations such as the benefits to visual elasticity and acuity after playing action video games (Green and Bavelier, 2007).

Academic interest remains high, with specific journals devoted to studying video games and their application in educative environments. These include International Journal of Gaming and Computer-Mediated Simulations, Journal of Virtual Worlds Research, and Simulation and Gaming. Special issues in other journals have also focused on educational gaming, as have many national educational conference threads. Gee’s What video games have to teach us about learning and literacy (2003), extolled the benefits of video games in education, and remains the seminal academic book in the field.

Theoretical Foundations

Games have certain shared characteristics, including a defined set of rules and, traditionally, an outcome in which a win, loss, or draw occurs. Video games can allow a seemingly endless expansion on the outcomes, leading to the development of open ended games, or ones which have no apparent ending. Multiple mini games within the larger context may result in a temporary win or loss for the players, but the larger gaming environment continues regardless whether individual players are present or not. This concept of virtual
persistent worlds was first realized in the 1970s when text-based fantasy environments known as multi-user dungeons (MUDs) became prevalent on many computer mainframes across the world (Turkle, 1997).

Since video games combine user input with graphical output, some academic attention has been paid to the action involved in engagement within the games. Early computer games and MUDs often relied on text-based interactions. These were heavily focused on reading and inputting text. Such action remains common in many educational video games, seemingly due to the fact that reading and writing remain important within school settings. In a nod to Gibson (1979), researchers have noted efforts to illustrate graphical notions, offering a pictorial reference for students, remain hampered by a lack of affordances within the medium, at least for purely educational efforts (Dickey, 2003).

Although graphical capabilities continue to expand commercially, educators find the resources needed to develop titles for conveying pedagogical content using the latest technology can be prohibitive due to programming difficulties and hardware expense. Fortunately, research has indicated users are willing to suspend their disbelief even in games with relatively rudimentary visual resources. This concept was first noted in the theater (Laurel, 1991) and later observed within virtual reality environments (Manninen, 2003).

The notion of community within persistent worlds is strong. Although users may never actually meet face to face, common online experiences and a sense of place, albeit a virtual one, may lead to bonding and friendship (Baym, 1994). Educators have sought to generate a sense of community within their own persistent worlds designed to be educational, notably in
such experimental titles as River City at Harvard University (Dede, Ketelhut, Nelson, Clarke, and Bowman, 2004).

In an attempt to define happiness, Csikszentmihalyi’s Flow Theory (1975) introduced researchers to the concept of playfulness within human-computer interactions (Webster, Trevino, and Ryan, 1993). When reaching a state of flow, people become engaged in their tasks to the point where time has little personal meaning, Csikszentmihalyi asserted. They are completely engaged, bringing a great sense of achievement based on strong intrinsic motivation and matching their skills to the tasks at hand. Researchers have noted video game designers deliberately incorporate elements of Flow Theory into their games to keep players involved (Chen, 2007).

Purpose

Interventions are time consuming within a school day already limited by short class periods. If specific predictors are reliable indicators for the efficacy of a particular type of intervention, such knowledge could be highly empowering to educators. Thus, research of this kind would offer valuable practical knowledge should it continue to yield similar results through multiple experiments.

Knowledge of predictors for success in a particular intervention is beneficial to educators. If a particular type of intervention can be consistently demonstrated as useful for certain student groups, then such knowledge empowers educators in the decision making process before instruction begins. General knowledge of what works and what does not work,
or at least which indicators offer a clue at predilection toward beneficial application, would be welcome in educational environments.

The purpose of this study is to explore potential indicators of success by measuring results generated during a series of voluntary interventions using a commercial educational video game focused on high school mathematics, and compare them to the subjects’ MBTI personality profiles. The game was offered on a purely voluntary basis. Students were offered detailed instructions on how to play the game and ample opportunities to engage in it. The game was left open and accessible to the students in the study for an entire semester. Following the semester, data was culled from the game and analyzed for statistical significance in comparison to subjects’ personality profiles.

Research Questions

For the sake of this study, the following research questions were addressed:

What MBTI personality profiles indicate voluntary engagement success when a student is offered an educational mathematics video game, featuring a persistent virtual world within which math practice is combined with action adventure?

Does gender play any role in engagement when an educational video game modeled after action adventure titles is used as the intervention?

Does measurable personality preference play a predictable role in the engagement of an action adventure based educational video game used as an intervention in high school mathematics?
Limitations

While it is hoped this research might be replicable, certain limitations to its scope are inherent. Speculations as to the predictability of the factors examined in this research will by necessity be somewhat limited due to the study’s population size. Further, additional personality type indicators not covered here will require additional research to uncover and more fully explore. Since there are 16 MBTI profiles, and this smaller population sample did not include all 16 types, additional research may uncover additional data of interest.

The reason for gender differences in the engagement of the educational video game are not fully explored within this study. Several reasons may exist for different gaming metrics achieved by students of different genders, including stakeholder and societal expectations, as well as other gender specific preferences not explored here. Gender preferences within video game styles may also contribute to certain outcomes since the video game intervention was deliberately designed to appeal to adolescent boys, according to the company that designed it.

Generalization to other video game styles may also be limited. Video games range in style from the simple to complex, from action oriented to more meditative, from puzzle solving to exploring three dimensional environments. Possibly, different video game styles could appeal to different student personality types, resulting in the encouragement or discouragement of academic proficiencies within the players. This game involved students playing together at the same time online, which may have generated social pressures some personality types enjoyed while others did not. Other game types, whether solitary or not as anthropocentric in a three dimensional virtual world, may well appeal to different personality types, and additional research is warranted in that regard.
Chapter Summary

Chapter Two will offer a review of related literature, starting with a look at the literature surrounding computer gaming in education. Barriers to the effectiveness of video games in the classroom will be examined, followed by a discussion of alternative uses of gaming technology, including uses in training. Prior published research on the game DimensionM is also covered. Finally, research on the Myers-Briggs Type Indicator in the classroom is covered. Research design and methodology are broached in Chapter Three, including details about the subject population and efforts to organize the experiment through recruitment. Details of the experiment’s operational procedures follow, and a detailed summary of gaming activity and data points collected are included, along with a summary of test instruments and gender makeup. The chapter concludes with the stated inquiries and hypotheses. Chapter Four will contain findings of the data analysis, starting with the raw data and following through on results derived from ANOVA within the five inquiries. A summary of the results concludes the chapter. Chapter Five will contain discussion, broader implications and avenues for additional research.
CHAPTER 2 REVIEW OF THE LITERATURE

Computer Gaming in Education

Although gaming is an ancient pursuit, the study of gaming in the social sciences can be traced to the late 19th and early 20th centuries with Cullen’s (1907/1992) anthropological studies for the Smithsonian. By the 1970s, computer games written in BASIC were ported from mainframes to personal computers for classroom use. Serious studies regarding the games’ effectiveness as classroom interventions could then be executed, especially in regards to their effectiveness as instructional interventions. However, this process remained hampered by a variety of factors. Pierfy (1977) noted research of educational gaming at the time was plagued by a lack of considerations regarding design and measurement. Indeed, this question of what, exactly, should or can be measured was noted by Pierfy, who examined 22 gaming studies. Pierfy indicated the studies showed interest was high among students engaged in gaming-based instructional interventions, and retention appeared to be stronger, but data results were unfortunately often more anecdotal than empirical.

Many educational gaming efforts centered on classroom computers in the 1980s, as MECC titles went mainstream when they were released along with Apple computer products that decade. Major gaming publishers also entered the edutainment market around that time (O’Neill, 1995). Many of these titles focused on digitizing skill and drill worksheets. Consistent feedback and the unwavering attention of the computer program were seen as advantageous, although lower level cognitive drills were seemingly most of what the technology could offer at the time. Academic interest in this aspect of the genre was explored by Wood and Stewart
(1987) who noted that context must maintain high interest for the students, otherwise a skill and drill game becomes as boring as a paper worksheet over time.

The problem of how to consistently describe gaming mechanics throughout the literature remained fractured. Dempsey, Lucassen, Gilley, and Rasmussen (1993) made an attempt at defining genres for the purpose of academic studies, but noted broad overlap between the genres, hampering specificities. Nonetheless, benefits were found by Dempsey and colleagues across studies of educational video games of the day, particularly with retention on post tests.

A commonly accepted group of definitions remained lacking, especially within a free-standing body of work regarded favorably by other researchers. Consequently, many researchers continued to define terms independently, a problem exacerbated by a wide variety of nomenclatural issues. Genres are broad and easy to define, but when two different games developed by different companies, perhaps on different platforms are studied, researchers may be faced with the nebulous task of accounting for differences in results based on poorly defined differences between the games. Nonetheless, definitions were put forward within larger compendiums covering a variety of instructional computer related treatises, and such an effort was proffered by Gredler (1996). She offered a differentiation between games and simulations within computing environments. To wit, Gredler asserted games have set rules offering a winning resolution while simulations are more experiential. At the point of her writing, in the mid-1990s, personal computer graphics had advanced sufficiently to allow graphical representation that was adequate for many educational simulations, and Gredler noted such programs could incorporate multifaceted cognitive strategies.
Virtual Reality (VR) also became more adequate with personal computer technologies of the day, allowing researchers to explore pedagogical capabilities within simple three dimensional environments represented on the user’s monitor. McLellan (1996) noted that cognitive visualizations and persistent virtual worlds that are graphical in nature rather than simply the text-based MUDs of years past, offered strong potential for instructional capacity. Indeed, this concept of persistent virtual worlds quickly found its way to commercial offerings such as Ultima Online, EverQuest, and Second Life. All manners of VR simulations were quickly adopted in video games with ever advancing graphical capabilities, and McLellan offered a useful taxonomy for researchers. Cab simulators, for instance, represent the interior (cab) of machinery, which proffers users opportunities to learn how to control a virtual representation of the machine (McLellan, 1996).

Questions persist about the overall effectiveness of educational gaming, and researchers continue to study the issue. A presumption of their effectiveness as one of many educational media tools is one angle researchers examine, and considerations of motivational benefits in the medium is another. Wouters, van Nimwegen, van Oostendorp, and van der Spek (2013) performed a meta-analysis on both issues and found high effectiveness in educational games for learning and retention. Participants seemed to learn more when the games were included in a mixture of approaches, and when working together in groups. They found that motivational benefits when compared to other approaches were not necessarily better, bolstering the notion that educational games are but one tool among many and not an educational panacea. In their meta-analysis of K-12 and college virtual reality educational games, Merchant, Goetz, Cifuentes, Keeney-Kennicutt, and Davis (2014) found gaming
environments largely effective in improving learning gains. Games were more effective in measurable learning outcomes than educational virtual worlds in general, perhaps owing to their focus on the objectives rather than allowing time for the players to engage in other activities. However, the novelty effect was apparent in some games. The authors concluded virtual reality based instruction in general, including video games as a subset, was overall effective.

