Applying Malone's Motivational Theory and Flow to a Study of Whether Playing Educational Video Games Influences Motivation and Impacts Learning Outcomes in 5th Grade Mathematics

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CERTIFICATE OF APPROVAL

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Abstract

The purpose of this paper is to explore the possibility that using video games as an educational tool will impact student motivation and learning outcomes for mathematics in a 5th grade classroom. It uses relevant literature and qualitative research to investigate if educational video games provide challenge, fantasy, curiosity, and control as a means of influencing intrinsic motivation, using Malone's Motivational Theory as a theoretical framework. Additionally, it explores similarities between intrinsic motivation and the characteristics suggested for a game to achieve Flow. Flow is a theory based on the balance of player skill and level of challenge, and can be used as a means for measuring how fun a game is. Specifically, this study examines the gaming features available at the learning website Study Island and how they are implemented in a 5th grade elementary school classroom. By conducting semi-structured interviews with teachers who use the website regularly and using existing standardized test scores to evaluate learning outcomes, I compare the emerging themes from these discussions with the suggested results provided by previous literature on the subject. Based on these comparisons, I attempt to answer the following research question: *Does playing educational video games influence motivation and impact learning outcomes in 5th grade mathematics?*

List of Figures

Table of Contents

I. Introduction

Students today are using information technology more each year in both their personal and academic lives (U.S. Department of Education, 2010). This presents educators with an opportunity to reach an ever-growing population of students through a new and intriguing medium. This is especially true for elementary school students, as more of them are able to develop proficiency in information technology at a younger age (U.S. Department of Education, 2010). A study by the Kaiser Family Foundation found that, "a high proportion of very young children are using new digital media, including 50% of four-to six-year-olds who have played video games and 70% who have used computers" (Henry J. Kaiser Family Foundation, 2003, p. 12). One technology that has been used as a classroom tool more frequently in recent years is educational video games. Educational video games provide new opportunities for teachers to motivate their students. This is important because, "today's learners bring a different approach to education and have a strong need for engagement" (Watson et al., 2011, p. 466). It allows teachers to reach their students by taking advantage of the number one use of computers by young students (U.S. Department of Education, 2010).

It is assumed that video games are fun and entertaining, and that by incorporating them into a classroom setting, students will find the subject matter associated with those games to be fun and entertaining as well (Alessi & Trollip, 2001, p. 280). However, interviews with faculty indicate that games are often used as a means of reviewing a lesson, providing the student (and the teacher) with a way to fill time between lessons, or as a fun educational activity that can be enjoyed during recess. In any case, the game is rarely the focal point of instruction, though it is often complementary to classroom activities. This would seem to indicate that the only legitimate purpose of using games in a classroom is purely for entertainment. Yet if that were

the case, the games would not need to be tied to instructional material. Therefore, it should be assumed that these games carry some advantages or benefits that other classroom activities do not.

So what are these advantages? With time being as precious as it is in our nation's classrooms today, what benefits do these video games provide that make them worthy of such a precious resource? The most commonly held belief is that video games in the classroom are good motivators for students (Alessi & Trollip, 2001, p. 271). There is no doubt that educators need to find a way to motivate students to learn. Consequently, the primary issue that this study on educational video games will address is as follows: *Does playing educational video games influence motivation and impact learning outcomes in 5th grade mathematics?*

In order to answer this adequately, we must first define what motivation is and determine how it can be measured. This study will use Malone's Motivational Theory (Alessi & Trollip, 2001, p. 25) as a foundation to measure the different aspects of how video games may or may not motivate students to learn. More specifically, it will investigate whether games are able to provide intrinsic motivation, which Malone defined as having the following four primary components: challenge, fantasy, curiosity and control. Thus, the next question is: *To what degree do educational video games incorporate aspects of challenge, fantasy, curiosity, and control?*

In addition to having a possible affect on motivation, this paper will investigate whether there is a benefit in actual learning outcomes. These outcomes are usually measured through assessments such as standardized tests and regular report card grading. By examining the differences between grades of classes that use video games and those that do not, the following

question can be examined: *How much measurable impact do educational video games have on math learning outcomes, if any?*

In a study on video games, a definition of what components make up a video game is necessary. Since games are primarily considered fun activities, it is essential to utilize a framework that can break down how to calculate the fun factor of a game. This study will use a theory called Flow, which is based on the importance of matching a player's skill level with a challenge that is adequate, but not overwhelming. Since many of the characteristics associated with motivation also relate to Flow, this study will examine the following: *Does Flow in video games have an impact on motivation?*

Using Flow, I will be able to measure how much fun a game provides (Chen, 2006, p. 7). Malone's Motivational Theory will provide me with the tools necessary to analyze whether or not a game is intrinsically motivating students to learning the content associated with the video game. Once these characteristics have been determined, I will be able to investigate to what degree (if any), these characteristics impact a student's desire to learn and the outcomes that result. In this way, I will either highlight which components of educational video games contribute to motivation and how effective they are in doing so, or I will discuss why motivation has not been achieved and what improvements could be made to increase the effectiveness of these games. Thus the final questions are: *If educational video games influence motivation for learning, what effect do they have? If they do not, why is motivation not being affected?*

II. Literature Review

Malone's Motivational Theory

In determining whether or not playing video games impacts motivation for learning, we must first determine how to measure motivation. Malone's Motivation Theory suggests there are two types of motivation – intrinsic and extrinsic (Alessi & Trollip, 2001, p. 26). Extrinsic motivation comes from external sources, and are often some form of reward, whether it be monetary, recreational, or some other desirable experience. These are not directly related to the learning activity and consequently, they are not considered to be as useful as intrinsic motivators for promoting education. Some existing research even goes so far as to suggest that extrinsic motivators discourage learning since the reward becomes the focus rather than the educational goal, though this is controversial (Alessi & Trollip, 2001, p. 26).

In contrast, intrinsic motivation is more effective because it comes from personal satisfaction of the learning activity. The idea is to make the instruction "fun" and as a result, the learning becomes not only a requirement but also an enjoyable goal to strive for. Since intrinsic motivators "come from within the person" (Alessi & Trollip, 2001, p. 25), they must be highly individualized in order to be effective. Since intrinsic motivators are the most beneficial, this is what educators should strive to include the most of. Malone's Motivational Theory suggests that there are four primary characteristics included in intrinsic motivators: challenge, curiosity, control and fantasy (Alessi & Trollip, 2001, p. 25). While not all of these characteristics are necessary in order to provide intrinsic motivation, the more they are integrated into an activity, the more effective it becomes. "The more a program includes these four elements, the more successful learning is because people enjoy it more" (Alessi & Trollip, 2001, p. 25).

While challenge is arguably the most important of the elements associated with intrinsic motivation, it is also one of the most difficult to develop for. Adequate challenge is a critical component of motivation in education. If the challenge is too little, students will quickly get bored and become inattentive. If the challenge is too great, they will grow frustrated and give up on the activity. When planning for a diverse group of students, an educator must be able to vary the level of difficulty to accommodate various skill levels or risk losing the attention of certain students. Not only do different students have varying degrees of expertise, but their knowledge also changes as they learn. "Varying the difficulty of material as learner performance improves maintains challenge throughout the lesson" (Alessi & Trollip, 2001, p. 25).

Teachers should also take advantage of student's natural curiosity. There are two types of curiosity – sensory and cognitive. Cognitive curiosity occurs when information is introduced that conflicts or contradicts a student's current understanding of the given subject. This gap between what is understood and what is not prompts interest in the subject matter, and encourages students to delve deeper into the content to improve their knowledge. Sensory curiosity focuses on the student's visual and auditory cues. By introducing images and sounds that are attractive or unexpected, the teacher is able to stimulate the students' senses and draw their attention to the learning activity.

Learner control helps the student to make a claim of ownership in the learning activity and promotes participation. One way to do this is by presenting the learner with choices. Prompting the student for input "permit[s] the learner to determine sequence or lesson parameters, such as difficulty" (Alessi & Trollip, 2001, p. 25). Another aspect of learner control is feedback. It should be clear that the student's choices are having an impact, whether it be positive or negative, and that impact should be relayed back to the student in some form. This

allows the learner to make an informed decision based on previous experiences when they are presented with their next choice.

Fantasy is the final component suggested for increasing intrinsic motivation. This does not necessarily refer to a fictional setting, but rather allows the learner to imagine themselves in a setting other than the learning environment. "In any lesson, it may be valuable to encourage learners to envision themselves in a situation where they can really use the information they are learning" (Alessi & Trollip, 2001, p. 26). This can be accomplished purely through imagination, or can also be supported by visual aids, such as props or virtual worlds on a computer. The more believable (though not necessarily realistic) the fantasy, the more likely the learner is to connect the material to personal experience, which is the purpose of intrinsic motivation.

Defining Educational Video Games

There is a considerable amount of research that suggests that educational video games increase intrinsic motivation. However, before considering this, we must define what an educational video game is and what components it is comprised of. "Although people know a game when they see it, giving a concise definition is difficult" (Alessi & Trollip, 2001, p. 271). There are a number of different factors involved in a game. Goals and rules make up the foundation of a game, with the goal being what the player is trying to achieve and the rules defining restrictions, choices, penalties and so on. Almost all games involve some sort of competition. While this can refer to player versus player interactions, it can also incorporate player versus machine, player versus oneself, or player versus time, or some combination therein. "People play most games to be challenged" (Alessi & Trollip, 2001, p. 279). The

challenge in most games is consists of the obstacles (often defined by the rules or other players) that the player must overcome in order to reach their goal. Fantasy is also an important part of games, and can range from a near-realistic representation of events to pure fiction and fabrication. Games also provide a safe environment in which players can experiment with circumstances that may be too dangerous or expensive in reality. Finally, most games are entertaining in some way, even if this is not their primary function. While not all games contain all of these components, the more these characteristics are present, the more "game-like" the activity becomes.

Alessi and Trollip (2001) state that there are three phases to any game: the introduction, the body, and the conclusion. The purpose of the introduction is to set the stage for the game prior to play, the body is where the player will actually play the game, and the conclusion presents the results after the game is finished. The above-mentioned components of games are general and are presented in one or more of these phases through more specific game components. The introduction presents the player with directions that outline the goals and rules of the game, including constraints, and penalties for break these rules. It also may present the player with choices regarding how many players and the level of difficulty for this play-through.

