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The Effects of Digital Games on Engagement and Motivation

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Abstract

The purpose of this study was to determine the effects of digital games on students' engagement and motivation. This study took place in a small, rural school in the Midwestern United States. The subjects for this study were two classes of seventh-grade students in grade-level mathematics. Digital review games and paper-and-pencil reviews were alternated from weekly for the eight weeks of the study. Data collection tools included student completed Likert scale questionnaires, on- and off-task counts and behaviors, a teacher reflection journal and final student questionnaire. The results showed that students were more behaviorally engaged during paper-and-pencil style reviews but more emotionally and cognitively engaged with the digital games. Overall, this study was inconclusive on whether digital games had a greater impact on both student engagement and motivation over paper-and-pencil style reviews. These findings suggest a blending of digital games and traditional reviews would be best in middle school mathematics.

Keywords: digital games, reviews, mathematics, student engagement, motivation

In middle school, students have to learn how to deal with physical changes, new interests that distract them, and loss of self-confidence as their mathematical skills are tested (Centers for Science, Mathematics, and Engineering Education [CSMEE], 2000). Middle school is also the time when many students start to dislike school or certain subject areas. Mathematics tends to be a difficult subject for most middle schoolers especially because many students are not developmentally ready for the abstract concepts associated with mathematics (CSMEE, 2000). When students struggle to grasp certain mathematics skills, doubt sets in and self-esteem decreases.

Acquiring strong mathematical skills is important in order for middle students to function adequately in their daily life, not only in school, but outside the classroom (Erturan & Jansen, 2015). In high school and college, students will find mathematic concepts embedded within other content areas (e.g., science and social studies). In their daily lives, mathematics will also be prevalent (e.g., managing money). Mathematics is not going to go away after students graduate school and neither will a student's negative feelings about mathematics if they have had a bad experience with it.

According to Erturan and Jansen (2015), a student's mathematics anxiety can impact their performance. Often, students walk away from a test feeling defeated because they were not prepared for it. Mathematics assessments are not easy to prepare for and when students do not feel ready for a test their confidence deteriorates. Smith and Throne (2009) stated that educators can boost students' enthusiasm and active participation in mathematics through competition. Students are generally excited to play games in mathematics, especially when there is competition involved. Games like Kahoot! and Quizizz are ideal platforms for helping students competitively review for assessments (Robinson, 2017).

Middle school students go through a unique transformation as they develop into young adults. Their experience in mathematics during this time can determine their mathematics mindset for the rest of their life. It is important that middle school teachers make their students feel successful by building up their confidence through well-planned reviews (Attard, 2013; Ritzko & Robinson, 2006; Smith & Throne, 2009). Many middle school students do not know how to study on their own for mathematics, so it is imperative that teachers find engaging ways to help them review. Therefore, the research question that guided this study was: *In what ways, if at all, does integrating digital games into a 7th-grade algebra class affect students' engagement and motivation?*

Theoretical Framework

John Keller's ARCS (Attention, Relevance, Confidence, and Satisfaction) model of motivational design theory was created as a tool to guide the development of motivating instruction and the assessment of students' motivation (McConnell, Hoover, & Sasse, 2001). ARCS stands for the four steps necessary to promote and sustain students' motivation to learn: attention, relevance, confidence, and satisfaction (Keller, 1987). Attention refers to capturing and maintaining the learner's interest. Relevance refers to addressing the learner's needs and relating the topic to his or her experiences. Confidence refers to building a positive experience that allows the learner to feel success and includes communicating to students that their success is based upon the effort they put forth. Finally, satisfaction refers to providing opportunities for students to use their new skills to reinforce successes they have already had.

The ARCS model begins with grabbing and maintaining the attention of the learner. Games are great attention grabbers that also satisfy the intrinsic human need to be the best (Smith & Throne, 2009). Students frequently play digital games on their electronic devices with

the goal of achieving higher scores. Educators can incorporate digital games into their instruction to address students' desires for competition while also covering the concepts being focused on in class. Digital games can build the confidence of students as they do well while also reinforcing to students that their success depends on the effort they put into the game. The satisfaction step in the ARCS model can also be achieved when students are motivated to increase their effort because they feel challenged or accomplished (McConnell et al., 2001). Digital games empower to students by allowing them to play the game repeatedly for the chance at a higher score (McAlister, 2013). The ARCS model of motivational design theory may have been developed before the creation of digital games, but this model supports the use of these games as motivational tools in the classroom.