Barriers to Video Gaming in Education

Multiple barriers to using technology in the classroom exist within a variety of interventions, and video games are no exception. General perceptions of video games have led many stakeholders to deem video games as falling strictly within the entertainment field, and give educational choices less serious consideration in the classroom. Schrader, Zheng, and Young (2006) found negative teacher perceptions to hinder adoption of educational titles in the classroom. Many educators in their study thought generically of video games as being simplistic and trite, rather than potentially beneficial educational tools. In addition, many titles are not tested for educational usability, which would give an indication for their efficacy in instructional design (Warren, Jones, and Lin, 2011).

Concern about violence in video games also manifests itself in stakeholder complaints. Much research on the effects of video game violence indicate arousal of subjects when playing violent video games, and this remains a consistently measurable physiological phenomenon throughout repeated experiments by different researchers with multiple titles (Anderson & Bushman, 2001). While this phenomenon is also observable in subjects engaging in other media
such as movies, the stigma regarding video games persists, resulting in occasional legislative efforts to restrict the purchasing of violent video games by minors. Consequently, teachers, administrators, and some parents may object to the notion of video game use within classroom environments.

Studies in the video gaming field are sometimes fraught with controversy, especially due to the violence angle. Kierkegaard (2008) noted a lack of correlation with increased video games use, graphics, and violent content with actual spikes in violent crime. This holds true, Kierkegaard asserts, despite the individually measured increased physiological arousal observed when players engage in violent games. Related to violence are concerns with video game addiction, although this becomes even harder to empirically measure. While physiological arousal can be measured in players during and shortly after a gaming session, addiction is widely measured only by self-reporting. Hunter (2005) made an effort at defining addiction in complex multiplayer games, another area more nebulous than many researchers seem to prefer. Negating presumptions about social isolation and gamers in general, Hickerson and Mowen (2012) found in a questionnaire of 166 gamers waiting in line to buy the newest multi-user first person shooter at the time, Call of Duty: Black Ops, that some players surveyed use online gaming for social bonding.

While acknowledging the research on video game violence and addiction is mixed and ongoing, the most recent meta-analysis for the American Psychological Association by Granic, Lobel, and Engels (2014) suggests that video games may provide a release for pent up negative emotions rather than physical violence. The authors also suggested video games are beneficial tools for education, and provide additional potential health and social benefits.
With educational video games, the students’ attention is on the computer screen and away from the teacher, posing some difficulties for those instructors used to being the center of attention. Conversely, if no teacher input is apparent, learning results may be feared to be less than desired. Thus, for an instructional video game to have good effectiveness as an intervention, Dede and Ketelhut (2003) indicated good professional development was vital so that teachers learned to use the intervention well, and adapt to being more of a coach than lecturer during the length of the intervention. As time progresses and more teachers are familiarized with popular titles, video games are seeing gradual acceptance in the classroom. A recent survey by Millstone (2012), found that among 505 teachers surveyed in the United States, mostly at the kindergarten through fifth grade levels, roughly a third used video games in their classes two to four days per week, and 18 percent used them daily. Nonetheless, about ten percent of respondents indicated dissatisfaction with video game use in their classrooms, including behavioral issues, inappropriate content delivery, and conflict with other students.

Technology, specifically the lack of high end video gaming equipment, software, and personal computer capabilities in the classroom, continued to be a hindrance to widespread adoption of advanced educational titles throughout the early 2000s. Research efforts such as those by Elliot, Adams, and Bruckman (2002) documented developmental barriers in game creation. Particularly, programming the game in such a way to ensure it contained required pedagogical elements proved problematic. Some of the simpler efforts in creating instructional gaming software, its simplicity necessitated due to hardware and programming requirements, may well have lacked the affordances needed for appropriate pedagogical content (Dickey, 2003). Affordances, in this case, indicate appropriate opportunities for interaction within the
virtual environments. Thus for a computer game to be effective educationally, teachers often perceived it to require extensive programming in order to do what the teacher desired it to do instructionally. If it could not be easily programmed, and the teacher had no way to do so, teachers perceived the lack of affordances as rendering the software less useful in the classroom (Dickey, 2003). Creating quality educational video games may take considerable resources and labor in order to craft games carrying specific teachers’ desired pedagogical content. If a useful game could not be purchased, perhaps a purchased game could be made more useful by teachers for their own classroom use. In light of this fact, some researchers made use of pre-developed, commercial off the shelf (COTS) products which were able to modified, or “modded” for more educational pursuits.

Game companies noted the modding phenomenon, where players modified the existing code to enhance or add to game play. Rather than restricting modding efforts, savvy companies released the programming code and encouraged it. A typical high end video game can take upwards of two years to produce, on a budget similar to a movie. It may spend a few months on the sales charts before falling off, to be replaced by the next big title. Game makers discovered when titles are allowed to be modified by end users, they get played for longer periods of time, with end users releasing their own content to other users who continue using the platform. This occurrence, called repeatability by gaming companies, may stoke fan interest long enough for a sequel to be produced, creating a groundswell of new interest upon its release. Thus, modding results in potential additional revenue for the company.

Educational researchers embraced modding, partly due to the extensive barriers from creating an advanced educational game from the ground up. These efforts resulted in several
interesting experiments involving the creation of virtual worlds in which pedagogical content could be transmitted. History and social studies seemed to benefit highly from these efforts. The most notable of these involved Massachusetts Institute of Technology’s Revolution, a mod of Neverwinter Nights. Neverwinter Nights is a fantasy/medieval role playing game. MIT researchers recoded it so that characters and environments appeared to be in the American Revolution period, and reset quests to allow players to experience colonial life from a variety of character viewpoints (Squire and Jenkins, 2003).

The coding for persistent online worlds were also appropriated for educational purposes during this time with extensive customized coding, most notably in the Active Worlds environment initially used by Harvard’s River City (Dede, Ketelhut, Nelson, Clark, and Bowman, 2004), and the Quest Atlantis game through Indiana University (Barab, Thomas, Dodge, Carteaux, and Tuzun, 2002). Both games allowed students in disparate locations to log in and engage in pedagogical content within a three dimensional virtual environment. Other modding of existing commercial games that started out appearing to hold educational promise, particularly the Civilization III title, were also used to positive results by researchers, either with additional pedagogical content inserted into the game or creative use of existing content for educational purposes (Squire, 2004).

Modding also solved one barrier to implementation: the lack of content adjustment. Many instructional video games are frozen in content with no opportunities for teacher adjustment, much as the content of paper textbooks remains frozen. With modding, teachers are able to add, delete, or adjust content and offer it as an instructional intervention with locally derived content. For instance, teachers discovered that changing the language settings in
The Sims allowed students to practice non-English language skills in a three dimensional gaming environment. Such dynamic opportunities began to be seen as critical to successful adoption in the classroom around this time (Deubal, 2002). This trend has continued. Rankin and Shute (2010) found great success in harnessing the fun found in massively multi-player online gaming environments by repurposing EverQuest II as a virtual immersive foreign language environment.

Programming environments available to teachers in which they or their students can program their own video games or similar fun activities began to rise in popularity with increased web access for the nations’ schools. Alice, an earlier National Science Foundation (NSF) funded instructional computer programming environment, involves the use of animation for three dimensional objects. Alice has been used to help students make three dimensional animations in a game-like setting, which helps them understand programming and problem solving (Moskal, Lurie, and Cooper, 2004). Scratch is a Massachusetts Institute of Technology effort also funded by the NSF. It offers video game like activities that encourage creativity and programming in students. Although not limited to gaming development, the applications developed in Scratch are designed to lead students toward greater understandings of programming (Brennan, Resnick, and Monroy-Hernandez, 2010).

Related to both the issues of programming appropriate educational video games and the lack of high end gaming equipment in the classroom to run the programs, researchers noted that decent classroom computers for students, either in one-to-one programs or within the classrooms, were lacking in surveys. These surveys indicated lower end titles were often found installed on machines available to students in schools (Becker, Ravitz, and Wong, 1999).
One tactic used by researchers to ameliorate this barrier was to design games based on older personal computer technology (Jones, 2004). Other tactics included efforts at programming instructional titles for less expensive, portable handheld devices such as Nintendo Gameboys, then comparing results with traditional classroom paper exercises (Lee, Luchini, Michael, Norris, and Soloway, 2004).

Class period time became another issue for researchers to address when attempting to integrate complex video games as interventions during the school day. With class times ranging typically from 45 to 55 minutes, and some of that time required for attendance, housekeeping, and initial instructions, the time remaining to engage in a meaningful manner with a complex instructional video game is limited. Researchers typically addressed this barrier in two ways. One is by using games which do not require lengthy sessions in order to glean appropriate content (Squire, 2004). The other is to introduce the video gaming intervention in after school or summer programs where class time is less of an issue (Squire and Jenkins, 2003).

Finally, as high stakes testing spread throughout the nation with the start of the new century, alignment to state and local standards became a key component to many instructional interventions. Video games did not escape this requirement. Many COTS products used in classroom situations were necessarily aligned after the fact by both teachers and researchers, in attempts to satisfy the requirements for overcoming this barrier (Squire, 2004).

**Alternative Uses of Gaming Technology**

Researchers have discovered other beneficial uses for video gaming technology, providing interesting discoveries for the school and workplace related to education. Vision
improvements, and the improvement of vision related activities such as reading are among these areas showing considerable interest by researchers.

Improving spatial resolution and overall enhancing of visual acuity were observed benefits to playing action video games in a study by Green and Bavelier (2007). Visual acuity is a needed skill across a variety of fields, including air traffic control and other computer monitor-based jobs. Dye, Green, and Bavelier (2009) found measurable differences in reaction times when video games were used as training devices. The so-called reflexive skills are measurably enhanced by playing video games for training purposes. In addition, the eyes can be exercised, so to speak, and vision actually enhanced through a series of repetitive movements; this function can be assisted through the playing of action video games as shown in a study by Li, Polat, Makous, and Bavelier (2009).

Video game play was found to help adults with the ocular disorder amblyopia, or lazy eye (Ngo, Nguyen, and Levi, 2012). Twenty subjects age 15 to 61 diagnosed with amblyopia were placed in two video game groups and one control group. Ten were placed in a group playing first person shooter action video games, three in a group playing a non-action video game (SimCity Societies), and the remaining seven did not play any video games. The first and second groups showed demonstrable improvement in visual acuity and plasticity.