The body places the player(s) into the game scenario. The scenario is the environment in which the game takes place and determines how realistic or fantastical the game will be. Once the scenario is established, the player assumes the role assigned to them and begins making choices on how to interact with the scenario based on the nature of competition. While some choices relate to game management (quitting, requesting assistance, and revisiting directions), most choices revolve around game strategy. "How the various choices are to be accomplished must be easy to learn and readily accessible" (Alessi & Trollip, 2001, p. 291). Players will need

to take into account their competition as part of their strategy. Competition depends on the type of game being played, and can have one or more players working individually or as a team. In either circumstance, players may be competing against others or against a calculated measure of some sort, such as a time limit or high score. In addition, there should be an acceptable balance of skill versus chance in the game. Too much luck will frustrate skilled players, while too much reliance on skill will not allow new players to compete with more experienced gamers. There should also be a certain degree of uncertainty present in order to stimulate challenge in the activity. "[F]or a game to be challenging the attainment of its goal must be uncertain" (Alessi & Trollip, 2001, p. 286). This can be accomplished by varying the difficulty level, hiding necessary information for success, and increasing the chance factor.

The conclusion of the game handles the results once play has finished. There is some form of acknowledgement for the player's result, whether they were successful or not. If there are rewards attached to victory or other achievements earned during play, such as a personal best score, they are distributed at this time. "Whenever possible, the reward should not become the end in itself; rather, it should be another factor that can be manipulated to create a good learning environment" (Alessi & Trollip, 2001, p. 295).

Having defined the parameters and components of what makes up a game, it is important to refine that definition for the purposes of this paper to clarify what an educational video game is. A video game, by extension of the previous discussion, is any game that is played using a computer or other technological device as the input and output equipment connecting the player to the game environment. Additionally, an educational video game, sometimes referred to as edutainment, is a video game that is somehow connected to educational material, either directly or indirectly.

Flow

While the previous discussion addresses the necessary characteristics used to define what a game is, there are industry frameworks available that help determine how fun or entertaining an experience it can provide. These frameworks focus on how developers can meet the needs of their consumers, but can also be used to analyze the different components of a game. One such industry framework is called Flow. Flow is based on the idea of creating an experience that is so natural and enjoyable that the person playing the game begins to lose track of the conscious fact that they are participating in an activity. They get so engrossed in the game they are playing that factors such as time and surroundings become secondary to the gaming experience. "During the Flow experience, we lose track of time and worries. Indeed, our level of focus maximizes our performance in and pleasurable feelings from the activity" (Chen, 2007, p. 31). As a result of the game becoming our primary focus, our attention and performance in that game increases significantly. Perhaps most significantly is the concept that Flow can be used to assess fun, an otherwise arbitrary and immeasurable concept. "At this point, fun can be defined as Flow, a balance of the relationship between challenge and ability" (Chen, 2006, p. 7).

There are eight major components of Flow. As with our definitions of motivation and games, not all components are required, however the more these characteristics are present, the stronger the effect is. These components are as follows:

1. A challenge activity that requires skills
2. The merging of action and awareness
3. Clear goals

4. Direct feedback
5. Concentration on the task at hand
6. The sense of control
7. The loss of self-consciousness
8. The transformation of time

Central to the theory of Flow is the balance between challenge and ability. An adequate balance must be found in order to maintain a player's focus and interest while playing (see Figure 1). If the challenge greatly exceeds the their skill level, players will become frustrated and give up. Conversely, if the player's ability is significantly greater than the challenge being presented, they will quickly become bored with the game and move on to another activity. "Fortunately, human beings have tolerance, there is a fuzzy safe zone where the activity is not too challenging or too boring, and psychic entropies like anxiety and boredom would not occur" (Chen, 2006, p. 5). This is known as the Flow Zone, an area where the game experience has just enough balance between challenge and ability to keep the player interested without causing so much anxiety that they become discouraged and disconnected.

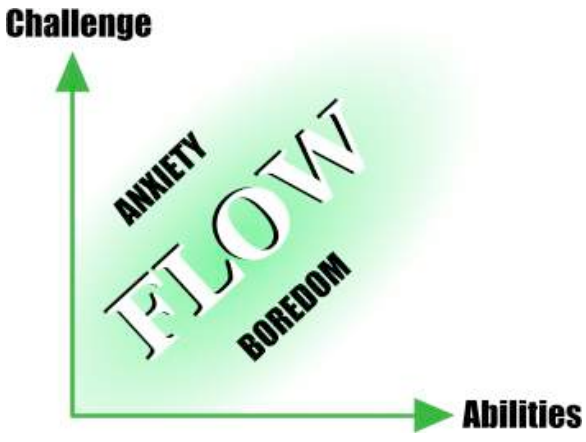

Figure 1: Flow as a balance of challenge and ability (Chen, 2006, p. 5)

One way to attempt to keep game players in the Flow Zone is to use a technique known as Dynamic Difficulty Adjustment (DDA). DDA is used to adjust the difficulty level of the game based on the player's performance up to that point. So if a player is struggling with a section of the game, the difficulty level is lowered to encourage them to persevere through that section. On the other hand, if a player is succeeding with ease, the difficulty level is raised to provide more of a challenge and keep that player engaged. This is not a one time decision – as the player proceeds through the game, the challenge will constantly need to be adjusted as the player is introduced to new areas, given new strategic choices, and encounter new obstacles (see figure 2).

One of the challenges in DDA and in managing Flow in general is the fact that different players have different Flow Zones. More experienced gamers, sometimes referred to as "hardcore" gamers, will have Flow Zones that require more challenge than their skill level might suggest. Likewise, novice players will likely require a Flow Zone that slowly introduces challenges so they can get used to available actions and techniques. "In order to design a game for broader audiences, the in-game experience can't be linear and static. Instead, it needs to offer a wide coverage of potential experiences to fit in different players' Flow Zones" (Chen, 2006, p. 9).

Many DDA systems are too focused on the balance between challenge and skill level and do not take into account the other components of Flow (Chen, 2006, p. 13). One solution to this is to incorporate player choice into DDA. Rather than deciding what the player's Flow Zone is, "the game needs to offer a pool with a wide spectrum of activities and difficulties for different types of players to swim inside. Based on players' tastes, each individual will choose different choices and work at a different pace to navigate through the game" (Chen, 2006, p. 13). This is

referred to as Active Flow Adjustment, since it is allowing the player to adjust their own experience to custom-fit their personal Flow Zone. It also meets the Flow condition for a sense of control, since the players are defining their own experience in the game. However, this can be taken too far, to the point where player choice produces negative Flow effects. "Too many choices overwhelm the user and maybe even the computer. When people can't decide what to choose, they are at a loss. Being required to make frequent choices could also be annoying, further interrupting gameplay" (Chen, 2007, p. 33). In order for Active Flow Adjustment to be effective, other components of Flow must also be incorporated, such as clearly defined goals and direct feedback based on the player's choices. The merging of these components creates an experience that is both effective and individualized, and as a result the game can provide enjoyment to a broader audience.

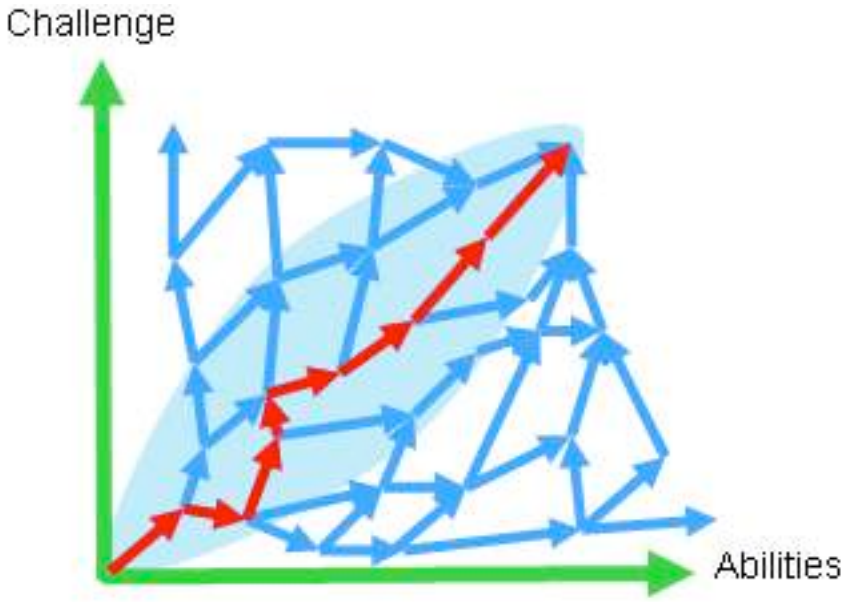

Figure 2: Multiple choices allow Active Flow Adjustment (Chen, 2006, p. 13)

Using Flow in Games to Analyze Motivation

So far this paper has discussed what components are used to make up a game, how Flow can be used to make that game interesting and fun. Additionally, it has suggested the importance of including intrinsic motivation in learning activities. Existing research has suggested that video games provide opportunities for influencing motivation. During a study on cognitive-affective transitions during game play, Rodrigo (2011) stated, "recent research has shown that, among grade school students learning geography, games increase intrinsic motivation, decrease extrinsic motivation, and increase achievement" (p. 86). I will now attempt to look at how educational video games impact different aspects of motivation in learning, and investigate if Flow may be associated and implemented in these games. By showing similarities between Flow, motivation and game definition, I hope to demonstrate that Flow can be used as an effective measure for determining how motivating an educational video game may be.

The first thing usually presented in a game that will help develop motivation is the goal. Goals are the desired outcome of the play experience, and are what the player should be striving to achieve. Flow theory suggests that goals need to be clearly defined and obtainable. "If the player doesn't see a clear winning condition, or feels like they can't possibly win, the game is suddenly a lot less interesting" (Hunicke, LeBlanc, & Zubek, 2004, p. 3). Goals are closely tied to the intrinsic versus extrinsic motivation debate. Extrinsic motivators provide a goal that is separate from the learning experience. This separates what the student is striving for from what the activity is teaching them. Games can act as intrinsic motivators by aligning the educational objective with the game goal. The enjoyment attributed with achieving a game goal encourages students to spend more time with the material that is connected to that game. "To the extent that we are successful in pairing instructional content with appropriate game features, this cycle

results in recurring and self-motivated game play" (Barendregt & Bekker, 2011, p. 81). Gaming objectives that closely relate to the content of the information being presented will encourage intrinsic motivation, which will in turn support success both in learning and in the game. Thus, video games are able to produce positive cycles that can cause significant increases in student understanding.