Review of Literature

Engagement in mathematics during the middle years is imperative to a student's success in the future (Attard, 2013; Star et al., 2014). Unfortunately, due to many factors, engagement decreases as students move from the primary years to middle school. When implemented in classrooms, computer games have been identified as ways of increasing students' engagement in the classroom (Howard-Jones & Demetriou, 2009). In 2001, gaming companies saw a six billion dollar profit from video game sales; by 2010 that profit increased to 16 billion dollars (Chang et al., 2016). According to Cruickshank and Telfter (1980), video games promote a responsive environment where players receive immediate feedback, which is what makes them so enticing. Can students' engagement be increased through the integration of digital games in classrooms? What is the most effective way to incorporate digital games into a middle school mathematics classroom? In the following sections, the definitions of motivation and engagement, influences

on students' mathematics motivation and engagement, how technology impacts motivation and engagement, and how games affect dopamine and motivation will be reviewed.

Student Engagement and Motivation

To understand what influences a student's engagement and motivation in mathematics, it is important to understand the meaning of both engagement and motivation. Attard (2013) and Chang et al. (2016) suggest that there are three types of engagement: behavioral, emotional, and cognitive. According to Attard (2013), "Behavioral engagement encompasses the idea of active participation and involvement; emotional engagement includes students' reactions to school, including teachers and peers; and cognitive engagement involves the idea of investment and recognition of the value of learning" (p. 570). By working on homework, participating in discussion, and following the rules, students are behaviorally engaged. Emotional engagement encompasses a student's feelings towards the class, teachers, and peers. Cognitive engagement includes a student's motivation and effort to go beyond the requirements and being open to challenges (Chang et al., 2016).

Motivation is defined as a person's desire and the actions they take to reach a goal or complete a task (Bakar, Ayub, Luan, & Tarmizi, 2010). Therefore, a higher level of desire and effort put towards accomplishing a goal should result in a better classroom performance (Rugutt & Chemosit, 2009). For a student to put forth the effort to reach a goal they must be engaged behaviorally, emotionally, and cognitively. According to Rugutt and Chemosit (2009), "Students engage in learning through behaviors and motivation, and those learners who are highly motivated remain engaged, enthusiastic and are more likely to participate in academic activities" (p. 18). The synergy of a student's motivation and their engagement are important in

helping students succeed. Unfortunately, students do not always have this union between their motivation and engagement while in their middle school mathematics class (CSMEE, 2000).

Factors Influencing Engagement in Mathematics

Decreased student engagement in the middle school years can have negative effects on a student's future opportunities in high school and after graduation (CSMEE, 2000). If students become disengaged in a middle school mathematics classroom, they will miss out on concepts and skills that they may need in later mathematics classes. This disengagement could also prevent students from taking a higher level mathematics course in high school, thus limiting further understanding of mathematics and, possibly, limiting future life choices. It is important to understand the different factors that influence a student's engagement. According to Attard (2013), outside factors that can cause students to become disengaged include growing up in the 21st-century, the transition from primary school to the middle level, and the influence of family and peers. As an adolescent in the 21st-century, middle school students are constantly being influenced by new technologies and the pressures of social media. These distractions can pull their attention away from school. The stress of transitioning from the elementary school level to the middle grades, and pressure from family members and friends can also influence the amount of attention a student places on their classes and school work.

Elements within a mathematics classroom that impact student engagement include the topic relevance, grouping of abilities, and the social interactions within the room (Attard, 2013; Star et al., 2014). When students see real-world connections to the mathematics concepts they are learning, they will be more engaged in the lessons. Ability grouping can also have a positive effect on students; however, students in higher level groups can feel more pressure while students in lower groups may lack self-confidence. The interactions between teachers, students,

and peers can have the greatest impact on student engagement (Attard, 2013). Working with a peer or a teacher to understand a concept increases students' engagement and their motivation towards mathematics. Digital games are more than students just playing against a computer; they are means of interaction unlike anything teachers have seen before (McAlister, 2013). Students are more willing to work with their classmates and share their successes and failures on a game. Thus, it is important for educators to integrate technology into the classroom so that students are successful.