Just playing simple action video games may help improve the reading speed and accuracy of children diagnosed with dyslexia. Gori, Franceschini, Ruffino, Viola, Molteni and Facoetti (2013) found in a group of 20 students exposed to 80 minute sessions of video game play daily, that the students showed improved reading ability and attention spans over those in the control group.
Video game research to assist the blind goes beyond the visual plasticity approach. Merabet, Connors, Halko, and Sánchez (2012) developed the Audio-based Environment Simulator (AbES) to teach navigation to the blind. Placing audio cues within a virtual environment, subjects were effectively able to learn three dimensional navigation of an existing building.

Related to visual acuity, and of further interest to the medical field, studies have indicated certain action video games measurably benefit physicians who perform laparoscopic surgery. Requiring considerable hand-eye coordination, laparoscopic surgery involves use of small remote instruments controlled while observing computer monitors. Doctors who played such action games as Super Monkey Ball 2 and Star Wars Racer Revenge made far fewer errors when performing laparoscopic surgery than those in the control group (Rosser, Lynch, Cuddihy, Gentile, Klonsky, and Merrell, 2007). Such findings have led to the development of more surgery-specific gaming software on home console platforms such as the Nintendo Wii (Reilly, 2008). More recent research has backed up the original assertions, and as laparoscopic simulators have been developed for the Wii, they have successfully shown good results in training programs (Jalink, Goris, Heineman, Pierie, and ten Cate Hoedemaker, 2013).

In addition, the medical field has benefited by the fact that measuring actions and cognition is easier with now common video game instruments such as the Nintendo Wii’s remote, the Wiimote. For instance, continuous hand movements in muscle-memory exercises were easily measured using the Wiimote in a study by Dale, Roche, Snyder, and McCall (2008), which demonstrated the projection of real world movement within a virtual gaming environment that has positive physiological training potential. Research shows newer control
methods of video games beyond traditional joysticks are more compelling to end users. An increased sense of virtual presence and spatial cognition was measured using newer motion based controllers found in home gaming consoles by Shafer, Carbonara, and Popova (2012). They suggest video games may continue to gain in higher levels of enjoyment as real world inputs become more fluid and natural within virtual environments.

Simulators have a strong history of use in high technology fields. Air traffic controllers are trained with simulators based on gaming technology. The simulators provide instructors with feedback on how well a candidate is performing. Simulators such as these allow mistakes to occur without real world consequences, thus offering a safe way to fail (Wald, 2008). Likewise, the Texas Maritime Academy at Texas A&M University - Galveston uses giant simulators that mimic the major ocean-going vessels of the world, and allows those training as naval pilots to virtually dock a variety of ships in representations of the world's major ports (Myers, 2007).

The use of video game technologies in training simulators for school workers, and for those trained in disciplines at the university level, is a continuing phenomenon. School bus simulators have been designed specifically for those school workers needing the license (eSchoolNews, 2001). Additionally, educational training simulators for student teachers have been attempted with reportedly positive results. The STAR Simulator allows teacher preparation students at University of Central Florida to partake in a virtual classroom in order to practice teaching and student management techniques (Dieker, Hynes, Stapleton, & Hughes, 2007).
Exer-gaming, the practice of bringing together physical activity and video games, has been popular in schools with the addition of such COTS products as the Nintendo Wii Fit and various dancing games (Weir, 2008). Concerns regarding the amount of screen time children engage in, as correlated with their body mass index (BMI), have led researchers to measure the effectiveness of devices designed to limit screen time as well as the addition of exer-gaming to the curriculum. Results of one such study (Epstein, Roemmich, Robinson, Paluch, Winiewicz, Fuerch, and Robinson, 2008) indicate electronic limiters show benefit with children in lower socio-economic households. However, additional research seems to indicate exer-games are no panacea to childhood obesity, either. Baranowski, et al (2012) found in a five week study of children nine to 12 years old no measurable increase in activity among subjects in the exer-gaming group than those in the non-exercising video games control group. Thus, their research concluded that families simply acquiring exer-gaming titles will likely not see measurable exercising benefits among children playing the games. More research in the field is needed to see what role exer-gaming titles may play in helping to combat childhood obesity.

Related to obesity is the notion of body image. Behm-Morawitz (2013) surveyed 279 Second Life players regarding the influence their online avatar had on their real world selves. As in many MMORPGs, users can choose avatars which may or may not resemble their true bodies. Behm-Morawitz wanted to find if an enhanced online avatar contributed to efforts at real world betterment such as weight loss and other healthy efforts, for which she found positive correlations.

Autism has received considerable attention and research in recent years, including the treatment of those students on the autism spectrum through the use of video games. Tanaka et
al (2010) discussed the development of a video game called Let’s Face It, which seeks to assist autistic students in facial recognition. In a trial of the software, with a group of 42 students receiving 20 hours in the program, the students showed measurable improvement in facial identity perception over the control group.

Mazurek, Shattuck, Wagner, and Cooper (2012) analyzed data from the National Longitudinal Transition Study-2 (NLTS2), and discovered about 64 percent of students on the autism scale in the study spent most of their free time in non-social electronic media, including individual video game play, and less time in social electronic media. In a roundtable discussion of the issue, Ferguson, Anderson-Hanley, Mazurek, Parsons, and Warren (2012) noted that autistic students seem fascinated with screen time even more so than other students, and video games in general may be viable tools for teachers, with caveats including cautions against overuse. Unfortunately, the group concluded, so far a lack of rigorous testing and viable clinical trials in the area hampers cohesive solutions.

Mazurek and Engelhardt (2013) found in surveys of families with boys of typical development and those on the autism spectrum, that autistic boys spent considerably more time playing video games than their typical development siblings, which the authors considered potentially problematic for possible behavioral issues. In a separate study (2013), Mazurek, Shattuck, Wagner, and Cooper found a correlation between autistic boys’ over exposure to video game play with inattention and oppositional defiant behavior. On the other hand, Ferguson, Gillis, and Sevlever (2013) found video games effective in teaching social skills to students on the autism spectrum. Specifically, sports titles played on the Wii home gaming console were found useful in providing opportunities to work on good sportsmanlike conduct.
Potential cognitive improvements have been found in studies of older subjects playing massively multiplayer online role-playing games (MMORPGs). A total of 39 subjects aged 60-77 played World of Warcraft two hours a day over two weeks, and showed improvements on their cognitive baseline test scores following the experiment. Those performing worse initially enjoyed the greatest improvement on the post test (Whitlock, McLaughlin, & Allaire, 2012). In a separate study, Wolinsky et al (2013) found cognitive improvement in geriatric patients after playing computerized crossword puzzles and action video games. Since the games are available on home computers, the authors suggested these types of treatments be more widely implemented. In a custom designed three dimensional video game, Anguera et al (2013) found cognitive decline was arrested in older players, and measurable benefits persisted elsewhere in areas like multi-tasking.

Crowdsourcing, or involving the efforts of multiple people online toward a common goal, is the impetus behind an online videogame called Foldit, which seeks to engage players in biometric solutions involving computational enzymes. Khatib et al (2011) presented a paper showing the utility of the online game and how it is used for protein structure modeling. Eiben et al (2012) showed how Foldit was used to help design enzymes for alternative fuels. The notion of enlisting multiple game players in concerted effort for a common goal seems a promising one as outlined in these two papers.

Research on DimensionM

DimensionM is a math-focused educational videogame. Started by gaming company Tabula Digita (now DimensionU, Inc.), DimensionM was developed from its beginning as an
educational offering that could be sold to schools with the purpose of engaging students in additional math solving activities. It is web-based, and as such allows students from disparate locations opportunities to play together online, and compete against one another using the scoring system in the game. Scoring in the game is accomplished through quickly answering math questions correctly. Researchers discussed below have generally found the game to be effective in raising math scores among the student populations in which it is used as a resource, and/or have seen a noticeable increase in subjects’ personal positive attitudes toward math after engaging in the interventions.

Gillispie, Martin, and Parker (2009) measured achievement gains and attitudes among 29 middle school students, finding statistically significant gains in achievement but no significant changes in attitude toward mathematics following an intervention with DimensionM. The game was used in a mathematics remediation course for the students, all of whom were identified as being less than proficient on state exams in mathematics.

Kebritchi, Hirumi, and Bai (2010) found that 193 high school students using the DimensionM software scored higher on district math exams than those in the control group. The experimental group also showed statistically significant improvement in pre- and post-test scores. Students and teachers reported positive experiences with the software, with students reporting increased motivation toward math studies following the experiment’s conclusion.

In a quasi-experimental effort with 225 middle school students, Ritzhaupt, Higgins, and Allred (2011) reported increased positive self efficacy in mathematics among students playing DimensionM, along with increased post-test scores. However, not enough of an increase in either was found to be statistically significant. Gender, socio-economic status, and frequency of
computer use showed no statistically significant impact on the other measures. The authors called for longitudinal studies and suggested educator knowledge of the game along with increased actual playtime may increase its effectiveness in enhancing scores.

Araya, Jiménez, Bahamondez, Calfucura, Dartnell, and Soto-Andrade (2014) examined the player logs of third through tenth grade students engaged in DimensionM across data logs from the National Tournaments of Online Mathematics and Science games in Chili, for which DimensionM is used as the competitive vehicle. Data from the final third of the 2009 national championships was examined in the study, which involved 3,432 students participating in the game. They found increased mathematical modeling skills, particularly among fifth graders and older who were able to develop algebraic models that allowed correct input-output pattern prediction, a skill set useful for data-mining and other pattern recognition occupations. Male students, those from private schools, and those of higher socio-economic status were able to develop useful models more successfully than other students in the study, which correlated to results from national exams in Chili. As the tournaments will expand throughout Latin America, the authors expressed an expectation for multinational studies of similar results to be performed in the future.

MBTI in the Classroom

Efforts at appropriating psycho-social predictions of achievement for school children have an illustrious history. Bloom (1976) considered IQ and cognitive skills to be responsible for at least half a student’s score in any given course. IQ testing, however, is fraught with peril for
researchers whose audiences may infer, rightly or wrongly, ill intent or outcomes (Heckman, 1995). Using the MBTI as a predictor of success in academic settings rather than IQ seems to be much more acceptable, as it has found wide application in academic and career counseling, business management, and education in general. In fact, when developing early prototypes of the instrument, Isabel Myers used her children, their classmates, then high school students across western Pennsylvania as early test subjects (Myers and Myers, 2010).

The MBTI is a personality assessment based on Jungian theories of psychological types (Myers, 1962). Answers from the instrument result in the subject’s placement in one of 16 types within the following bipolar groups: extrovert versus introvert, sensing versus intuitive, thinker versus feeler, and judger versus perceiver. Carl Jung’s theory of types was introduced in the 1920s, type tools were developed in the 1940s, and the initial MBTI instrument was published in the 1960s. All this results in an exceptionally long time of use for an instrument in the field of psychometrics, and has resulted in the administration of the instrument to millions of subjects (Moore, Dettlaff, and Dietz, 2004). The four preference scales in the MBTI can indicate students’ preferences in the classroom, as noted by the researchers below. The four scales are Extrovert/Introvert (E/I), Sensing/Intuition (S/N), Thinking/Feeling (T/F), and Judging/Perceiving (J/P).