In contrast, gaming and learning goals that are not closely related can have negative effects on the learner. Charsky & Ressler (2011) studied the effectiveness of using concept maps with educational video games. They noted that, "When the game activity and the learning activity are congruent and mutually supportive, learning improves; conversely, when the game activity and the learning activity are mutually exclusive, learning tends not to improve, even though the learner tends to perform well in the game" (p. 604). It is for this reason that care must be taken when designing a curriculum that incorporates educational video games. Nelson, Erlandson, & Denham (2011) stated in their study on global evidence channels in online role-playing games that, "If virtual game environments are going to find a place within formal educational settings, researchers need to pay careful attention to the affordances, weaknesses and design of such environments for learning and assessment" (p. 89).

The next phase of a game is presenting the rules of play. There are often limitations or obstacles established that represent what lies between the player and their goal. These inhibitions are the challenges presented to the player, and are arguably the most important part of what makes a game interesting and fun. In studying the strategic decisions children make while playing video games, Hamlen (2011) noted that, "children reported the challenge or thinking required for the game to be the primary reason they like playing the games they play… This contradicts common assumptions that children are being cognitively lazy when playing video

games" (p. 538). Unfortunately creating an adequate challenge is probably the most difficult task that game developers are faced with. Boehmer's (2011) study on brain training with video games revealed that, "as the tasks become more difficult, some students see their success slow down, and their motivation falls off" (p. 30). Ideally an educational game presents a near perfect balance of challenge and skill level, also known as the Flow Zone. This keeps players engaged without causing frustration or boredom. The problem is that different players rarely have the same skill levels, and the game must find a way to adjust accordingly. This same issue is critical to learning activities trying to motivate students. "The most important principle is that the level of challenge should be individualized for and adjusted to the learner. A lesson should not be too easy, but also not too difficult" (Alessi & Trollip, 2001, p. 25). Flow theory suggests that Dynamic Difficulty Adjustment be used, so that each game is custom-tailored to provide adequate challenge, and by extension motivation, to the player/learner. This unique ability to adjust how content is presented provides the necessary balance of challenge and skill to maintain the student's attention.

Active Flow Adjustment is an example of a Dynamic Difficulty Adjustment system that is designed around presenting the player with strategic choices. These choices allow the player to select their own path through the game, and may even allow them to determine what level of challenge they experience. This puts the player in control of their experience, which is another key component of developing intrinsic motivation in learning. While studying the effects of free choice on the effectiveness of educational video games, Barendregt & Bekker (2011) found that, "computer games can motivate children for learning through their motivational power, and they offer a powerful learning tool by providing interactivity and the possibility to 'learn by doing'" (p. 80). These choices made available in games allow students to become more involved in the

learning process. This encourages active participation by students rather than solely relying on the passive absorption of knowledge and information. Feedback is a necessary component of enabling students to make informed decisions in educational games. Players need to know what options are available to them, what progress they have made towards their goals, and effects occurred as a result of previous decisions. Penalties resulting from rule violations or incorrect decisions discourage the user from making further mistakes. Rewards and progress suggest that the player is making progress, both in the game and in learning the educational objectives if they are connected.

When deciding what choices to select, students need to find the necessary resources to succeed at the game, and often times they turn to each other to discuss strategy or to find a worthy opponent. The format of multiplayer video games naturally to interact with each other and work together to achieve common goals. Lindstrom, Gulz, Haake, & Sjoden (2011) studied the difference between pedagogical goals of a game and the actual practice that occurred in the learning environment. They observed that students, "talked to each other about what they were doing, discussed choices and gave advice to each other…" (p. 100). Cooperative teamwork especially has its educational advantages. While researching the effects of single-player versus multiplayer games, Harteveld & Bekebrede (2011) noted that, "multiplayer games contain more socially oriented goals. In these games, the goal is to cooperate to achieve something or to beat the other players…" (p. 50). Individual interactions within teams often create educational opportunities where students can learn from each other and not just from teachers or parents (Hamlen, 2011, p. 533). This type of learning is beneficial since it often occurs organically, and thus is more likely to connect with a student intrinsically. In addition to cooperative experiences, competition can also be a motivating factor in games. Even if a game does not have competition

as a part of its design, players will often create competition by issuing challenges to other students to achieve certain objectives or scores. This encourages students to spend more time developing stronger strategies and reviewing the choices that they are making, with the intended purpose of improving their success in the game and by extension the learning activity.

Goals, challenges, and choices are frequently wrapped in some sort of scenario. While the scenario doesn't always have a direct connection to gameplay mechanics, it creates the atmosphere and environment in which the game takes place, and often adds meaning or purpose to the goal. These scenarios often address the final two components of intrinsic motivation, fantasy and curiosity. Fantasy is the imaginary context in which learners find themselves. These environments provide students with a purpose for completing their tasks that would otherwise be missing or less impactful. "When comparing the motivation of students who learned in the game-based learning environment to those who learned in a traditional school environment, they found that students demonstrated statistically higher levels of intrinsic motivation in the game-based environment" (Vos, Van der Meijden, & Denessen, 2011, p. 128). In terms of Flow, this fantastical setting helps to draw the player into the game experience. Unlike many board or card games where the player is aware that they are participating in a game, video games are able to present environments that permit the player to forget their current reality. This is a critical component of Flow, as these worlds can mimic reality or be purely fictional, but if designed correctly allow players who are fully engrossed in the game experience to achieve a heightened sense of focus and concentration, increasing the efficiency of the task. Video games encourage more intrinsic learning by incorporating the material in a fun and interactive activity.

Fantasy scenarios also inspire curiosity from the one playing the game. This is especially true of sensory curiosity, which consists of unexpected or attractive visual and auditory cues.

Sounds can be used to confirm actions or responses that occur during gameplay. This draws the player's attention and indicates that something significant has occurred or needs to be addressed. Visual cues work in the same way, often using bright or contrasting colors, or other visual effects such as flashing or blinking objects to draw the player's attention to a specific section of the screen. Visuals and sounds can also be used to enhance the fantasy element of the scenario by providing ambient background music and backdrops on which the game's events take place.

Cognitive curiosity can also be presented as part of the scenario, as well as the challenges associated with the game. Including uncertainty as a part of the game can also increase cognitive curiosity. Uncertainty can be generated by introducing luck or randomness as part of the game, using variable levels of difficulty, or presenting incomplete information (Alessi & Trollip, 2001, p. 286). All of these game elements can be used to raise situations that challenge the learner's previous understanding of an event or situation. When the student becomes unsure of what has been presented to them, it implicitly encourages them to seek more information on the subject in order to resolve those differences. Davis (2011) suggested that games and simulations might help develop more innovation in students, stating that, "our students need to think creatively to solve problems and this can only occur in active learning environments which could be created by utilizing games and simulations" (p. 7). By challenging student's expectations, games encourage students to experiment and explore in ways they may not consider otherwise.

Implementation of educational video games has a significant impact on how effective they are at motivating students. While the game itself may produce intrinsic motivation if it successfully achieves Flow, it can take time to reach that goal. Video games are a teaching tool like any other technique or activity an educator might use, and as such it requires a certain amount of time and planning to be effective. There should be an explicit purpose to including

educational video games as part of classroom activity, and adequate time must be provided for those purposes to be accomplished. Video games often do not produce desired motivational increases quickly. "A significant amount of time is invariably spent reading directions, taking turns, obeying rules, and generally attending to the scenario of a game" (Alessi & Trollip, 2001, p. 297). However, this should not discourage the use of games in the classroom. Instead, educators need to plan enough game time for students to become engrossed in the experience and reach a level of Flow that will in turn lead to intrinsic motivation. This is perhaps the most critical component since, "entertaining game aspects are motivating, but they must be supported with carefully selected tasks, teacher guidance and monitoring, and assessment of the learning outcomes" (Charsky & Ressler, 2011, p. 605).

"Digital games often contain multiple motivational factors – such as fantasy, interaction, conflict, and challenge – which should be helpful to motivate people to learn" (Liao, Chen, Cheng, Chen, & Chan, 2011, p. 78). These games present learners with goals to achieve and challenges that should be balanced against their skill level. By finding this balance, students are able to experience Flow, which enhances their concentration and motivates them to explore the fantasy and curiosity presented in the game scenario. The previously covered studies suggest that achieving Flow through successfully designed educational video game elements may contribute to intrinsic motivation for learning in 5th grade mathematics, which will be the primary focus of this study.

III. Methods and Methodology

Population Selection

For this study on how educational video games influence motivation for learning, I conducted a qualitative analysis based on two individual interviews conducted with current teachers who use video games from an educational website called Study Island website in their classroom. The intent of these discussions was to focus on motivation and learning outcomes in the classroom, specifically regarding lessons that include the Study Island video games. Merriam (2009) describes this use of interpretive qualitative research as, "… understanding the meaning a phenomenon has for those involved" (p. 22). Constructionism is a key component of this idea, since those being studied are creating their own meaning for the events that occur in their environment. Thus the information derived does not portray the topic directly, in this case the perceived impact of these games on motivation and learning outcomes, but rather it is the perception of that topic through the eyes of the study's participants, namely the teachers. With this in mind, it is important that appropriate sources were selected. This included interviewing key stakeholders and comparing their statements with reputable literature resources.

It is for this reason that two specific 5th grade classroom were selected as the primary source of participants for this study. I chose a school with which I have significant contacts that will allowed me to have direct access to a classroom that has already implemented Study Island, as well as the assessments connected to the lessons taught using this resource. This school is located in upstate NY, which makes it convenient for me to visit for face-to-face interview sessions.