Technology and its Impacts on Motivation and Engagement

The use of technology by adolescents has greatly increased since 2001. According to Chang et al. (2015), about 66% of children aged 8 to 18 have a cell phone, and 76% have an iPod (or similar) device. With over two-thirds of students having access to devices, educators have the opportunity to implement more technology-based lessons into their classrooms. For technology to be effective, however, students need to be engaged and on task. All students may experience some time off-task when they become bored or frustrated; however, students who completely disengage, spending a large amount of time off-task, show lower learning outcomes (Mulqueeny, Kostyuk, Baker, & Ocumpaugh, 2015). In a study by Chang et al. (2016), the use of video games to learn fractions was tested against paper-and-pencil practice. Through their research, Chang et al. (2016) learned that the students who were on-task while using video games showed increased engagement while students using paper-and-pencil demonstrated a decrease in engagement. When video games are used effectively, many benefits can be observed. According to Siegle (2015), video games can increase not only engagement, but also collaboration, spatial awareness, and problem-solving skills. These skills are needed when

students are working together to perform a task while making decisions in a fast-paced video game environment.

For educators, it is important to understand how to effectively implement video games in a classroom setting. According to Siegle (2015), there are four key steps to successfully use gaming to increase student engagement in the classroom. First, the classroom stakes surrounding the game need to be low enough that students can enjoy the game. Students need to know that game results will not influence their grade and that they have the opportunity to win. Certain games may require students to play as teams, and these should be structured so that each child has the chance to be a winner. Secondly, it is imperative that games focus on essential academic content (Seigle, 2015). Games should enhance what little instructional time teachers already have. The third step to effectively implementing gaming in the classroom is to set aside time after the game has been played for teacher-student debriefing (Seigle, 2015). Taking time at the end, or throughout the game's implementation if possible, to go over the concepts presented within the game will help students understand what they might be doing wrong and how to fix the problem. Finally, it is important to give students time to reflect and the chance to correct misconceptions (Seigle, 2015). After playing a game in the classroom, students need time to learn and grow from their mistakes. Using games as assessments does not allow students to grow from their mistakes.

Games, Dopamine, and Motivation

McAlister (2013) suggests "the desire to quantify our experiences and learning is human nature" (p. 29). Gaining points throughout a game allows someone to show what they know. The compulsion to earn the most or be the best is part of what makes games so engaging (McAlister, 2013). Having grown up with TV game shows, interactive video games, and the

internet, students from the Millennial generation are willing to devote a great deal of time to master new games and electronic devices (Robinson, 2013). Dedication to doing well on a digital game can be a strong motivational tool for students. According to a study by Ritzko and Robinson (2006), 80% of students find question-and-answer style games, similar to Jeopardy, the most useful in learning and reviewing concepts.

Research on the amygdala of the brain, has shown that it becomes activated when students are in a positive emotional state (Willis, 2007). When a student is positively stimulated by a learning game, he or she is utilizing this part of the brain. According to Willis (2007), "students tested under these conditions show better working memory, improved verbal fluency, increased episodic memory for events, enhanced creative problem solving, focus, and higher order executive function and decision-making abilities" (p. 35). All of these skills are imperative to a student's success and can be achieved by playing a game because of a chemical neurotransmitter called dopamine. Dopamine is released while children are playing, laughing, and having fun. While a lack of dopamine in the amygdala is associated with attention deficit hyperactivity disorder (ADHD), an enhanced amount of dopamine helps facilitate learning (Willis, 2007). The excitement of succeeding at a game is the perfect catalyst for a release of dopamine. When this happens, a student's brain is more stimulated and ready to learn.

When educators reduce risk from games to make them fairer, the games can turn into public assessment (Howard-Jones & Demetriou, 2009; Robinson, 2013). Incorporating a little uncertainty into a game makes it more exciting and takes away from it feeling like a test. In a study by Robinson (2013), students had the choice of certainty and uncertainty while answering content related questions. If students chose certainty, they automatically got a point. However, if they chose uncertainty there would be a coin flip, one side was worth two points and the other

was worth no points. In a different study by Howard-Jones & Demetriou (2009), before hearing the questions, students chose if they wanted to go double or nothing. Similar to the coin flip in the game of certainty and uncertainty, students who went double or nothing and got it right were awarded two points. If students got the answer wrong, they received no points. In both studies, students preferred a level of risk in their learning games (Howard-Jones & Demetriou, 2009; Robinson, 2013). Digital games, such as Kahoot! and Quizizz, incorporate uncertainty through the accuracy and speed of answering multiple choice questions (Robinsons, 2017). The faster a student correctly answers a question, the more points out of one-hundred they are awarded. The risk of going faster can lead to students doing well and earning more points or making mistakes and gaining no points. While obtaining a reward creates positive emotions, an unexpected loss helps teach students how to avoid making those mistakes again (Howard-Jones & Demetriou, 2009).