As far as students are concerned, researchers have suggested extroverts prefer self-paced instruction and interactive educational experiences. Extroverts can get bored easily in traditional classroom settings. They enjoy activity rather than sitting quiet for long periods of time. Reading and writing, naturally more still and quiet than other activities, may not be the best suitable learning methods for them in every situation (Provost, 1993). Extroverts think and
learn best while communicating with others. They enjoy team learning activities, and hands-on practices in educational settings (Sakamoto and Woodruff, 1992).

While a teacher used to traditional instruction may find satiating extroverts’ need for talk and activity annoying, introverts are much more acclimated to traditional structured school environments, with desks in a row and quiet time spent studying. Introverts appear to prefer the traditional teacher role as a guide for students, and are typically content to sit quietly while the teacher lectures. In contrast to their extrovert counterparts, they may disdain class discussions, and not perform as well in group activities requiring quick analysis and decision making (Sakamoto and Woodruff, 1992).

Sensing and Intuition indicate how subjects like to acquire information. Myers and Myers (2010) assert sensing types concentrate on the written page, while intuitive types may be thinking ahead about concepts in the entire book. Sensing students are more hands on, preferring real world activities they can manipulate in person. They enjoy being given information rather than using their imagination to see where the information might lead. They also enjoy facts, numbers, and memorization (Sakamoto and Woodruff, 1992). Students preferring Intuition tend to be big picture types, who like to see overall concepts and how they might relate to one another. They like to go with their gut, or hunches, rather than spend too much time analyzing things. They are not typically fans of structured and rigorous learning environments, where the pace is controlled. They tend to prefer open ended environments where they can use their imagination to discover things they were not led to by an authority figure (Provost, 1993).
Thinking and Feeling indicate means of judging, or making decisions. Thinking students tend to be more logical when making decisions, and less emotional about analytical processes to come to their conclusions. Feeling students tend to bestow more subjective values to the decision-making process based on personal data. Feeling children tend to become more people oriented when they grow up, as opposed to their thinking counterparts, who tend to be more adept with facts and organization. Feeling students usually like to be well liked, thriving on encouragement. Thinking students tend to weigh the evidence before finalizing their decisions, while feelings students are more concerned with the emotions in themselves and others when making decisions (Myers and Myers, 2010).

Judging and Perceiving are strong indicators of how much students prefer structured learning environments. Those tending toward judging tend to prefer highly structured classrooms with rigid deadlines. They enjoy completing assignments, and tend to place a high value on academic accomplishments (Provost, 1993). Perceiving students are much more laid back about academics. They are classic underachievers. They enjoy open learning environments favoring serendipity, and may tend to procrastinate in turning in their work (Sakamoto and Woodruff, 1992).

Although not perfect, meta-analyses of the MBTI instrument as applied across multiple disciplines reveal strong test-retest reliability and internal consistency (Capraro and Capraro, 2002). Although Myers and Briggs suggested the instrument is not ideal for job placement (Myers, McCaulley, Quenk, and Hammer, 1988), it has been used for that as well as for the prediction of student success in various academic fields (Hammersley-Fletcher & Brundrett, 2008). Dewar and Whittington (2000) suggest that introverts may be better suited to online
learning environments, while extroverts may grow impatient with online learning. Schroeder (1993) suggested new college students’ personality types may differ from their instructors, thus leading to discouragement of the students when engaged in certain higher education classes. He found Introverted/Intuitive (IN) students tend to make higher grades while Extroverted/Sensing (ES) students tend to make lower grades.

Ultimately, the indicator has a well established history of accurately placing subjects within appropriate types. This reliability has decades of testing and re-testing behind it, among millions of subjects across the globe. Jungian concepts such as persons being naturally introverted or extroverted have become part of the common vernacular as the indicator has spread in popularity and usage (Myers and Myers, 2010). All the above make the instrument an ideal tool for the purposes of this study.

Other Measures of Personality and Video Games

The Big Five personality traits encompass another personality measurement different from MBTI and also used by researchers. The Five Factor Model offers five dimensions of personality traits. The traits are openness, conscientiousness, extraversion, agreeableness, and neuroticism (McCrae and John, 1992). Some researchers have compared the amount of time spent playing video games and the subjects’ reported Big Five personality traits. Witt, Massman, and Jackson (2011) compared middle school students’ Big Five personality traits with the amount of video game usage they reported. Students exhibiting more openness, or willingness to engage in new activities and ideas, showed a correlation to playing more video
games. Chory and Goodboy (2011) found that college students playing violent video games reported higher openness and extroversion.

Seeking connections between personality traits and video game play as related to college grade point averages (GPAs), was the focus of a study by Ventura, Shute, and Kim (2012). Subjects reported their GPAs and personality traits, then answered survey questions regarding video game play time, diversity and number of games. For personality traits, the researchers focused on openness and conscientiousness. Openness was defined as willingness to engage in new activities and linked to motivation to learn. Conscientiousness was defined as a good work ethic, and correlated to academic achievement. The authors asserted some students reporting specific amounts of time within their favorite video games had higher GPAs, possibly due to increased exposure to problem solving within the games. Students spending considerable time playing video games were correlated to lower GPAs. Higher time spent playing video games showed correlation to lower conscientiousness personality traits, while those players engaging in a wide diversity of games were linked to higher openness personality traits. However, some studies suggest that students in general, and female students in particular, tend to trend toward lower GPAs with over exposure to all kinds of media (Walsh, Fielder, Carey and Carey, 2013).

Guilford’s (1967) theory of creativity asserts multiple solution development indicates high levels of creativity, and Torrance’s (1987) Test of Creativity is based on Guilford’s assertions. Jackson et al (2012) found that 491 students, age 12 years, predicted higher creativity scores on the Torrance Test if they reported higher video game use on a survey. Other technologies on the survey included computer, Internet, and cell phone usage.
CHAPTER 3 METHODOLOGY

Introduction

The broad purpose of this study was to see what relationship personality type holds on educational gaming in the classroom, and if predictions can be safely made about a student’s performance in an educational game setting based on their type indicator. In order to examine the relationship, subjects enrolled in high school math, grades 10 - 11 at the target campus, were offered the Myers-Briggs Type Indicator. Students were then offered opportunities to play a voluntary math game in a mini computer lab set up in their high school math classroom, and were encouraged to participate in the game during class and other times during the day such as before or after school, during lunch and break. Participation was not mandatory, and participation progressed organically by the subjects.

Tabula Digita offered free licensed use of their software for the school district for the duration of the experiment, along with training of the investigator and classroom teacher. Each student subject was assigned a login name and password, and the gaming program maintained data for the participants during each session. Data within the game was collected through the tracking of student performance following player login. Data points collected included number of games played, total time spent playing, points earned by correctly solving mathematical problems, average points earned per game, and average points per minute earned in the game.

The experiment occurred in the spring semester, beginning in the first week and concluding in the last week of school. The activities did not interfere with state exams, and were allowed during the spring semester due to their voluntary nature.
Population

Data was collected from a population of high school students attending a rural school in east-central Texas. The superintendent and principal signed off on permission for the research to take place on their campus the summer of 2011. The student population is rural, four percent African-American, 14 percent Hispanic, and 82 percent white. A total of 53 percent are classified economically disadvantaged, and 25 percent are classified as at risk of failing to graduate. Total student population is approximately 480 from Kindergarten through 12th grade. One percent are classified English as a second language speakers, and six percent are classified special education. In 2010, 40 seniors graduated. In 2011, 25 seniors graduated. The district and high school are ranked academically recognized by the Texas Education Agency. The elementary campus was awarded the National Blue Ribbon School of Excellence by the United States Department of Education in 2009.

Recruitment

The school employs two math teachers for high school and a science teacher who occasionally teaches calculus if student population warrants. Of the two main math teachers, encouragement to have their students participate resulted in one of the teachers agreeing, the other declining to make her classes available for the experiment. Thus student recruitment efforts focused on those students in the first teacher’s classroom, who were in grades 10 through 11. Publicity for the project was generated through announcements sent home with students and classroom visits at the beginning of the semester.
Recruitment efforts for the project involved class presentations to 10th and 11th graders of the mathematical gaming portion of DimensionU, a software suite developed by Tabula Digita, an academic video game company. DimensionM, the math portion of the gaming environment, focuses on math skills and exploration. In this educational videogame, students compete in teams for capture the flag or goal achievements. Mathematical problem solving is integrated in the game play.

Additional recruitment literature was sent home with the students in an effort to win parental support and permission slip signatures. Permission forms were approved by the University of North Texas Internal Review Board prior to the experiment. Around the time of the experiment’s completion, leadership at Tabula Digita changed the company’s name to be eponymous with their lead software suite.

Fall semester 2011 involved publicity and recruitment for the project, along with educative outreach to parents and students. By the start of spring, 2012, families in the school district had agreed to allow 42 students who subsequently signed their own assent forms, to participate in the project.

Operations

Test runs in the summer on the school’s laptop cart computers showed the laptops were capable of handling DimensionU software, but additional test runs of the program on other school computers resulted in the discovery that the school’s computer lab desktop computers were barely adequate. Game play lagged on the older lab desktop computers,
making gaming sessions difficult and at times impossible in the computer lab. Subsequently all program work was shifted to school laptops.

Since the laptop cart was shared among all classrooms in the high school, special considerations were given to the volunteering math teacher for exclusive use of a handful of laptops for the experiment. A mini lab of four laptops was set up in her room during the spring semester, with the understanding they were to be used primarily for playing the DimensionM math game. Power cords were arranged to prevent accidental tripping, and an Ethernet switch was temporarily installed in the room to handle all four laptops being online at once. Students engaged in the game could play along together in the online environment, or engage in the activities alone.

Additional copies of the program were installed on other laptop computers in the laptop cart, so that students would have additional access to the program outside the math teacher’s classroom. Some complaints were fielded by other teachers about the math teacher receiving the classroom mini-lab, but were smoothed over via administrative buy-in and personal explanations as to the reasons for the mini-lab given by the investigator.

The concept of free time can be a precarious one for teachers to admit to having during their class time. An idea for using class time for work is the cultural norm. However, the game in this case was stressed to stakeholders as focusing on skills the students were covering in the classroom. Thus, time spent on the game was pitched as skill practice rather than recreation. Times when students had finished other work was made available throughout the semester to spend on the mini laptop lab to play the game. Additional opportunities were made available in other classrooms through the laptop cart. With the program installed on certain laptops on the
cart, interested students could engage in the game during other free time opportunities on days other classes used the cart.