I selected two specific teachers as my sources for information on Study Island. The first has a history of working with the website, having participated in the initial launch of using the program in her building. In addition, she is an experienced teacher who is an expert on the material that needs to be covered at that grade level, and was invaluable as a resource for demonstrating how the games in Study Island are incorporated into the curriculum. Likewise, she was able to provide insight on the typical day-to-day challenges of operating a 5th grade classroom, and how the use of Study Island impacts those obstacles, either in a negative or positive manner. The other teacher is the primary mathematics instructor for the grade level. She was able to provide critical comparisons between the techniques used in the video games and the techniques she uses in more traditional lessons.

Both of these teachers work with 5th grade students, who in many ways represent an ideal age group. They are still young enough to be part of the elementary school system, thus falling into the target audience for the Study Island software. Moreover, they are old enough that they have developed their own experiences and feelings, and are more likely to communicate these events with their instructors. As a result, the teacher should be able to provide some degree of insight into their students' unique perspective of the games, in addition to a general overview of how the curriculum incorporates Study Island and the outcomes that result.

Data Collection

Two individual interviews were conducted in December 2011. Both interviews were semi-structured discussions on how educational video games are used during math instruction. Prior to my interviews, I asked both teachers to have an informal discussion with their students

regarding Study Island to gauge their interest in the games provided by identifying some of their favorites and generally inquiring whether or not they used these games outside of the classroom. This was done to help provide me with some insight into the student perspective vicariously through the teacher.

I then focused primarily on teacher-directed questions (Appendix B). The first few questions asked focused primarily on how they integrate video games into a normal week. I also asked if what changes they had noticed in learning outcomes as a result of using video games over the past year and a half. Both teachers were part of the recent transition to include Study Island, and as such would have insights into how lessons have changed and whether student performance has been affected as a result. Discussion focused on the perceived and expected benefits of using these games, and how those benefits related to meeting learning goals. Likewise, we discussed their history with using the same games in previous year's classes, with the hope of getting a perspective on how the students' use of these video games changes over the course of the year.

Questions then began to focus on the different components of Malone's Motivational Theory, including challenge, fantasy, curiosity and control. They were asked to discuss their experience regarding student response to challenge in lessons, and how well the games meet a wide variety of skill levels. Additionally, they were asked about how much control a student has over their learning experience within the game and whether it is adequate to meet the student's needs. We also discussed to what degree students become engaged in the game, and whether video games lead to classroom distractions.

All interviews took place in the elementary school building where the teachers work during their break periods. As discussed above, I used a set of leading questions in all interviews to help direct the discussion, but allowed the discourse to deviate if it was moving in an interesting or relevant direction. Both interviews were video recorded to capture as much detail as possible so a full analysis could be conducted at a later time and place closely following the observation. Ensuring the safety of all participants is of primary importance to this study, and as such the inclusion of video recording required specific and careful handling. All video files were used only as visual notes for extracting relevant quotes and discussions, with none of the actual footage being included in the results of the study to preserve anonymity. Access to these files was strictly limited, with the video being stored only on my personal computer during analysis. Once the study was completed, all existing copies of the video were destroyed or deleted. In addition, all participants were be asked to sign a participant consent form (Appendix A) prior to the interview, which explained the purpose of the study, what their role was, and that their participation was completely voluntary.

In addition to these discussions, I was able to access a history of the New York State standardized test grades for 5th grade math in this building. The purpose of these tests is to determine if a student is on track to achieve proficiency for future college-ready exams, such as the New York State regents (New York State Education Department, 2011a). I was able to use this information to observe any significant changes in standardized math test scores and whether or not those changes suggest an improvement in math learning outcomes as a result of using video games on a regular basis.

I was also provided with class report card grades for the third and fourth quarters of the two previous year; one before Study Island started being used and the first year it was

implemented. This allowed me to perform direct comparisons of class grade averages in mathematics from before and after the video games became a regular activity in the class. These grades provided insight as to what practical and measurable changes may have resulted from the inclusion of video games as an educational tool.

In order to develop an understanding of how the games functioned, I spent a considerable amount of time experimenting with the games themselves. I tried a variety of different games available on Study Island, and as I played the games, I took notes relating to the characteristics of Flow and Malone's Motivational Theory. This mostly consisted of testing different options regarding difficulty level selection and how it affected how the game functioned. In addition, questions were intentionally answered correctly and incorrectly to see what impact it had on difficulty level (ie. did lots of missed questions cause the game to get easier, etc).

Data Analysis

When the data collection process was completed, the cumulative dataset was analyzed by searching for repetitive patterns among the different sources. "Findings *are* these recurring patterns or themes supported by the data from which they were derived. The overall interpretation will be the researcher's understanding of the participants' understanding of the phenomenon of interest" (Merriam, 2009, p. 23). Initial patterns were found by first individually coding the literature and transcripts acquired during data collection. Once the coding process was complete, the information was analyzed using open coding; that is organizing the coded data into loosely related categories. Once open coding was complete, analytical coding was used to

narrow down these results even further by focusing on "coding that comes from interpretation and reflection on meaning" (Merriam, 2009, p. 180).

Since most computer software available to aid in coding was either too expensive or did not provide necessary features, all coding took place manually using spreadsheet software. Relevant data points were recorded into the first cell of a row, with the corresponding cells in adjacent columns used to assign categories to that data. These categories could then easily be sorted and adjusted as the process was refined.

Specific techniques were applied in order to ensure the validity of the findings of this study. Member checks were performed with the teachers to ensure that the information collected during the interviews was correct, and to ensure that the conclusions being made fit with what was discussed. Likewise, triangulation using multiple sources of data ensured that the data collected was accurately represented. Additionally, the strategy of reflexivity was applied, as I performed self-evaluations during the study and openly included any personal feelings or bias that arose, including my assumptions of what the results of the study would produce. Finally, I was constantly in contact with my faculty advisor to discuss the direction and results of my findings. I also submitted the finished product to a multiple faculty reviewers to ensure that the techniques I used and results I derived were the result of accurate and professional study.

IV. Anticipations and Limitations

Anticipated Findings

Based upon existing research and my existing knowledge of educational video games, I expected to find that while Study Island as a whole plays an important role in the curriculum, the games contained therein are mostly an afterthought and not a critical part of the learning experience. Despite this, I did expect that the games were considered enjoyable and motivating for the students, especially early in the academic year when it is still new and exciting. However, I do expect student interest, and thus the motivational and educational effectiveness, to wane as the games will likely not encourage them to continue to play, nor will it maintain their attention over the duration of the year. I suspect these games are used primarily as a rewards system for good behavior and participation, or perhaps as a complimentary activity to introduce a topic or reinforce material that has already been covered. Students will enjoy games at first, but then get bored with them due to repetitive nature and lack of challenge. Since the game itself does not intrinsically encourage the student to play, either by adjusting the difficulty setting or by containing content that is relevant to the student, the value of the reward will diminish over time, and other rewards and activities will become more important to the student.

Another assumption is that these games will either contain no multiplayer options, or only a competitive multiplayer system. Either situation will probably result in students creating their own competitive activity by sharing results, resulting good early results. Unfortunately, the gap between stronger and weaker students will likely contribute to weaker students spending less time engaged in the games since they will have lower scores than their peers. This is the opposite of the desired effect, which would be to encourage the weaker students to spend more

time with the educational game. While there may be some situations in which one student may encourage or aid another, I expect most student-to-student interaction to revolve around score comparisons.

Overall I expect that even these temporary advantages will prove worthwhile in the classroom, especially early in the school year when information is being reviewed and new relationships are still being formed. However, I believe the value of these games will decrease over the course of the school year as students become disinterested in replaying the same games over and over, and weaker students become frustrated with their lack of progress.

I do believe that teachers will see the benefits of having their students playing these games by providing a fun way for them to study. I am even more certain that they will note weaknesses associated with the current setup, and will have numerous suggestions for how Study Island's games could be improved to make them more interesting and effective throughout the entire year.

Limitations

There are a number of limitations that need to be considered while reviewing this study. One of the primary limitations was the time and scope of the project, as there were only a few months available to work on this task. This included coming up with a topic, reviewing relevant research to develop a proposal, defending the proposal, finding interview participants, gaining approval from the Institutional Review Board, conducting the interviews, and analyzing the results. Getting permission from the Institutional Review Board took considerably longer than

anticipated, and as such greatly limited the remaining amount of time available to gather and analyze information from teachers who already had busy schedules.

In addition, the study was greatly limited in the number of participants compared to what was originally proposed. There were some concerns about incorporating student observation and interviews into the study, and thus this study focused only on a small number of key teachers who were available and regularly using games in their classrooms. So while the primary users of these games were students, their perspective had to be interpreted through their teacher's perspective.

Additionally, there were a number of factors involved that limit the generalizability of the findings of this study. In particular, a low number of participants were involved, and they were all working in the same building and school district. Due to these geographic restrictions, all teachers and students had a similar socio-economic and cultural background. This highly bounded situation limits how broadly these results can be applied at the state or national level. A more comprehensive study would need to take place with a much larger demographic range of both students and teachers across multiple school districts in order to accurately generalize these findings to the larger 5th grade math population.

Another significant limitation was the lack of historical information with implementing video games in the classroom. The district had only begun using these games on a regular basis a year prior to the study, and as such was still adjusting to how these new resources could best be used. As a result, there was only minimal data available to gauge how effective the program was thus far, and what information was collected could be the result of how a particular class interacts with the video games rather than giving an accurate portrayal of the average student.

This lack of history also limited how much quantitative information could be collected. While there was a wealth of information available representing math assessment prior to the use of video games, there was only a year's worth of data to compare it to, which again could be skewed based on how well that particular class of students performed.

V. Findings and Results

Walkthrough of Study Island

Both of the teachers I interviewed for this study use an educational website called Study Island. This website has a number of different components including practice tests, worksheets, and video games. When a student first enters, they are prompted to select a lesson to study and how many questions they would like to have included in this session. They are then able to select which of the available components they would like to use to interact with the lesson material. Selecting the game option will bring up a list of about 40 different games that are categorized as being beginner, intermediate, or challenging (see Figure 3). There are no limitations as to which games are available; the student has to the choice to select from games at any level. Depending on the game, students are sometimes also asked to select a difficulty setting ranging from 1 to 10, with 1 being the easiest and 10 being the hardest.