Digital games are a great tool for educators to utilize to increase student engagement in the classroom (Howard-Jones & Demetriou, 2009). The research on how to effectively integrate games into a middle school mathematics setting indicates that by incorporating games that are content rich with an element of risk teachers can expect to see significant improvements. These improvements include increasing student motivation and engagement. By following the four key steps to implementing games rich with mathematics content and a hint of uncertainty, teachers can hope to increase students' engagement and motivation.

Methodology

This study was designed as an action research project to better understand the effect of digital games on student engagement and motivation. Digital review games and paper-and-pencil reviews were alternated from week to week for the eight weeks of the study, with a total

of three digital review games and three paper and pencil reviews (Table 1). The digital review games were created and administered on the web program Quizizz. Students used Chromebooks to log in and play the games. The paper and pencil reviews were displayed on the classroom's SMART board using a different SMART notebook page for every 1-2 questions. Students used a personal whiteboard and dry erase marker or notebook paper and pencils to answer the questions. Both styles of review had 10-25 questions depending on what concepts were taught that week.

Table 1
Weekly Rotation of Review Types

	Review Type	Content
Week 1	Paper and Pencil	Integers
Week 2	Digital Game	Integers
Week 3	Paper and Pencil	Integers
Week 4	No Review*	No review
Week 5	Digital Game	Solving Equations
Week 6	No Review**	No Review
Week 7	Paper and Pencil	Solving Equations
Week 8	Digital Game	Solving Equations

*No review was conducted this week due to no school for Minnesota Educator Academy (MEA) conference
** No review was conducted this week

Each weekly, fifty-minute review period started with gathering materials before going through the review activity and ended with students filling out their Likert scale questionnaire (Appendix A). When students walked into class, a message on the board directed them to gather the materials that would be needed for that day's review. On paper-and-pencil style review days, questions were displayed on the board for students to start solving. After a few minutes, the

teacher modeled how to solve the question(s) with the students before moving on to the next SMART notebook page. On digital review game days, students began by logging into the Chromebooks with their school email before going to the Quizizz webpage. Once students were on the correct page, they could access that day's review through a game code displayed on the front board. When playing Quizizz, the multiple choice questions were in a different order for each student and students completed the review at their own pace. When students completed the game, they were able to play again until everyone had completed the review at least once. After all the students were done, the problems that students struggled the most with were reviewed with the entire class.

During both style of reviews, the teacher-researcher used the data gathering tool to record how many students were on- and off-task as well as the behaviors students were displaying. To allow the teacher to work with students when they had questions, the on- and off-task count (Appendix B) was completed five minutes into the review and then every ten minutes until the end of the class. Each time a count was taken, behaviors for both on- and off-task students were recorded. Possible on-task behaviors included working on or answering the problems and asking a teacher or a classmate for help. Off-task behaviors could include drawing and talking with classmates. At the end of each class period, (both during digital review and paper and pencil review days) students completed an anonymous Likert scale questionnaire. The Likert scale questionnaire included five statements designed to determine if students were engaged emotionally, behaviorally, or cognitively. Statements included: "working hard", "working the whole class period", "topic was interesting", "topic was challenging", and "help was sought out". Students recorded whether they strongly agreed, agreed, neither, disagreed, or strongly disagreed with each statement.

The subjects for this study were two classes of seventh-grade students in a grade-level mathematics class at a small, rural school in the Midwestern United States. A total of 56 students, 22 males and 34 females, made up the study population. The racial demographics of the students in the study included 91% white, 3.6% Asian, 1.8% Hispanic, 1.8% Black, and 1.8% students who identified as two or more races. Table 2 shows the breakdown of each class by gender, students on Individualized Education Plans (IEPs), and English Language Learners (ELL). A passive-consent letter explaining the study was sent to the parents of all students in class. The letter was read with the students and they were instructed to show it to their parents. In the letter, parents were encouraged to reach out to the teacher-researcher if they had any concerns, questions, or if they wanted to opt out. None of the parents chose to opt their child out of the study.