Finally, the volunteering math teacher made her room available before and after school, and during the 20 minute morning break afforded to high school students. The cafeteria was shared with all grades, Pre-Kindergarten through 12. Since high school had the last lunch, starting at 1:00 pm, high school students were afforded a 20 minute snack and free time break starting at 9:40. During these moments and at other opportunities, students were encouraged to engage in the DimensionM game.

Gaming System and Selection

Prior to the experiment, an examination of viable commercial games allowing multiple participants to engage in math activities appropriate for high school use indicated DimensionM was an excellent candidate for this study. A public relations firm e-mailed a news blurb to those involved in educational gaming blogs and other enthusiast sites concerning the latest developments with Tabula Digita. Reaching out to this public relations firm offered a connection to corporate offices at Tabula Digita in the year preceding the experiment. A proposal to run the experiment using their software was made, and a request to allow their software to be used in the target school gratis for the length of the experiment was accepted by the corporation. Tabula Digita provided logins for 100 students, more than enough for all participants, set up the school with one of their Texas employees as a contact for technical support, and provided free training and support to the investigator and the volunteering math teacher for the duration of the experiment.
DimensionM is a three dimensional gaming environment in which student avatars engage with math problems and one another on a virtual playing field. Upon logging into the game, students are free to explore and manipulate variables in the environment. Points are scored through the solving of math problems, which are displayed on the screen with multiple choice answers, much as in typical state based exams.

In one iteration of the game, students travel around looking for virtual objects which must be propelled toward a target. Upon successfully hitting the target the game offers a math question. Quickly and successfully choosing the right answer the first time awards the most points. Students may also trap other students, adding to the competitive atmosphere of the game. Violent gaming elements are deliberately softened, although students may shoot, in a manner of speaking. For instance, to trap another player, a student may shoot sticky goo at the other student’s avatar.

The gaming system records each student’s efforts within the system. Data points collected include the number of games played (labeled here as interventions), total time played (converted to seconds for analytical purposes), total points awarded in the games (accumulated through quick and precise answers as noted above), points per intervention earned (labeled here PPI), and average points per minute (PPM).

Test Instruments and Surveys

Students who agreed to the experiment and returned parental permission forms, and signed their own assent forms, were given the Myers Briggs Type Indicator (MBTI) Type M, a personality profile tool featuring 93 paired comparison questions in three sets. The MBTI
assessment was completed by all participants. Of the 42 students participating, 12 different personality types were observed. These were given a numerical value for the sake of analysis. Below is table 1, indicating the numerical values assigned to the different personality type indicators.

<table>
<thead>
<tr>
<th>MBTI Value</th>
<th>MBTI Definition</th>
<th>Numerical Value</th>
<th>N Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENFJ</td>
<td>Extraverted iNtuitive Feeling Judging</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>ENFP</td>
<td>Extraverted iNtuitive Feeling Perception</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>ENTJ</td>
<td>Extraverted iNtuitive Thinking Judging</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>ENTP</td>
<td>Extraverted iNtuitive Thinking Perception</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>ESFJ</td>
<td>Extraverted Sensing Feeling Judging</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>ESFP</td>
<td>Extraverted Sensing Feeling Perception</td>
<td>6</td>
<td>4</td>
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<td>Extraverted Sensing Thinking Judging</td>
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<td>4</td>
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<tr>
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<tr>
<td>ISFP</td>
<td>Introverted Sensing Feeling Perception</td>
<td>12</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 1: MBTI numerical values

Participation and Interest

As stated earlier, the experiment took place in the spring semester, which culminated in state exams. Participation and interest among the subjects started strong, and waned as the semester progressed. Since the experiment relied on observation of voluntary game play, encouragements to play were offered to the students such as reminders they could use free time to play the game in the four laptop classroom lab. A nearly even number of female and male subjects participated with 20/22 split respectively among the genders. Data points for the study centered on measured participation amounts as recorded by the gaming system, gender, and personality indicator.
Inquiries and Hypotheses

Five inquiries were considered regarding the effect of gender and MBTI profile on participation with the DimensionM gaming system in this experiment. Each inquiry had three corresponding null hypotheses to be examined. Inquiry 1 explored whether there were any statistically significant effects of gender and MBTI personality profiles on the number of games (interventions) in which a subject voluntarily engaged. The three null hypotheses are listed below:

- $H_{01}$: There is no effect of gender on number of interventions.
- $H_{02}$: There is no effect of MBTI on number of interventions.
- $H_{03}$: There is no interaction of effect of gender and MBTI on number of interventions.

Inquiry 2 investigated whether there were statistically significant effects of gender and MBTI personality profile on the amount of time in which subjects voluntarily engaged in the educational games (interventions). The three null hypotheses for Inquiry 2 are as follows:

- $H_{01}$: There is no effect of gender on time on interventions.
- $H_{02}$: There is no effect of MBTI on time on interventions.
- $H_{03}$: There is no interaction of effect of gender and MBTI on time on interventions.

Inquiry 3 examined whether there were any statistically significant effects of gender and MBTI personality profile on total points earned in the games. This differs from the time element, because a student may play less but score more. The three null hypotheses for Inquiry 3 are below:

- $H_{01}$: There is no effect of gender on total points.
- $H_{02}$: There is no effect of MBTI on total points.
H₀₃: There is no interaction of effect of gender and MBTI on total points.

Inquiry 4 investigated whether there were statistically significant effects of gender and MBTI personality profile on points per intervention (PPI). This differs from total points earned because it is an indicator of proficiency in the game. The three null hypotheses for Inquiry 4 include the following:

H₀₁: There is no effect of gender on points per intervention.
H₀₂: There is no effect of MBTI on points per intervention.
H₀₃: There is no interaction of effect of gender and MBTI on points per intervention.

Finally, Inquiry 5 examined whether there were any statistically significant effects of gender and MBTI personality profile on average points per minute (PPM) earned by the subjects. This differs from PPI as it measures the entire average PPM across all games played by the subjects. The three null hypotheses for Inquiry 5 are the following:

H₀₁: There is no effect of gender on average points per minute.
H₀₂: There is no effect of MBTI on average points per minute.
H₀₃: There is no interaction of effect of gender and MBTI on average points per minute.

Conclusion

The study progressed throughout the spring semester of 2011. Participants (n=42) were closely divided among female (n=22) and male (n=20). MBTI preferences were self selected by participants, then they were allowed voluntary access to a commercial educational video game focusing on mathematics which collected several data points in the game. Null hypotheses for
five areas of inquiry were proposed, and subjected to statistical analysis, further description of which takes place in the following chapter.
CHAPTER 4 FINDINGS

Introduction

A total of 42 subjects, female (n=20) and male (n=22), participated in a semester long voluntary educational gaming program, DimensionM, during free time before, after, and during school, and in allowed classroom time. The subjects participated in taking an assessment for the Myers-Briggs Type Indicator (MBTI), and their corresponding personality types were compared to participation and performance within the learning game environment.

Analysis of variance was used with SPSS 17 on the data in Table 2. Five inquiries were explored, considering whether there were any significant effects of gender and MBTI profiles on the gaming data generated, including number of interventions, amount of time voluntarily spent in the interventions, total points, points per intervention, and average points per minute scored.

<table>
<thead>
<tr>
<th>Student</th>
<th>No. Interventions</th>
<th>Time on Interventions (in seconds)</th>
<th>Total Points earned in Intervention</th>
<th>Points Per Intervention Avg PPM F/M-0/1 MBTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>4</td>
<td>2927</td>
<td>1365</td>
<td>341.25 27.98 0 6</td>
</tr>
<tr>
<td>02</td>
<td>6</td>
<td>3166</td>
<td>3180</td>
<td>530.00 60.27 0 1</td>
</tr>
<tr>
<td>03</td>
<td>6</td>
<td>2247</td>
<td>595</td>
<td>99.17 15.89 1 2</td>
</tr>
<tr>
<td>04</td>
<td>10</td>
<td>4965</td>
<td>5795</td>
<td>579.50 70.03 1 10</td>
</tr>
<tr>
<td>05</td>
<td>6</td>
<td>2168</td>
<td>2940</td>
<td>490.00 81.37 1 2</td>
</tr>
<tr>
<td>06</td>
<td>6</td>
<td>2218</td>
<td>1350</td>
<td>225.00 36.52 0 7</td>
</tr>
<tr>
<td>07</td>
<td>7</td>
<td>1819</td>
<td>1535</td>
<td>219.29 50.63 0 6</td>
</tr>
<tr>
<td>08</td>
<td>6</td>
<td>1604</td>
<td>970</td>
<td>161.67 36.28 0 11</td>
</tr>
<tr>
<td>09</td>
<td>1</td>
<td>559</td>
<td>0</td>
<td>0.00 0.00 0 6</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>1508</td>
<td>1415</td>
<td>283.00 56.30 1 3</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>438</td>
<td>20</td>
<td>10.00 2.74 0 7</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>2829</td>
<td>2755</td>
<td>688.75 58.43 1 3</td>
</tr>
<tr>
<td>13</td>
<td>6</td>
<td>2728</td>
<td>2410</td>
<td>401.67 53.01 1 12</td>
</tr>
<tr>
<td>14</td>
<td>5</td>
<td>1493</td>
<td>400</td>
<td>80.00 16.08 0 5</td>
</tr>
<tr>
<td>15</td>
<td>22</td>
<td>1005</td>
<td>4800</td>
<td>218.18 29.49 1 5</td>
</tr>
<tr>
<td>16</td>
<td>3</td>
<td>649</td>
<td>0</td>
<td>0.00 0.00 0 6</td>
</tr>
<tr>
<td>17</td>
<td>7</td>
<td>2586</td>
<td>1770</td>
<td>252.86 41.07 1 8</td>
</tr>
<tr>
<td>18</td>
<td>3</td>
<td>2549</td>
<td>1360</td>
<td>453.33 32.01 1 2</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>214</td>
<td>60</td>
<td>60.00 16.82 0 11</td>
</tr>
</tbody>
</table>

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Table 2: Gaming and MBTI data

Table 3 shows the between-subject factors used in the analysis, including a breakdown of MBTI scores, how many subjects scored the corresponding 12 MBTI personality profiles, along with gender totals.

<table>
<thead>
<tr>
<th>Between-Subjects Factors</th>
<th>Value Label</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBTI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ENFJ</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>ENFP</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>ENTJ</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>ENTP</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>ESFJ</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>ESFP</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>ESTJ</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>ESTP</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>INFJ</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>INFP</td>
<td>4</td>
</tr>
</tbody>
</table>
Inquiry 1

Inquiry 1 involved testing whether there are significant statistical effects of gender and MBTI personality profiles on the number of interventions in which a subject voluntarily engaged. This was the prime inquiry of the study, and focused on the main question surrounding personality type and whether it had any bearing on the voluntary willingness to engage in the video game intervention. The following three null hypotheses were addressed in this inquiry, $\alpha = .05$:

$H_{01}$: There is no effect of gender on number of interventions.