Figure 3: Game selection screen on Study Island

All games follow the same basic formula once they are started. The student is presented with a math question based on the topic selected and has four multiple-choice answers to choose from. Once the student selects an answer, they are given feedback as to whether or not it was correct, with incorrect answers requiring the student to try again. Penalties for incorrect answers vary by game, sometimes penalizing the student by giving them less attempts to complete a task, but most often it skips that turn and moves on to the next question. If a question is answered correctly, then it allows the student to begin the play part of the game, where the student will actually interact with the game they selected and earn a score based on how they perform. Once the time limit or number of attempts has passed for that section of the game, the next question is presented. This cycle continues until the student has finished the indicated number of questions.

Once the game is finished, students are presented with a summary screen that outlines their progress (see figure 4). This screen displays the number of questions attempted, the percentage correct, and the score earned. It should be noted that there is no direct correlation between the score and the percentage of questions answered correctly. If their score is high enough, they are also placed on the school high score list, although all names on the list are blocked on at this particular district. Each high score list is per lesson, per game, so a high score in a game on one lesson will not exist on the high score list for the next lesson. Students are then able to play the game again or return to the main screen. Once a student has correctly answered 70% of the questions, they earn a blue ribbon for that topic and are considered to have successfully passed that lesson.

Figure 4: Final score and leaderboard summary screen

There is a large variety of available settings and styles for each game. All of the games are simple, Flash-based interactions that have short bursts of play time ranging from about 30 seconds to 2 minutes in length. Most games require the student use the mouse or keyboard to perform a carefully timed action or as a quick response to an on-screen event in order to succeed. Some examples include using the mouse to aim an arrow in an archery game (see figure 5), use the mouse to aim a spaceship gun to shoot down enemy ships, or shoot a hockey puck past a moving goalie.

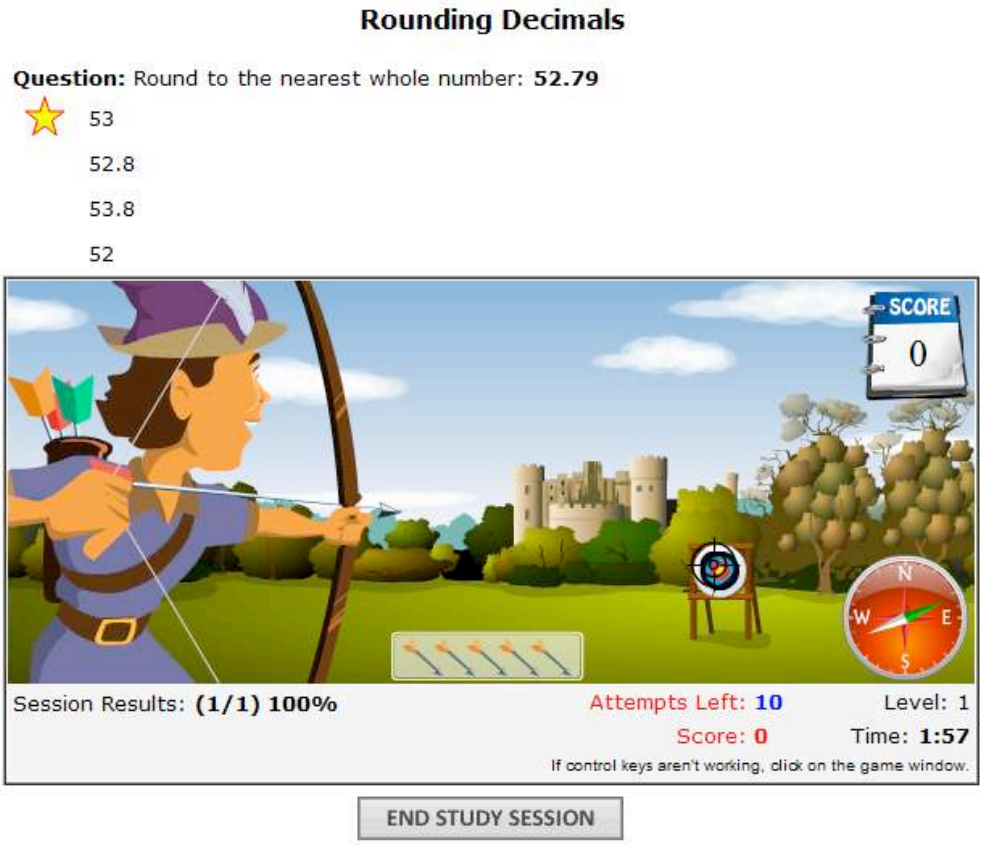

Figure 5: Archery gameplay example

All of the included games use animation, bright colors, and sound effects to create a fun atmosphere while the student is playing. In addition, each of the multiple-choice options is somehow integrated into the game setting (see Figure 6). In some instances, the options are actually integrated into the gameplay, such as the maze game that hides each answer in a different part of the maze, or the spaceship game that assigns each answer to an enemy and has the student shoot down the correct answer.

Figure 6: Question presentation in archery game

Video Games as a Review Tool

To get a better perspective of how the game is actually used in the classroom and how much impact it has, I interviewed two experienced teachers who have been using Study Island for over a year. Both teachers indicated that these games are used primarily as a review tool for the lessons that they have already covered. One teacher noted:

> I mainly use it as review. Like right now we're doing adding and subtracting decimals. So there are adding and subtracting decimals questions they can use in Study Island. So

we did it in class and then used Study Island as a reinforcement (Participant 1, personal communication, December 7, 2011).

Students are allowed to play the games during recess and during a rotating center time. Center time allows for approximately 45 minutes of play time, with Participant 1 indicating that students have at least one day a week to play and Participant 2 indicating that it is an option every day. It was also noted that in the inclusion classroom, students with special needs spent significantly less time on Study Island, as they are frequently pulled out of regular classroom activity for services. While some students in both classrooms indicated that they do take advantage of having access to Study Island at home, they only use it once in awhile. One teacher speculated that this was due to computer time restrictions, and that they would rather use their limited time playing a different game then those on Study Island.

Game Variety Encourages Engagement

Students in both classrooms indicated to their teachers that they thoroughly enjoy the different games that are available on Study Island. Participant B in particular noted how excited the students got over the large variety of games available. One of the benefits of this was that it allowed students to be able to choose a game that they found interesting. She noticed that many students in her classroom tended to favor games that were related to other activities they enjoyed since they could draw a connection between their experience with a particular sport or activity and the game they were playing. In both situations, students showed great interest in the opportunity to play a video game during school.

In fact, both teachers indicated that one of the few issues they experience as a result of using video games in their classroom is that students get so into the game that they often get overly excited. "They are so into it that they are loud and they don't realize how loud they are" (Participant 2, personal communication, December 7, 2011). While neither teacher expressed any issues with getting students to transition back into classroom activities, they both mentioned incidents where their involvement in the game caused them to forget that they were in a classroom where other students were working quietly. Sometimes students clicked overly loud on the keyboards while playing, but many times it was just an expression of excitement over their achievement. "They are so excited about what they are doing that they want to tell the other person what they did. Like they did so well on this game, 'Oh look at the score I got!' Its that kind of a thing" (Participant 2, personal communication, December 7, 2011).

Disconnect Between Game Goals and Educational Material

Another commonality was that both teachers noticed a lack of connection between the games and the content. "The games aren't really math related. Like one of them is shooting a bow and arrow into a target. And when you look at that its nothing related to math, but I think the games allow the kids to want to go on and to actually want to do the questions and get the right answer" (Participant 1, personal communication, December 7, 2011). In an attempt to present as many game options as possible, Study Island has taken a generic approach by separating the academic questions from the game challenges. The problem with this is that only part of the time is being spent interacting with the math content, while the other part of the game is pure entertainment, "whereas with math games with dice [or other in-class number-based

games], they are usually constantly thinking about numbers or place value or things like that, but it does intrigue them to go on the computers so it's a motivator for them" (personal communication, December 7, 2011). This suggests that the Study Island games tend to cover less material in the same amount of time spent doing other academic activities. However, this is an acceptable tradeoff since students are more engaged in the material then they would be with other experiences.

Despite these shortcomings, both teachers still felt that the students were benefiting from the extra time being spent with the material. When asked if the games allow students to develop a better understanding of the material, Participant 2 replied:

> I think they do have a better grasp of the content, I think it gives the content in a different form. I've already taught it in the way I can teach it, and I think it gives it to them in a different form. And if they're able to produce it in a manner that I want them to produce it, and then they're also able to present it in a different manner, that definitely shows a better understanding of the content (personal communication, December 7, 2011).

She went on to emphasize that the games are more interesting and engaging then the worksheets that could be used as a replacement for the games, which still providing the same effect.

Limited Difficulty Adjustment

One way in which the video games are more beneficial then a paper worksheet is their ability to be dynamic in nature. While Study Island doesn't provide a lot of automatic adjustment, it does provide a modified program for students who are struggling. "They weren't

doing well on the regular program so the computer automatically modified it for them" (Participant 1, personal communication, December 7, 2011). Participant 2 agreed, stating that, "If they didn't do well, it drops them down a level" (personal communication, December 7, 2011). When a student struggles with a particular topic, the game will enter modified mode, which provides easier questions. It remains at this difficulty level until they are able to exhibit enough proficiency to earn a blue ribbon (70% accuracy) at which point it goes back to the normal mode where they can try again at the higher difficulty. One of the teachers noted that this was one of the primary reasons that Study Island was implemented. While this modified mode does exist for struggling students, there is not automatic adjustment towards a more challenging difficulty if students are succeeding.

In addition to these automatic adjustments, students have some degree of manual control over how challenging the game is, though not the difficulty of the math questions asked. Neither teacher was certain to what extent this feature gets used, with one of them noting, "To be honest, I don't even know if they know about the difficulty levels of the games" (Participant 1, personal communication, December 7, 2011). Perhaps more telling was the fact that both teachers agreed that if students were aware of the difficulty setting, they would attempt to use it to increase their changes of getting a higher score rather than establishing a more challenging scenario. "I could see a kid choosing beginner to get a better score, because if they are really good at it, they might want to do beginner or intermediate so they could get a higher score, where advanced might be more challenging for them" (Participant 1, personal communication, December 7, 2011). Participant 2 agreed by stating, "They would pick something easier to score a higher score. They wouldn't go in and challenge themselves" (personal communication, December 7, 2011).