Table 2
Student Demographics for Each Mathematics Class

	Males	Females	IEPs	ELL
Class #1	10	17	3	1
Class #2	12	17	3	0
Total	**22**	**34**	**6**	**1**

Multiple data sources, both qualitative and quantitative, were used to determine if digital review games had an impact on student engagement and motivation. Observations of students' on- and off-task behavior were collected during each lesson. After each lesson, students completed a Likert scale questionnaire and the teacher-researcher completed a reflection and recorded how the lesson was implemented (Appendix C). Finally, after multiple weeks of participating in both digital review games and paper and pencil reviews, students completed a

questionnaire related to what they liked and did not like about each style of review (Appendix D). Together, these data sources were triangulated to determine if digital review games affected the students' engagement and motivation.

The teacher-researcher used the on- and off-task behavior data and the student's Likert scale questionnaire responses to determine whether students were more engaged during either the digital or paper and pencil review days. Student responses on the questionnaires helped determine whether students found the reviews challenging and if they were motivated to ask for help when they had questions. Before the end of the day, the teacher-researcher took the time to fill out the teacher journal prompts, reflecting on how the lessons went. Journal prompts focused on whether or not the lessons worked for all students, including what types of successes and challenges students had. After completing the six review days, the students took the final questionnaire to explain what they liked and did not like about each review type and indicated which type of review they preferred overall. The teacher-researcher used the information from both of these tools to determine whether the students and teacher identified similar successes and challenges with each type of review.

Analysis of Data

The purpose of this study was to determine the effects of digital games on students' engagement and motivation. Students were given weekly reviews, alternating between paper-and-pencil style and digital review games. Both qualitative and quantitative data were collected using student Likert scale questionnaires, a teacher journal, on- and off-task behavior tally and observation sheet, and a final student questionnaire. These tools were used together to gather information about student engagement and motivation during the implementation of digital games.

The quantitative data from the on- and off-task behavior counts and the Likert scale questionnaires were put into a Google Sheets spreadsheet. Percentages for the total students on- and off-tasks were calculated at the five-, fifteen-, and twenty-five minute marks for both digital games and paper and pencil reviews. Prompts for the Likert scale questionnaires were tallied based on how many students answered each question with strongly agree, agree, neither, disagree, or strongly disagree. The totals for each question were analyzed based on the type of student engagement it represented. The first two questions, which asked students whether they were working hard in class and for the whole class period, focused on behavioral engagement (i.e. on-task vs. off-task behavior). The third question, which asked students about their interest in the work, focused on emotional engagement. The final two questions, which asked students about being the challenge of the work and whether they asked for help, focused on cognitive engagement.

The qualitative data (i.e., the on- and off-task behavior reports, the teacher journal, and the final student questionnaire) were analyzed and divided into categories. The on- and off-task behaviors were split into two categories: on-task behaviors and off-task behaviors. The teacher journal data were categorized by successes and challenges. The student questionnaire data were divided into likes of paper and pencil reviews, dislikes of paper and pencil reviews, likes of digital games, and dislikes of digital games. The final question on the student questionnaire was also analyzed to determine how many students preferred digital games, paper and pencil reviews, or both.

Findings

The effects of reviews on behavioral and emotional engagement.

The first part of the research question this study addressed was how engaged students were during the two different styles of reviews. Data from the teacher journal, the on- and off-task count and behaviors, and the student questionnaire all provided evidence related to how students are engaged behaviorally and emotional in the lessons.

The Likert scale questionnaire, which focused on students' emotional, behavioral, and cognitive engagement, had five different questions. The first two questions focused on behavioral engagement and how the students rated themselves on the effort they put into their work and if the extended through out the entire class period (Figure 1). Over the six weeks of using both digital games and paper and pencil reviews, 88%-89% of the students rated themselves as agreeing or strongly agreeing to working hard in class. While students felt that they worked hard in class, more students worked the entire class period when using paper and pencil reviews. Ninety-two percent of students agreed or strongly agreed to working the entire class time on paper and pencil, while only 86% of students felt the same when using digital games. As much as these percents differ, they are still extremely close for both styles of review

games. Overall, very few students disagreed to working hard or the entire class period.