$H_{02}$: There is no effect of MBTI on number of interventions.

$H_{03}$: There is no interaction of effect of gender and MBTI on number of interventions.

Figures 1 and 2 show the SPSS output for analysis of variance for gender, MBTI, and gender * MBTI.

Tests of Between-Subjects Effects

Dependent Variable: Number of Interventions

Table 3: Between subject factors, MBTI and gender totals

<table>
<thead>
<tr>
<th></th>
<th>ISFJ</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>ISFP</td>
<td>3</td>
</tr>
<tr>
<td>Sex</td>
<td>Female</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>Male</td>
<td>22</td>
</tr>
</tbody>
</table>

Five inquiries were subjected to statistical analysis of variance, as outlined in the following sections.
<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>630.860^a</td>
<td>18</td>
<td>35.048</td>
<td>3.727</td>
<td>.002</td>
</tr>
<tr>
<td>Intercept</td>
<td>1369.982</td>
<td>1</td>
<td>1369.982</td>
<td>145.687</td>
<td>.000</td>
</tr>
<tr>
<td>Gender</td>
<td>123.527</td>
<td>1</td>
<td>123.527</td>
<td>13.136</td>
<td>.001</td>
</tr>
<tr>
<td>MBTI</td>
<td>373.697</td>
<td>11</td>
<td>33.972</td>
<td>3.613</td>
<td>.005</td>
</tr>
<tr>
<td>Gender * MBTI</td>
<td>178.408</td>
<td>6</td>
<td>29.735</td>
<td>3.162</td>
<td>.021</td>
</tr>
<tr>
<td>Error</td>
<td>216.283</td>
<td>23</td>
<td>9.404</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2432.000</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>847.143</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. R Squared = .745 (Adjusted R Squared = .545)

Figure 1: Tests of between-subjects effects, number of interventions.

The model is significant, with an F ratio of 3.727, p value < .01. The data indicates a subject’s gender has a statistically significant effect on number of interventions in which they engaged, with an F ratio of 13.136, p value < .01. The interaction between gender and MBTI is significant, with an F value of 3.162, p value < .05. The adjusted R squared indicates a 54.5% variation in the number of interventions is explained by gender, MBTI, and gender * MBTI.

Figure 2 shows the individual t-scores for the estimated regression coefficients of each MBTI score.
## Parameter Estimates

**Dependent Variable:** Number of Interventions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>B</th>
<th>Std. Error</th>
<th>t</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>9.00</td>
<td>2.168</td>
<td>4.151</td>
<td>.000</td>
<td>4.514</td>
<td>13.486</td>
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</tr>
<tr>
<td>[gender=0]</td>
<td>-4.00</td>
<td>3.756</td>
<td>-1.065</td>
<td>.298</td>
<td>-11.769</td>
<td>3.769</td>
<td></td>
</tr>
<tr>
<td>[gender=1]</td>
<td>0</td>
<td>. . . . . .</td>
<td>. .</td>
<td>. .</td>
<td>. . . . . . . . . . . . . .</td>
<td>. . . . . . . . . . . . . .</td>
<td></td>
</tr>
<tr>
<td>[MBTI=1]</td>
<td>1.00</td>
<td>4.337</td>
<td>.231</td>
<td>.820</td>
<td>-7.971</td>
<td>9.971</td>
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</tr>
<tr>
<td>[MBTI=3]</td>
<td>-4.500</td>
<td>3.067</td>
<td>-1.467</td>
<td>.156</td>
<td>-10.844</td>
<td>1.844</td>
<td></td>
</tr>
<tr>
<td>[MBTI=4]</td>
<td>11.000</td>
<td>3.756</td>
<td>2.929</td>
<td>.008</td>
<td>3.231</td>
<td>18.769</td>
<td></td>
</tr>
<tr>
<td>[MBTI=7]</td>
<td>-1.500</td>
<td>3.067</td>
<td>-.489</td>
<td>.629</td>
<td>-7.844</td>
<td>4.844</td>
<td></td>
</tr>
<tr>
<td>[MBTI=8]</td>
<td>-.400</td>
<td>2.566</td>
<td>-.156</td>
<td>.877</td>
<td>-5.707</td>
<td>4.907</td>
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<tr>
<td>[MBTI=9]</td>
<td>-1.000</td>
<td>3.541</td>
<td>-.282</td>
<td>.780</td>
<td>-8.325</td>
<td>6.325</td>
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</tr>
<tr>
<td>[MBTI=11]</td>
<td>-2.000</td>
<td>3.756</td>
<td>-.533</td>
<td>.599</td>
<td>-9.769</td>
<td>5.769</td>
<td></td>
</tr>
<tr>
<td>[MBTI=12]</td>
<td>0</td>
<td>. . . . . .</td>
<td>. .</td>
<td>. .</td>
<td>. . . . . . . . . . . . . .</td>
<td>. . . . . . . . . . . . . .</td>
<td></td>
</tr>
<tr>
<td>[gender=0] * [MBTI=1]</td>
<td>0</td>
<td>. . . . . .</td>
<td>. .</td>
<td>. .</td>
<td>. . . . . . . . . . . . . .</td>
<td>. . . . . . . . . . . . . .</td>
<td></td>
</tr>
<tr>
<td>[gender=0] * [MBTI=9]</td>
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<td>. . . . . .</td>
<td>. .</td>
<td>. .</td>
<td>. . . . . . . . . . . . . .</td>
<td>. . . . . . . . . . . . . .</td>
<td></td>
</tr>
<tr>
<td>[gender=0] * [MBTI=12]</td>
<td>0</td>
<td>. . . . . .</td>
<td>. .</td>
<td>. .</td>
<td>. . . . . . . . . . . . . .</td>
<td>. . . . . . . . . . . . . .</td>
<td></td>
</tr>
<tr>
<td>[gender=1] * [MBTI=2]</td>
<td>0</td>
<td>. . . . . .</td>
<td>. .</td>
<td>. .</td>
<td>. . . . . . . . . . . . . .</td>
<td>. . . . . . . . . . . . . .</td>
<td></td>
</tr>
<tr>
<td>[gender=1] * [MBTI=3]</td>
<td>0</td>
<td>. . . . . .</td>
<td>. .</td>
<td>. .</td>
<td>. . . . . . . . . . . . . .</td>
<td>. . . . . . . . . . . . . .</td>
<td></td>
</tr>
<tr>
<td>[gender=1] * [MBTI=4]</td>
<td>0</td>
<td>. . . . . .</td>
<td>. .</td>
<td>. .</td>
<td>. . . . . . . . . . . . . .</td>
<td>. . . . . . . . . . . . . .</td>
<td></td>
</tr>
<tr>
<td>[gender=1] * [MBTI=5]</td>
<td>0</td>
<td>. . . . . .</td>
<td>. .</td>
<td>. .</td>
<td>. . . . . . . . . . . . . .</td>
<td>. . . . . . . . . . . . . .</td>
<td></td>
</tr>
</tbody>
</table>
In examining the individual t-scores, MBTI=4 and MBTI=5 are found to be statistically significant ($\alpha = .05$) with the independent variable number of interventions. MBTI=6 comes closest to being statistically significant among the remainder. The interaction of gender=0 (female) combined with MBTI=5 is also statistically significant. Note that MBTI=4 is the numerical representation for MBTI type indicator ENTP; MBTI=5 is for ESFJ; and MBTI=6 is for ESFP.

If a subject scored an MBTI type indicator of ENTP, on average the number of interventions in which they participated increased by 11. Note that only one subject, of the 42 in the study, scored a type indicator of ENTP, so this should be taken into consideration when considering the results. If a subject scored an MBTI type indicator of ESFJ, on average the number of interventions in which they participated increased by 13. Four subjects in the study scored type indicators ESFJ. If a subject scored an MBTI type indicator of ESFP, on average the number of interventions for which they volunteered decreased by seven. Four subjects in the study scored ESFP. Finally, if a subject was female, and scored ESFP, her number of interventions on average decreased by almost 14. Of the four subjects scoring ESFP, three were female and one was male.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>(gender=1) * [MBTI=6]</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(gender=1) * [MBTI=7]</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(gender=1) * [MBTI=8]</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(gender=1) * [MBTI=10]</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(gender=1) * [MBTI=11]</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(gender=1) * [MBTI=12]</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* This parameter is set to zero because it is redundant.

Figure 2: Parameter estimates, number of interventions.
Inquiry 2

The second inquiry involved testing for statistically significant effects ($\alpha = .05$) of gender and MBTI with their interaction of time on interventions. The following three null hypotheses were tested in this inquiry:

$H_{01}$: There is no effect of gender on time on interventions.

$H_{02}$: There is no effect of MBTI on time on interventions.

$H_{03}$: There is no interaction of effect of gender and MBTI on time on interventions.

Figure 3 shows the output for the test of between-subjects effects, with the dependent variable as time on intervention:

### Tests of Between-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>3.270E7</td>
<td>18</td>
<td>1816941.364</td>
<td>.788</td>
<td>.694</td>
</tr>
<tr>
<td>Intercept</td>
<td>1.169E8</td>
<td>1</td>
<td>1.169E8</td>
<td>50.696</td>
<td>.000</td>
</tr>
<tr>
<td>gender</td>
<td>7932898.556</td>
<td>1</td>
<td>7932898.556</td>
<td>3.441</td>
<td>.076</td>
</tr>
<tr>
<td>MBTI</td>
<td>1.362E7</td>
<td>11</td>
<td>1238407.790</td>
<td>.537</td>
<td>.858</td>
</tr>
<tr>
<td>gender * MBTI</td>
<td>6251879.603</td>
<td>6</td>
<td>1041979.934</td>
<td>.452</td>
<td>.836</td>
</tr>
<tr>
<td>Error</td>
<td>5.302E7</td>
<td>23</td>
<td>2305371.496</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.796E8</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>8.573E7</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. R Squared = .381 (Adjusted R Squared = -.103)

Figure 3: Test of between-subjects effects, time on interventions

This model did not prove to be statistically significant, with an F value of .788. No additional testing was performed with this model.
Inquiry 3

The third inquiry explored whether there were any significant effects of gender and MBTI personality profile on total points earned in the games. The following three null hypotheses were tested in this inquiry:

\( H_{01} \): There is no effect of gender on total points.

\( H_{02} \): There is no effect of MBTI on total points.

\( H_{03} \): There is no interaction of effect of gender and MBTI on total points.

Figure 4 shows the output for the test of between-subjects effects, with the dependent variable as total points:

![Tests of Between-Subjects Effects](image)

The F value is 1.291, and the model is not statistically significant. No additional testing was performed with this model.