Prominence of Scoring System

Adjusting the settings to increase the odds of a higher score shows just how important score is to the student. This was perhaps the most emphasized point made by the interviewees, that while students found other factors of the games to be enjoyable and entertaining, they were always primarily concerned with improving their scores and sharing their successes with others. "Score, placement, that's what they are most interested in is their score. They are driven by what they do on their video games at home, and that's by score" (Participant 2, personal communication, December 7, 2011). This sometimes creates competition with students challenging each other to get a better score, but oftentimes there was just as much excitement about earning a personal best. Both teachers were certain that earning a high score was likely the most significant motivational component of the games on Study Island.

It is important to note that the score is tied to game performance, and for most games is not directly related to academic achievement. While answering questions correctly may give more time or more attempts during the game, it is not necessarily a one-to-one correlation. As a result, students are not necessarily able to draw comparisons between their score and their knowledge of math. This is significant in that students are not able to recognize why they earned a better score; they simply know that they performed better or worse. Additionally, they are primarily focused on improving their previous scores, rather than trying to accomplish a specific level of achievement. Participant 2 in particular noted that her students are usually too focused on improving their own score to notice how it compares to any kind of standard or preset goal (personal communication, December 7, 2011). In this sense, the score is overriding other forms of feedback, such as the blue ribbon awarded when a student demonstrates a certain level of academic success.

In addition, the way feedback is provided to the students can be confusing, as similar terminology is often used to exemplify different achievements. For example, as students play the archery game, they are awarded a score based on where their arrows land on the target. When the game is finished, they are presented with two numbers: their archery score and their session results based on the questions asked. However, if a student earns a high enough session result, they earn a blue ribbon which displays that result, but lists it as their score (see Figure 7).

Figure 7: Blue ribbon achievement for passing a subject

Lack of Impact on Assessments

Both teachers were confident that the inclusion of games was beneficial to their students. They believed that the intriguing and fun presentation of the material provided students with

another way to experience the mathematical topics being taught during lesson time as a means of reinforcement. They were less certain, however, about whether there was a measurable impact on student grades. Participant 2 was sure that she had seen no measurable impact to date on student grades since Study Island was implemented a year and a half earlier. Her counterpart felt that it wasn't something that could be accurately judged at this point due to how new the program was. "There could be [an impact on student grades as a result of Study Island], but I can't really make a correlation between the two of them because we just started using it last year. I can't really say that because of Study Island, they have higher test scores" (Participant 1, personal communication, December 7, 2011).

Both participants were kind enough to provide class math averages for the 3rd and 4th quarters of the previous two years (see Figure 8). By comparing the grades from the year prior to using Study Island and the first year of implementation, any noticeable changes should be apparent. While this dataset is not comprehensive enough to perform legitimate statistical analysis due to a small sample size and lack of longevity, it still can be used to give a general idea of any difference in assessment. In this case, there was no significant change in grades from the years prior to Study Island and the first year it was used. This seems to support the teachers' claims.

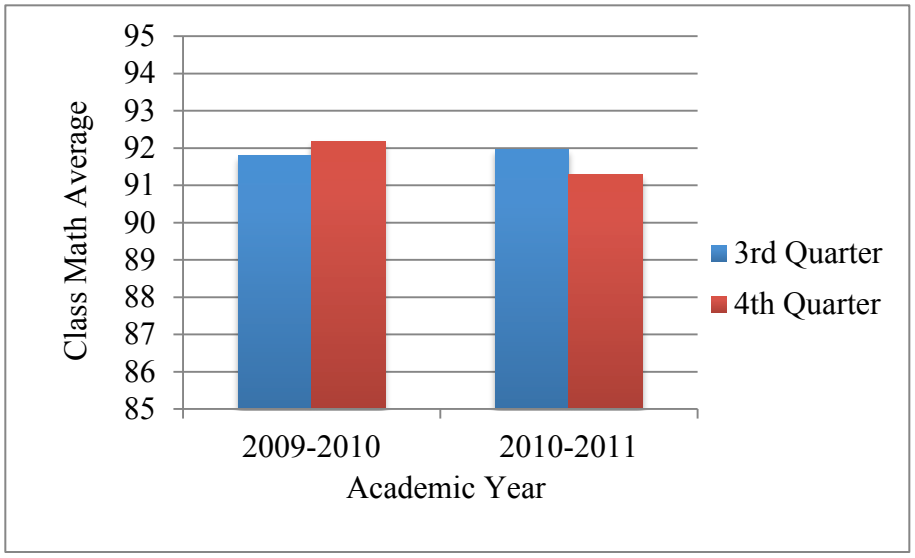

Figure 8: Average fifth grade math report card scores for 2009-2011

In addition to these class math grades, I was able to acquire the New York State standardized math test grades for this building over the past six years. Since Study Island was being used in all 5th grade math classrooms in this school starting in September 2010, some general conclusions can be drawn about its impact not only for the participant's individual classrooms, but for the grade level as a whole. A comparison between the first year Study Island was used and the years prior revealed that there was no significant change in measurable performance in math (see Figure 9). This once again maintains the interviewee's claims that thus far there has been no noticeable difference in assessment since the implementation of Study Island in the math program. It should be noted however that these test scores reflect different classes of students and therefore could contain some inaccuracies depending on their overall math comprehension and proficiency.

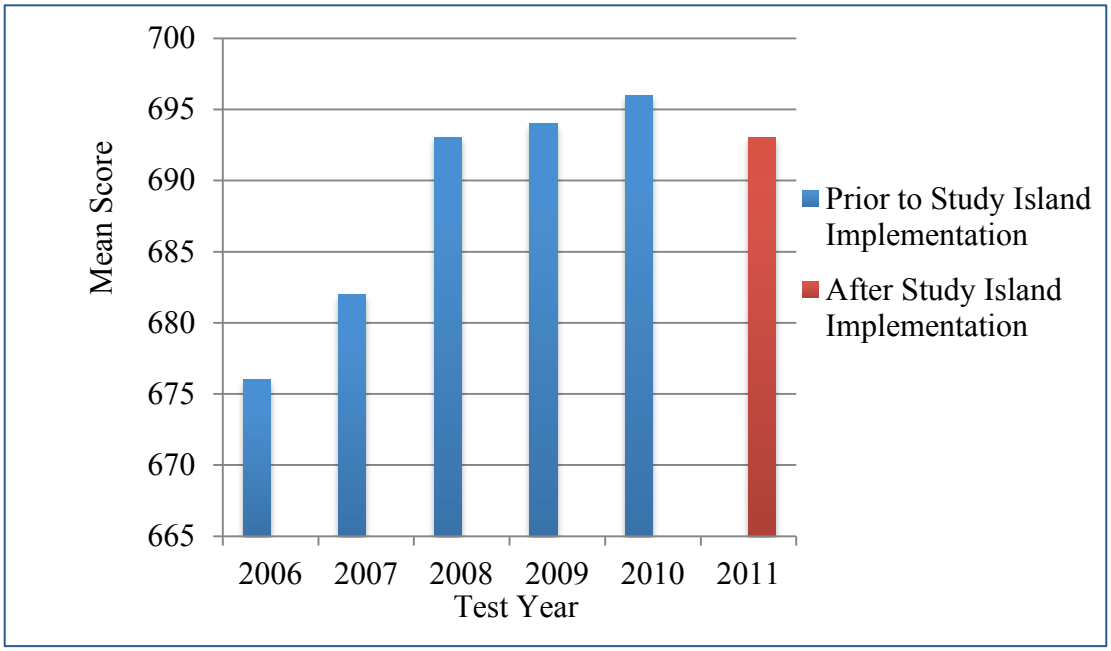

Figure 9: Fifth grade New York State math exam results

(New York State Education Department, 2011b)

Results were also compiled regarding fourth grade math test scores in an attempt to provide internal validity on the first class of students to experience Study Island (represented by the last two columns in Figure 10). This was done with the hopes of showing how this particular class of students progressed as a result of using video games. There is an increase in overall scores from fourth grade to fifth grade, which suggests that the use of Study Island produced positive results. However, similar comparisons over previous years (prior to Study Island) seem to indicate that there is no direct correlation between fourth grade and fifth grade math scores, making this assumption suspect at best. Additionally, other factors such as different curriculum materials and different teachers could have an impact on student performance. Further historical study is required to determine if these comparisons can be used as an accurate indicator of the impact of video games on math comprehension.

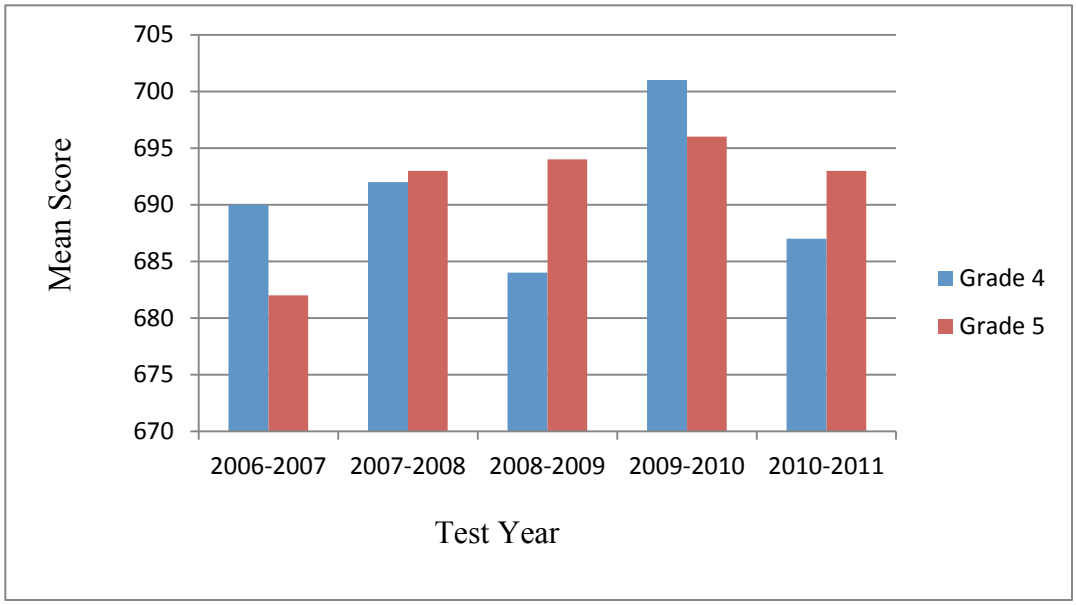

Figure 10: Comparing fourth and fifth grade New York State math exam results

(New York State Education Department, 2011b)

Discussion

There seems to be overwhelming evidence that the video games as they currently exist are not having an impact on learning outcomes in such a way that they are being reflected in assessments. Part of this might be attributed to the fact that the program is still in its infancy at this school and that teachers and students are still learning the best way to utilize these games. According to the teacher's interviewed, another possibility might be that the students are using these games to review existing knowledge, which while beneficial would not necessarily increase assessment results on new material. "There are times in which it is a benefit to the students to review what they have learned previously. This is more to remind them of what they

have learned… and to keep them proficient in their knowledge" (Participant 2, personal communication, December 7, 2011).