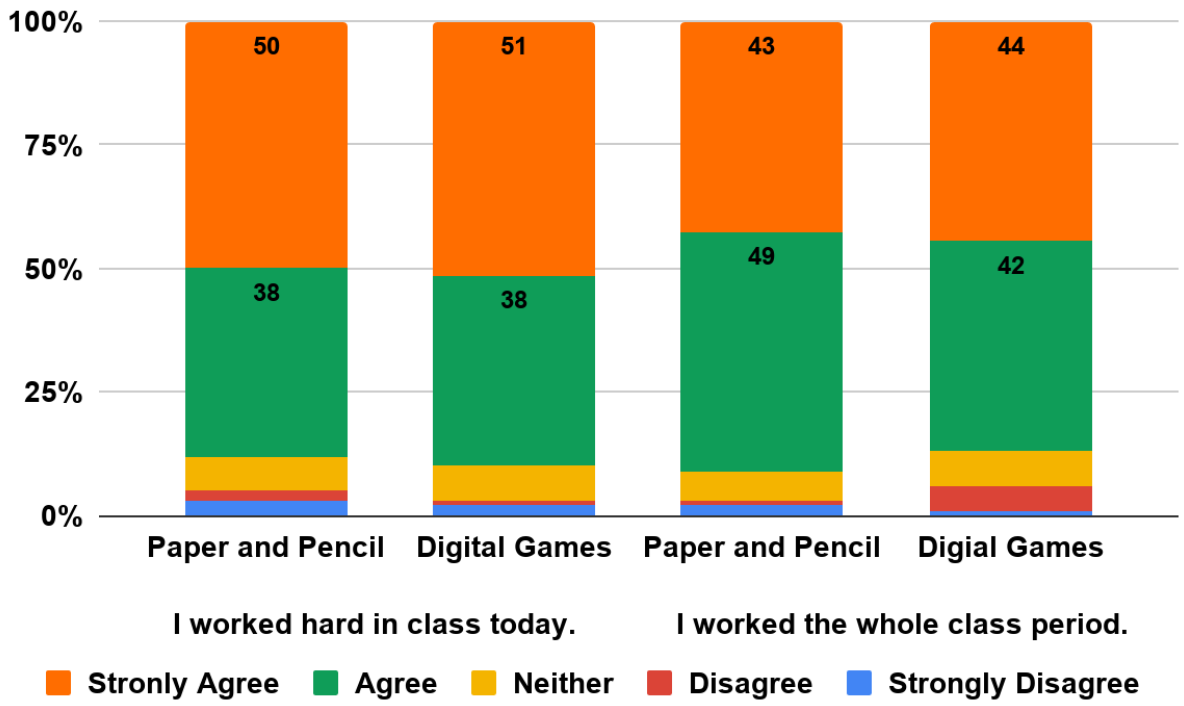

Figure 1. Likert scale questionnaire percentage for statements "I worked hard in class today" and "I worked the whole class period."

During the lessons, the teacher-researcher kept a record of how many students demonstrated on- and off-task behaviors at 5 minutes, 15 minutes, and 25 minutes into the review activity. These on- and off-task numbers represent how many students were behaviorally engaged at various times throughout the lesson (Figure 2). As the activity progressed, paper-and-pencil style reviews demonstrated an increase in student engagement while digital games demonstrated a decrease in student engagement. During paper and pencil reviews, 86% of students were on-task at 5-minutes, 89% at 15-minutes, and 91% at 25-minutes. Contrastingly, 93% of the students were on-task at 5-minutes, 91% at 15-minutes and 89% at the 25-minute interval during digital reviews. These results, along with the students' responses from the first questions on the Likert scale, showed that paper and pencil reviews kept students on-task for the

whole class. A reason for this could be that with digital review games students knew how many questions there were and what question they were on. With paper-and-pencil style reviews, students were unaware of how many questions were left thus keeping them focused longer.