---

a. R Squared = .503 (Adjusted R Squared = .113)

Figure 4: Test of between-subjects effects, total points
Inquiry 4

Inquiry 4 sought to determine whether there were any significant effects of gender and MBTI personality profile on points per intervention (PPI). The following three null hypotheses were investigated:

H$_{01}$: There is no effect of gender on points per intervention.

H$_{02}$: There is no effect of MBTI on points per intervention.

H$_{03}$: There is no interaction of effect of gender and MBTI on points per intervention.

Figure 5 shows the tests of between-subject effects, with PPI as the dependent variable.

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>1.797E+06</td>
<td>18</td>
<td>99846.890</td>
<td>2.340</td>
<td>.028</td>
</tr>
<tr>
<td>Intercept</td>
<td>2716921.495</td>
<td>1</td>
<td>2716921.495</td>
<td>63.660</td>
<td>.000</td>
</tr>
<tr>
<td>gender</td>
<td>636239.217</td>
<td>1</td>
<td>636239.217</td>
<td>14.908</td>
<td>.001</td>
</tr>
<tr>
<td>MBTI</td>
<td>827240.976</td>
<td>11</td>
<td>75203.725</td>
<td>1.762</td>
<td>.122</td>
</tr>
<tr>
<td>gender* MBTI</td>
<td>194232.964</td>
<td>6</td>
<td>32372.161</td>
<td>.759</td>
<td>.610</td>
</tr>
<tr>
<td>Error</td>
<td>981602.699</td>
<td>23</td>
<td>42678.378</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6696261.386</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>2778846.722</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5: Tests of between-subjects effects, points per intervention

This model was statistically significant, with an F ratio of 2.34, p value <.03. The subjects’ gender showed statistical significance effecting points per intervention, with an F ratio of 14.9, and a very low p value. However, gender combined with MBTI did not show significance. The
adjusted R squared was .370, indicating about a 37% variation in PPI accounted for by gender, MBTI, and gender * MBTI. Additional analysis, showing the individual t-scores for the estimated regression coefficients of each MBTI score, can be found in Figure 6.

### Parameter Estimates

**Dependent Variable:** Points Per Intervention

<table>
<thead>
<tr>
<th>Parameter</th>
<th>B</th>
<th>Std. Error</th>
<th>t</th>
<th>Sig.</th>
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<td>146.079</td>
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<td>391.357</td>
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<td>[gender=0]</td>
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<td>253.017</td>
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<tr>
<td>[gender=1]</td>
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<tr>
<td>[MBTI=1]</td>
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<tr>
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<td>[MBTI=5]</td>
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<td>.862</td>
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<td>.799</td>
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<tr>
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<td>.</td>
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</tr>
</tbody>
</table>

53
Examining the individual t-scores, MBTI=8 and MBTI=11 are found to be statistically significant, at .023 and .043, respectively. MBTI=8 is the numerical representation for the MBTI personality type indicator ESTP. Five subjects in the study scored an MBTI profile of ESTP. MBTI=11 is ISFJ, with six subjects in the study. Points per intervention fell by about 422 points, if a student was personality type ESTP. They fell by about 543 points if a student was personality type ISFJ. Note that female students fell about 472 points. Students in the categories of MBTI=4 and MBTI=5, ENTP and ESFJ respectively, went down too, although not to a statistically significant degree. However, the data shows they played more games, but scored fewer points per game overall.

Subjects with personality type indicators MBTI=8 and MBTI=11, ESTP and ISFJ respectively, typically played between 2 and 7 games total in the experiment. Students with personality profiles MBTI=4 and MBTI=5, ENTP and ESFJ respectively, played between two and 22 games throughout the experiment. Note the only ENTP subject played 20 games, which may have affected the results.

<table>
<thead>
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<th>Parameter</th>
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</tr>
<tr>
<td>gender=1 * MBTI=4</td>
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</tr>
<tr>
<td>gender=1 * MBTI=5</td>
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<td>gender=1 * MBTI=6</td>
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<td>gender=1 * MBTI=7</td>
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<td>gender=1 * MBTI=8</td>
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<td>gender=1 * MBTI=10</td>
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<tr>
<td>gender=1 * MBTI=11</td>
<td>0^*</td>
</tr>
<tr>
<td>gender=1 * MBTI=12</td>
<td>0^*</td>
</tr>
</tbody>
</table>

a. This parameter is set to zero because it is redundant.

Figure 6: Parameter estimates, points per intervention
Inquiry 5

Inquiry 5 explored whether there were any significant effects of gender and MBTI personality profile on average points per minute (PPM) earned by the subjects. The following three null hypotheses were investigated:

- \( H_{01} \): There is no effect of gender on average points per minute.
- \( H_{02} \): There is no effect of MBTI on average points per minute.
- \( H_{03} \): There is no interaction of effect of gender and MBTI on average points per minute.

Figure 7 shows the tests of between-subject effects, with average points per minute as the dependent variable.

**Tests of Between-Subjects Effects**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
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<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
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<td>18</td>
<td>1336.095</td>
<td>2.026</td>
<td>.056</td>
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<td>75.470</td>
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<tr>
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<tr>
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<tr>
<td>sex * MBTI</td>
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<td>.691</td>
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<tr>
<td>Error</td>
<td>15171.649</td>
<td>23</td>
<td>659.637</td>
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<tr>
<td>Total</td>
<td>114839.250</td>
<td>42</td>
<td></td>
<td></td>
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<tr>
<td>Corrected Total</td>
<td>39221.353</td>
<td>41</td>
<td></td>
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<td></td>
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</tbody>
</table>

\( a \). R Squared = .613 (Adjusted R Squared = .310)

Figure 7: Tests of between-subjects effects, average points per minute

The model is not statistically significant, with an F ratio of 2.03, p value > .05. No additional testing was performed with this model.
Summary

Four personality profiles, MBTI=4, MBTI=5, MBTI=8 and MBTI=11, ENTP, ESFJ, ESTP, and ISFJ respectively, were found to have statistically significant results when subjected to analysis of variance with number of interventions, and points per intervention. Students with ENTP and ESFJ personality profiles on average voluntarily engaged in 12 additional games in the intervention than their counterparts. Gender was also seen as statistically significant in this model. Boys were more likely to play more games, possibly due to the competitive nature of the game, but that is only a guess. If a subject had a personality type of ESFP, the number of games they volunteered to play fell by seven, and if they were female and ESFP, the number of games played fell by 14. Points per intervention, a metric describing how successful students were in solving math problems within the game, saw significant drop offs with personality types ESTP and ISFJ across both genders.

Only one subject held the personality profile of ENTP. Myers and Myers (2010) indicate ENT personality types operate on intuition. “Their lives will be so shaped as to give maximum freedom for the pursuit of intuitive goals. Because intuition is a perceptive process, these ENTs will deal with the world in the perceptive attitude, which makes them ENTPs.” (p.10). A personality type of ENTP indicates the subject is Extraverted iNtuitive Thinking Perceiving. Along with the other extroverted group that volunteered for more games, ESFJ, the ENTP was most likely to voluntarily engage in more game play. Ideally, at least one more subject with ENTP would be most beneficial in seeing if similar results would occur.

The ESFJ personality type refers to Extraversion Sensing Feeling Judgment. Like the ENTP subject, they are extraverted and may enjoy making acquaintances, a characteristic which may
lend itself to the social nature of the DimensionM game. ESFJ personality types also enjoy structure and rules, again something the virtual environment in the game offers. Finally, they tend to be people pleasers (Myers & Myers, 2010), and this may have had something to do with their volunteering for so many additional gaming sessions.

ESFP subjects played fewer games, especially if they were female. ESFP types are Extravert, Sensing, Feeling, Perception. The difference between ESFJ subjects is their preference for Perception. Myers and Myers (2010) state the benefits of Perception include having an open mind, high levels of understanding and tolerance, curiosity, and exuberance. The ESFJ subjects also fall into the Feeling Judging category, and Myers and Myers write that, “A reader who is conscious first that the ideas are pleasing or displeasing, supporting or threatening ideas already prized, is using feeling judgment.” (p. 3). It appears once the female students decided against participation in the game, they stopped volunteering to engage in the intervention. Possibilities for female subjects lack of willing participation include non-traditional delivery of math problems, an unfamiliar environment, a desire to disengage with male subjects playing the game, and failing to find the game compelling.

The points per intervention (PPI) metric had statistically significant drop offs with personality types ESTP and ISFJ. The former are extroverts, the latter introverts, and it’s interesting not just that both saw significant declines, but that the extroverted group is in there. ESTP personality types are Extroversion Sensing Thinking Perception. Thinking and Perception are the differences with the ESFJ subjects, who played less. A low PPI meant the player engaged in the game, but completed fewer math problems while playing. ESFJ subjects played less, while ESTP students performed less. Myers and Myers (2010) indicate ESTP subjects’ greatest
strength is realism, relying on what they have personally experienced. It is possible that the
virtual environment for solving math problems was not enjoyable to them. Subjects with
personality profiles of ISFJ are counterparts to ESFJ types. While ESFJ subjects played less, ISFJ
students had lower PPI. Myers and Myers (2010) indicate ISFJ types are typically slower in
dealing with multiple choice problems.

An ISFJ, working in a personnel office that used the Type Indicator, was asked
about her own technique for taking tests. She said, “Oh, I always read a question
three or four times. I have to!” She does not have to in order to understand, but
she does to in order to be satisfied that she understands. So she goes slowly, and
her slowness is the drawback. (p. 59)

Since the DimensionM game revolved around quickly solving mathematical problems, it
is understandable that subjects with ISFJ personality type indicators would have lower PPIs.
They tend to be more studious in examining test questions to their own satisfaction, and typically
perform slower on multiple choice exams, which is how the problems in the gaming environment
were presented.
CHAPTER 5 DISCUSSION

Introduction

MBTI has a long history of predicting the best environments suited for different learning styles. Pedagogical behaviors, tools, and environments for students with any given personality profile can be tailored to fit their needs when MBTI is used as a predictor for academic success (Provost, 1993). A virtual environment may be similar in several aspects to physical environments. Anthropomorphic avatars may resemble humans, word problems may resemble those found on standard exams, and group activities may take place virtually rather than face to face.

This idea of equivalency hearkens to the debate Clark (1994) and Kozma (1994) held over the influence various media hold in instruction. Clark opined that media was like a delivery truck. Regardless of the truck used, all things being equal, the content inside the truck remains the same. Thus, knowledge is the same regardless of how it arrives at the end user because the delivery mechanism does not affect the information content, just as a delivery truck does not affect its material content. A fact transmitted in a lecture, book, or slide show remains the same fact, for instance. Kozma felt the metaphor was too broad and held a tendency to miss the finer details of particular delivery methods, which might offer benefits in the transmission of data. Visual or audio data might better help end users understand the facts to a greater degree.