Another issue may lie in the disconnect between the educational goals and the gameplay goals. There is a distinctive difference between the education part of the game and the fun part of the game. Students are clearly able to identify when they are studying and when they are playing. This can result in negative behaviors where students try to skip as much of the learning aspects of the games as possible in order to maximize playtime. "Sometimes the kid just wants to get to the game, so they actually aren't doing the questions, they are just guessing A, B, C, D" (Participant 1, personal communication, December 7, 2011). This defeats the purpose of the game, which is to encourage students to enjoy spending time with the material.

Another problem with the disconnect between gameplay goals and educational goals is the scoring system. Alessi and Trollip (2001) identify the importance of this relationship, stating that, "a game's goal (winning) must be consonant with the learning goals and the activities that facilitate learning" (p. 296). Generally speaking this is not the case on Study Island. As Participant 1 indicated, "I do not think the game score is an accurate reflection [of student knowledge]" (personal communication, December 7, 2011). While the math questions being answered may have some affect on the just how well the student can perform, this is not a definitive connection. Using the archery game as an example, a student could theoretically answer every math question correctly, but still receive a poor score if they do not do well on the target practice aspect of the game. What's worse is that students who don't do as well on the educational aspects of the game could still score significantly better if they are particularly good at the game itself. This is negative reinforcement that puts improper emphasis on playing the

game well rather than practicing the material. The issue is that two separate scores are used: one for the questions and one for the game.

One proposed solution to this issue is finding a way to combine these scores in a manner that allows students to enjoy the achievement of earning a good score, but as a function of their success. So not only would correct answers enable them to score higher, but incorrect answers might come with a penalty. This is not to say that the game should be more difficult, but rather that a student's final score, the one that is used to determine their ranking on a leaderboard, should primarily be a function of how many math questions they answered correctly. In this way students are not only proud of their score, but can also directly associate their success with their ability to apply the material that was presented to them in the lesson.

Another option would be to further emphasize the success of scoring a blue ribbon. This would refocus the purpose of the game on answer questions correctly, rather than achieving a high score. One way this could be done is by using external rewards. A system could be established that would allow students to cash in on the blue ribbons they have earned for classroom prizes or privileges. While this focuses more on extrinsic rewards and as such is not likely to be as beneficial as the above-mentioned scoring change, it would still reemphasize the student on correctly answering the questions presented.

While there are not yet any visible results in learning outcomes as a result of using Study Island, there is still a significant amount of enthusiasm for playing these games. One of the greatest strengths of these games was the sheer number of options and genres available to the students. This allowed students a wide variety of options from which to choose, and they often chose games that were closely related to those that mattered to them. This directly relates to

Malone's fantasy component of motivation. Fantasy suggests the importance of allowing students to place themselves in fictional situations and scenarios. With so many games available, students are able to not only to briefly immerse themselves in a new world for the duration of the game, but they are able to choose a scenario that they are interested in. This makes for more intrinsic motivation, as the student is not being prompted to succeed by an external reward, but by interacting with something that has internal meaning to them. This is why students who are hunters expressed interest in the archery game and those who play sports were intrigued by the hockey and football games; these games had an internal meaning to them that made the experience more enjoyable. These fantastical settings can also be applied to Flow if the environment is so engrossing that it leads to a loss of self-consciousness. While there may not have been a game that was particularly exemplary of this effect, both teachers noted that students frequently got so caught up in their games that they forgot they were in a classroom setting. This suggests that the game was so intriguing that they got "lost" in the fantasy, and were far more focused on the virtual world that they were living in at that moment that they lost track of their physical surroundings and the rules that applied there.

In addition to fantasy, these games exhibit signs of both sensory and cognitive curiosity. Ironically, this is one area where the separation of educational material and game material seems to be acceptable. While the presentation of questions is often bland and lifeless, the games are colorful and animated. Key actions present sound effects that excite the students and can trigger emotional responses. These characteristics present situations that produce immediate interest in the game and quickly draw a student into the activity.

In contrast, the cognitive curiosity has more to do with the educational aspect of the game. While the games themselves can quickly become repetitive and bland due to their shallow

nature and short duration, only some of the students were getting bored, and even then it wasn't until much later in the year. This is particularly interesting considering that some of the students had been introduced to the games as part of their 4th grade instruction. Since the games themselves were not necessarily intriguing, one of the teachers suggested that students were still interested due to changes being presented in the educational content. Both participants indicated that they change the subject material on a regular basis, so while the games may remain the same, the mastery of knowledge needed to fully succeed in those games was changing all the time. In addition to these topical changes, Study Island has a large bank of math questions that are randomly rotated into each game. This prevents students from memorizing the answers to repeated questions and requires them to understand the concepts associated with the lesson. In this way, the total game experience is different almost every time the student accesses Study Island.

Another important component of Malone's theory is that of control. Study Island presents choice in two ways: choices and contingency. As has already been discussed, students are presented with a huge list of games from which they can choose to play. In addition, they are allowed to choose games from any difficulty level (beginner, intermediate, difficult), how many questions they can answer and sometimes a more specific level of difficulty within the selected game. While choices are good in the sense that they allow the student to customize their experience to meet their individual needs, the way Study Island presents it can be overwhelming. "Sometimes I think the choices it gives might be too much. Even before you get to the games you choose how many questions you get to answer, and it might be 1-35. You can't give a 10 year old that choice!" (Participant 1, personal communication, December 7, 2011). Rather than providing a comprehensive list of options, it would be more effective if a few clearly defined

options were presented to the student. This would still allow them to have control over their learning environment, but would encourage them to make use of it rather than avoiding it due to its overwhelming nature.

Similarly, the contingency rule is present but could use some improvements. Clear and direct feedback are essential to providing a motivating experience, as well as promoting the Flow of the activity. Again this can be a bit overwhelming due to the sheer amount of feedback. At any given time a student may be able to see their current score, time remaining, level, questions left, and session results. This makes it difficult to emphasize necessary information when the student needs it. Rather than providing useful feedback, important information is often lost in the glut of data being printed to the screen. Using the archery example in the game once again, there is very little feedback given when a student correctly answers a question, even though this is the primary purpose of the activity (see Figure 11). Especially when compared to the feedback given when the target is successfully hit (see Figure 12), the wrong aspects of the game are being emphasized, which can leave the student confused as to their current status. These aspects could be improved again through simplifying the user interface. The combination of game score and question results would again help here, as would using consistent fonts and animations for any critical messages that the student needs to see. The summary screen presented after the game could also be reorganized to emphasize the blue ribbon over the leaderboards, since that illustrates more individualized success.

Figure 11: Correct answer feedback in archery game

Figure 12: Game success feedback in archery game

Perhaps the most important characteristic of an educational video game is that of challenge. Both Malone's Motivational Theory and Flow emphasize the importance of matching challenge and skill level. While neither teacher felt that this was a major issue in Study Island, they did not emphasize it as a highlight of the system either. These games would greatly benefit from the Dynamic Difficulty Adjustment system discussed in Flow. Currently the system only adjusts automatically for students who are significant struggling with the material, and even then there is only a single level of adjustment available. There are manual options for students to change their difficulty level, but these are flawed. Flow shows the importance of maintaining an adequate balance of challenge and ability. With so many options for difficulty level however, it

would be very easy for a student to select one that is too hard or too easy, and this setting cannot be adjusted again until after that game is finished. This would force the student to play through an entire game in a situation that is either too frustrating or too boring. The sheer number of options available for difficulty adjustment also increases the likelihood that an incorrect level is selected and reduces the changes that a student will select one that matches their Flow Zone (see Figure 13).

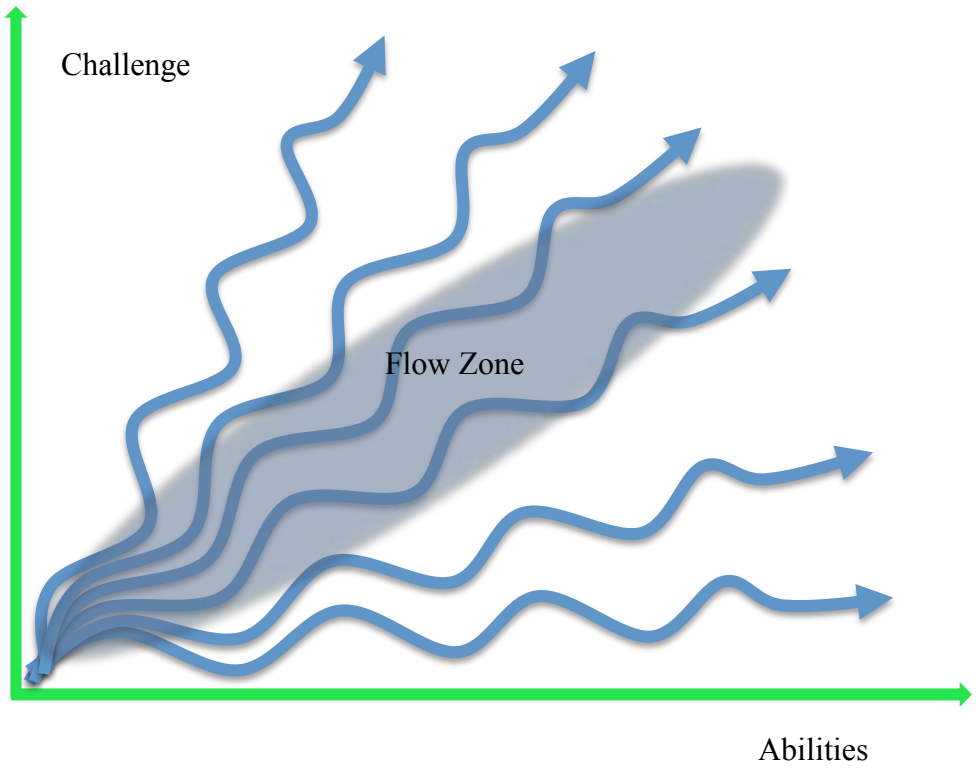

Figure 13: Difficulty level selection as it relates to Flow

Dynamic Difficulty Adjustment would solve this by adjusting the difficulty level on-the-fly, from question to question, based on performance. So if a student misses a question, the next question presented is easier, whereas a student who gets the first question correct would be presented with one that is more difficult. This way the game is always in or around the Flow

Zone for that individual. To account for these changing difficulty levels and to prevent students from intentionally selecting easier difficulties to earn better scores, the scoring system should be adjusted. The difficulty level of a question should have an impact on how many points can be earned. This takes the incentive of a high score and directly correlates it to achieving success on more difficulty questions.

One final area that needs improvement relating to challenge is teacher control. Teachers have very little control over what questions get presented in the games. The only real control they have is over what topic of questions is available from a specific subset defined within Study Island. "I would prefer it to be more customized where I could take things from 3rd grade, 4th grade, 5th grade, common core, regular math standards, and mesh it all together. Right now I can't" (Participant B, personal communication, December 7, 2011). This largely limits the scope of instruction compared to a normal classroom. Such a tight focus doesn't permit review of relevant information from prior lessons. Additionally, it provides very little variety in the subject matter. As Participant 1 pointed out, this is in sharp contrast to how state testing is conducted, which is a mix-up of all the material covered over the course of the year. Since the games are being used primarily as a review tool, it would be better if students could access a range of lessons while playing the games so they could review not just the current content, but everything that has been covered to date.

Implications and Further Study

It is important to recognize the strong similarities between Malone's Motivational Theory and Flow. There are a number of characteristics that overlap both of these ideologies, including setting clear goals, matching challenge with skill level, presenting direct and timely feedback,

and providing students with the tools necessary to control their learning experience. It appears that games that are designed in such a way as to keep the player in the Flow Zone are also creating intrinsically motivating experiences. This would suggest that educational game designers would be able to use the Flow framework to create games that are not only fun, but also able to motivate students to continue playing, and by extension, learning.

This highlights the importance of intrinsic motivation in educational games. While rewards systems can certainly be motivating, as is the case with the current scoring system, it separates the goal from the material to be learned. This separation allows students to achieve some level of success without mastering the material, and often times without being able to explain why they earned the score that they did. A more concise connection between game goals and educational goals is needed to promote an internal desire to master the material.

In many ways this study is an overview for a number of opportunities for more intensive investigation. Having pointed out the correlation between Flow and Malone's Motivational Theory, it would be beneficial to perform a more direct study on just how much impact these ideas have on one another. Does good Flow always lead to good motivation? Does motivation always indicate that the player is in the Flow Zone? Answers to these questions would have practical applications in the educational game development industry.

Another opportunity for further study would be to expand the existing participant group to include students. While the scope of this project prevented it, an ethnographic study that consisted of observations and interviews with students over the course of an entire semester or year would not only provide more accurate information on how students view the games, but also show how they respond to it over time.

As was mentioned in the limitations section of this paper, this particular district had a very limited history with the video games that were chosen for this study. Studying another district with more experience in utilizing educational video games with large numbers of students would provide an ideal setting for a quantitative analysis of how much impact video games can have on learning outcome assessment.

Yet another opportunity would be to study the learning environment itself and how that affects the use of educational video games. This particular study used classrooms where games were available regularly, but were not required. Instead, they were offered as solitary activities, which required limited computer resources. Further research on how to better implement these games into classroom instruction (rather than just review) and how to best manage the time and resources available would be recommended.

Finally, a study on a very specific population of students would provide more in-depth insights into how games are received and how effective they are. Specifically, those students with special needs would provide an intriguing opportunity. One of the teachers interviewed believed that these games would be particular useful for her inclusion students. "My special education students, because of the demand on their schedule, between seeing the special ed teacher, myself, OT [occupational therapy], PT [physical therapy], speech, they don't have time to get on there, and I think it would be most beneficial for them" (Participant 2, personal communication, December 7, 2011). Therefore a study as to how special education students could use video games to learn math material would be interesting as well.

VI. Conclusion

Educational video games have been apart of the school system for decades, and they likely won't be going away anytime soon. For this reason, it is important that we understand what benefits they can provide and how to realize them. In this particular study, the games used did not present any measurable benefit to learning outcomes based on the assessments provided. However there was plenty of evidence to suggest that the games were highly motivating for students when used as a reviewing tool. While represented in varying degrees, each of the four major components of Malone's Motivational Theory are often present in educational video games. The scenarios and game settings allow students to experience fantasy, while their interesting presentation leads to sensory curiosity. Gameplay content provides a form of cognitive curiosity, while on-screen feedback satisfies the contingency rule. Control is further promoted through choice with game options such as difficulty level. This ultimately leads to how much challenge is presented about in the game and how closely it aligns with student skill level. Many of these components coincide with the properties necessary to create good Flow in a game. Consequently, it can be suggested that Flow in video games directly strengthens the motivation experienced while playing a game. Ultimately, it is clear that educational video games have a significant impact on motivating students by encouraging them to spend time in review of existing material in a format that is fun and interesting.

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Appendix A

Participant Consent Form for Case Study Research

Eric Goodnough

This authorization is being requested in part to fulfill requirements of the State University of NY Institute of Technology's Human Subjects Research Review Board as well as state and federal regulations regarding the use of human subjects in research. The project involves a case study that may be used in my master's research at the SUNYIT Information Design and Technology Master's program. Excerpts or rewritten versions may also be submitted to professional journals for publication. The case study involves teachers in a 5th grade classroom setting that use the website Study Island in an attempt to investigate the effectiveness of using video games in education. The work involves one-on-one interviews with teachers during scheduled visits. I am planning on videotaping both of these interviews; however these recordings will be used as detailed notes only and will not be available to anyone other than myself. Since safety and security of the participants is of utmost importance, the videos themselves will not be included in any part of the final product and will be completely destroyed upon completion of the research.

I am a student at State University of New York, Institute of Technology at Utica/Rome, where I am studying in the Information Design and Technology program. I would be happy to answer any questions about the project, and can be reached at 315-529-9683 or goodnoe@sunyit.edu. You can also direct any questions to the chair of the Institutional Review Board at SUNY IT, Carolyn Christie-McAuliffe at christca@sunyit.edu or 315-374-1115.

I would like to reassure you that as a participant in this project you have several, rights.

- Your participation in these studies is entirely voluntary.
- You are free to decline to answer any question at any time,
- You are free to withdraw from the study at any time.

My notes from meetings, interviews, and observations will be kept strictly confidential. Excerpts from these notes may be made part of the final thesis.

Copies of the final publications will be supplied whenever possible and as requested.

I would be grateful if you would sign this form to show that you have read its contents.

_____ signed

_____ printed

_____ dated

Appendix B

Interview Questions

Implementation:

1. How frequently are students allowed to play video games in the classroom? How much time are they given to play in a single session?
2. How often do your students play the Study Island games outside school (never/somewhat/frequently)?
3. How do you use the Study Island video games in your classroom (topic introduction, content review, etc)?
4. Have you noticed an increase in math grades and test scores Study Island started being used?
5. What are your student's favorite games to play in Study Island (top 3)?
6. What component of the game do students seem to enjoy the most (setting/environment, challenge/difficulty, good score/placement on a leaderboard, etc)? Why do you think this is the case?
7. Do you feel that students understand the material better as a result of playing games on Study Island? If so, why is that? If not, what could be done to make those games more effective?

Flow:

8. Do students tend to "zone out" while playing a video game because they are too engaged in the game?
9. Do you see noticeable changes in attitude or focus with students after they play educational video games? Are these generally positive or negative?

Intrinsic Motivation:

10. In what ways does the game provide encouragement and incentive for further play even when a

student is not performing well? In what ways could a student be further encouraged to continue playing?

Control:

11. Do students interact with each other while playing games? What do these interactions look like (ie. one student helping another, competition, etc)?
12. How does the game provide regular and useful feedback based student performance? Are students able to explain their success/failure based on their game experience? How could this be improved?
13. Do you think video games on Study Island allow students to learn math at their own pace? What could be done to increase their control over the pacing of the game?

Challenge:

14. Are the scores and leaderboards provided sufficient incentives for encouraging students to succeed in the games on Study Island? Are there other components of the game that reward the student for playing? What might you add to encourage further exploration of these games?
15. Does the difficulty level selection available at the beginning of a game sufficient for providing students with a way to customize their game experience to match their skill level? What other options would allow this to happen more accurately?
16. Do you think most students change the difficulty level of a game or just choose the default level?
17. There are usually ten different difficulty levels available. Do you feel that this is too many? If so, how many should there be? How would you label these levels (currently a numeric system of numbers 1-10)?
18. Does the game adjust the difficulty level based on performance either during the game or between games (ie. get easier for struggling students or harder for students who are succeeding)? If not, do you think students adjust the difficulty level manually between games?
19. Does the difficulty level selection affect the questions asked or just the gameplay components? Do

you have control over what questions are asked or what difficulty level they are?

20. Do students set external (ie. not provided by the game) challenges for themselves or each other while playing games on Study Island? If so, does this improve their performance on the game? What types of challenges might they set (beat a personal high score, compete against another student, etc)?

Fantasy:

21. Does the game provide interesting scenarios and environments that keep students interested?
22. Do the games provide scenarios with practical applications of the material? If not, how could this be accomplished for math lessons?

Curiosity:

23. Do students encounter math problems on Study Island that are different or unique compared to the material covered in the classroom? How do they respond to these differences?
24. Which games provide graphics, sounds, or settings that are memorable for the students? What about these components makes them interesting?
25. In what ways do the games spark interest for the students relating to the media being used? Do they enjoy the colors, animations, and graphics? How could these be improved to make them more interesting?