This experiment observed that expectations with student performance based on their MBTI personality profiles are inline with other academic expectations generated from the instrument. As observed in this experiment, if an extroverted student prefers working and communicating in groups as indicated by the personality type indicator, he or she will likely
enjoy doing the same in a virtual gaming environment suited for working and communicating in groups. If a student’s personality profile indicated they prefer to spend time carefully examining data before making conclusions, a teacher may generally expect the student to perform less well on timed tests. If a video game requires making quick decisions on test-like material (as does DimensionM), students who prefer to take their time on tests will perform measurably less well in the game.

Discussion

In this experiment, subjects claiming ENTP and ESFJ personality profiles demonstrated a statistically significant greater number of voluntary interventions in the gaming environment. Conversely, female subjects, particularly among ESFP participants, were demonstratively lower. Subjects with ESTP and ISFJ personality profiles demonstrated statistically significant fewer points per intervention.

It is possible some data approaching significance might change with a larger population sample. For instance, MBTI=6 came close to showing statistical significance in Inquiry 1, indicating that students with personality profiles of ESFP may indeed be interested in playing the game almost as much as their ESFJ counterparts, especially if more male ESFP subjects participated. It makes sense that the data showed ESFP students might like playing the game as much, since ESFP and ESFJ students differ in their preferences for the structure of their learning environment, but are otherwise extroverts, detail oriented toward facts, and concerned with the feelings of themselves and others. Judging students who prefer more structure in their environments than their ESFJ counterparts may have enjoyed the consistency and rules of this
particular virtual gaming center. However with a larger dataset and longer playing times, comfort levels with the environment and subsequent greater voluntary play time may well see an increase for ESFP students. Gender may also lend a measurable difference in playing time according to the data collected in this experiment, and additional research with a larger group of subjects may reveal more of those differences even among similar personality types.

Myers and Myers (2010) indicate ESTP and ESFP personality types are adaptable and easy to work with, who also enjoy accumulating facts and spending time with others. In this study, ESFP students showed more time spent playing, while the five ESTP students showed a predilection toward earning fewer points per game. But, it should be noted the ESTP students only played two to seven games, so a larger sample size and subsequent larger dataset may affect future results of PPI. The main difference is perhaps likely due to differences in the Thinking versus Feeling scale. ESTP students tend to want to analyze data before making decisions. It is possible, with the competitive nature of quickly answering math problems in the game, ESTP players quickly became disenchanted as the game rewards players quickly picking out the right answer in order to earn maximum points.

A reasonable speculation is that more structured games may appeal more to ESFP students, too. The DimensionM environment is somewhat open-ended, allowing for broad user choice in actions. Users manipulate their avatars in order to run, look around, and propel objects at will. A more structured gaming system that perhaps limits the available actions more, such as an online card game, may be more preferable to ESFP students, and that certainly would be an interesting topic for future research.
A close call to statistical significance was observed with the average points per minute (PPM) model. It is unclear whether PPM is a significant metric when compared to the total points per intervention (PPI) earned. It is possible in some early games participants spent more time acclimating to the online environment, learning how best to control their avatars, exploring the boundaries of the environment, and figuring out the most efficient means to accumulate points. These early games played with fewer points earned may well have lowered the overall PPM below significant levels, but as students progressed in their knowledge and competency in the game, their overall point totals climbed higher. An experiment with subjects playing more, offering more data, may well bring observed PPM metrics into significance.

ISFJ personality types tend to over-examine test questions too, so it makes sense that they scored fewer PPI. The sensing types approach academic work at a slower pace as early as kindergartens. They also typically do not perform as well in arithmetic (Myers and Myers, 2010). With such a mathematical based educational video game as DimensionM, which encourages the quick solving of math problems through a point system that rewards players with accurately and quickly solving math problems, it seems a fair speculation that students with ISFJ personality types will perform poorly in the game. Conversely, other academic games not requiring math or hasty decisions may well see improvements in ISFJ performance.

Broader Implications

Students holding the 16 types of personalities measured by the MBTI will approach academics in different ways. For instance, intuitives who can quickly internalize words and their meanings will approach test taking and book reading in a typically more efficient manner than
their sensing opposites who naturally tend to distrust spoken and written words (Myers and Myers, 2010). Understanding the personality type of students preparing to engage in an educational video game would likely be of assistance in predicting student performance within the game, based upon the observations in this experiment.

Just as a teacher might expect students with certain personality types to perform better within one learning environment or another (group or individual work, discussion or individual inquiry and reading), so may the teacher expect students to engage better or worse in a video game based on its learning environment. Video games requiring group participation to be successful will likely be embraced by students who enjoy group work. Extraverts who enjoy interacting with people will likely enjoy interacting with people in a virtual video gaming environment just as they enjoy interacting with people in a real world classroom. Introverts who prefer studying alone, who enjoy books and other solitary pursuits, may likewise enjoy solitary educational video games requiring little interaction with other players.

Fact and details oriented sensing students may enjoy educational games that deal with facts and offer details to memorize, while their intuitive counterparts will likely enjoy games that offer opportunities to grasp big picture ideas, and do not dwell too heavily on rigid structures and routines. Thinking students may enjoy games in which they can establish group hierarchies, just as they tend to become leaders in a classroom group for the sake of efficiency, even at the potential cost of other group member’s feelings (Provost and Anchors, 1991). Feeling students may enjoy educational video games with open ended worlds offering exploration and less structured learning opportunities. Since they enjoy positive feedback (Myers and Myers, 2010), they may like games with reward systems offering built-in
encouragement toward accomplishing objectives. Likewise, perceiving students may enjoy open ended worlds in which learning may occur serendipitously. Since they love exploration and open ended assignments (Sakamoto and Woodruff, 1992), they may like an open ended virtual environment in which they can engage in the learning process at their own pace. Their judging counterparts may prefer the opposite: video gaming environments with clear cut rules and readily evident means to accumulate points.

Further Research

This experiment had a small sample size, and further research is needed to better observe the relationship between the MBTI and student performance in educational video games. Additional research is also needed in which different types of video games are used by the subjects. Closed environment, rigid rule games such as virtual card games may show an observed difference in player preference than those video games with more open-ended, large virtual worlds. Solitary games may make a difference for introverted players, versus team work games that may appeal to extroverted players. Games in which practice problems are woven into game play (such as DimensionM), may naturally be more beneficial toward those students who are good test takers, while games in which data may be analyzed at length without penalty may be better for those who are not. A greater understanding of the role gender plays in group interactions as well as video game preferences may also be of value to educators wishing to use educational video games in the classroom, as well as developers seeking to produce them. Additional research is needed with larger sample sizes and different video games to determine if the results observed in this research continue to hold true across larger data sets.
Conclusion

Provost (1993) indicates MBTI results may predict students’ preferred learning styles. Myers and Myers (2010) assert MBTI results may predict a person’s preferences for the processing of information. It stands to reason that MBTI results may predict students’ learning preferences within video games structured for one learning style or another. It is therefore incumbent upon educational video game designers to place elements of game play appealing to the different personality types within their gaming environments. Barring that, it is incumbent upon educators wishing to use these tools in the classroom to choose different games that do appeal to those different personality types, rather than relying on one game, or one type of game, as a generic solution for all.

This research indicates that determining a student’s MBTI may help predict their performance within an educational video game that aligns with or against the students’ learning preferences as indicated by their MBTI. Additional research is needed to determine if the results hold true across larger sample sizes and different types of video games, but these results are nonetheless not surprising since they are similar in nature to prior research in the field. Hopefully, this understanding will be of some assistance to educators, game developers, and future researchers.
Before agreeing to your child's participation in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

**Title of Study:** Predicting High School Student Achievement in a Mathematical Video Game

**Investigator:** John Rice, University of North Texas (UNT) Department of Computer Education and Cognitive Systems. **Supervising Investigator:** James Poirot.

**Purpose of the Study:** You are being asked to allow your child to participate in a research study which involves a mathematical video game and related survey questions and personality assessments. During the study we will ask students questions like how much time they spend on computers each week, how often they play computer games, and how much they like math. We will be asking students to fill out a personality profile and we will conduct a short pre- and post-test to see how much their math skills improved.

**Study Procedures:** Your child will be asked to participate in surveys and video game activities that will take about 30 minutes per week of your child's time. In addition, your child will be asked to take pre and post mathematics assessments and the Myers-Briggs Type Indicator personality assessment.

**Foreseeable Risks:** No foreseeable risks are involved in this study.

**Benefits to the Subjects or Others:** We expect the project to benefit your child by an increase in exposure to math based problems within an educational video game program. The program may provide benefit to other educators by offering insights into what personality types may or may not benefit from math based videogame interventions.

**Compensation for Participants:** None.

**Procedures for Maintaining Confidentiality of Research Records:** Your child will be assigned an anonymous number for the data collected in the project. The confidentiality of your child's individual information will be maintained in any publications or presentations regarding this study.
Questions about the Study: If you have any questions about the study, you may contact John Rice at jrice@iolaisd.net, 936-394-2361, ext. 227 or James Poirot at Jim.Poirot@unt.edu, 940-565-2824.
**Review for the Protection of Participants:** This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

**Research Participants’ Rights:** Your signature below indicates that you have read or have had read to you all of the above and that you confirm all of the following:

- John Rice has explained the study to you and answered all of your questions. You have been told the possible benefits and the potential risks and/or discomforts of the study.
- You understand that you do not have to allow your child to take part in this study, and your refusal to allow your child to participate or your decision to withdraw him/her from the study will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your child's participation at any time.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as the parent/guardian of a research participant and you voluntarily consent to your child’s participation in this study.
- You have been told you will receive a copy of this form.

________________________________________
Printed Name of Parent or Guardian

________________________________________
Signature of Parent or Guardian Date

**For the Student Investigator or Designee:** I certify that I have reviewed the contents of this form with the parent or guardian signing above. I have explained the possible benefits and the potential risks and/or discomforts of the study. It is my opinion that the parent or guardian understood the explanation.

________________________________________
Signature of Student Investigator Date

[Signature and date]

Office of Research Services
University of North Texas
Last Updated: July 11, 2011
Child Assent
Form

You are being asked to be part of a research project being done by the University of North Texas Department of Learning Technologies.

This study involves playing a mathematical video game, answering survey questions, and participating in a personality assessment.

You will be asked to answer survey questions and play the game regularly, that will take about 30 minutes per week.

If you decide to be part of this study, please remember you can stop participating any time you want to.

If you would like to be part of this study, please sign your name below.

______________________________
Printed Name of Child

______________________________ Date
Signature of Child

______________________________
Signature of Student Investigator Date

APPROVED BY THE UNT IRB
FROM 10/20/11  TO 10/19/12
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