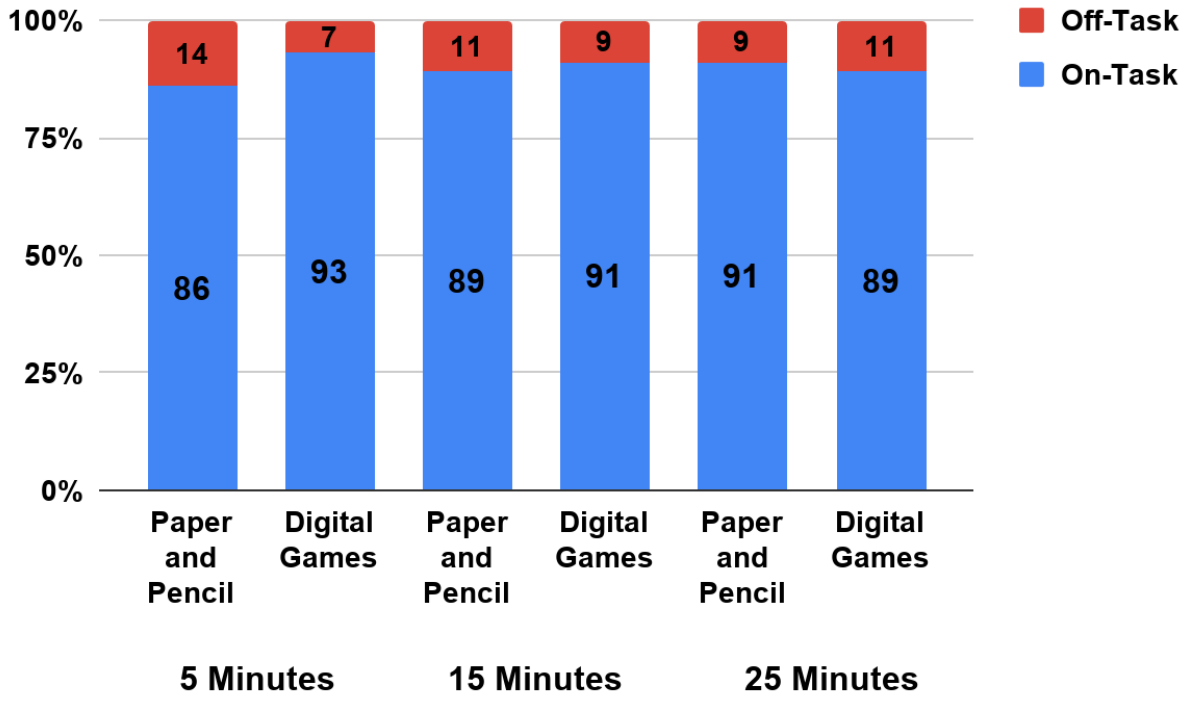

Figure 2. Percentage of students on- and off-task at time intervals of 5 minutes, 15 minutes, and 25 minutes.

The student behaviors observed also supported students being behaviorally engaged through both styles of reviews. The on- and off-task behaviors for both paper and pencil and digital games included many of the same behaviors (Table 3). Common on-task behaviors from both included working out the problems alone and with classmates, and asking the teacher for help. Digital games had the extra on-task behavior of students using the Chromebooks to select their answer for each problem. Off-task behaviors, other than talking with classmates varied based on the type of review. During digital games, many students would access other webpages

or their phones. While working on paper and pencil reviews, students' off-tasks were found drawing or laying their heads down at their desk.

Table 3
Common On- & Off-Task Behaviors For Each Style of Review

	On-Task	Off-Task
Digital Games	Working out problem Answering questions on computers Talking through problems with others Asking for/Receiving help from the teacher	Talking with other students On other webpages/devices
Paper and Pencil	Working out problems Helping others with a problem Asking questions or for help	Talking with other students Drawing on whiteboards/paper Laying head on a desk

After each lesson, the teacher-reflected on the successes and challenges of the lesson. Common successes related to digital game reviews included appreciating the instant feedback, the ability to ask questions when stuck on how to solve the problem, being able to work at their own pace, and the ability to repeat the activity more than once. Common successes for the paper and pencil reviews included students talking to neighbors when stuck, asking for help from the teacher, and getting solutions to each problem before moving on to the next one. Common challenges with digital games included students racing to be done first, worrying about who was in the lead, and only going over the solutions to a small handful of problems. Common challenges with paper and pencil reviews included students having more time to chat in between questions and drawing non-academic related pictures instead of working on the problem. While students were able to go at their own pace and repeat the digital game, only a small handful of questions could be reviewed at the end of class. Paper-and-pencil style reviews allowed for immediate debriefing after each problem. This not only allowed all students to get help on each

problem, but the work for the problem being discussed was still in front of them and fresh in their mind. The issue with digital games is that students only knew if they got each question correct or incorrect, not how to fix any mistakes.

The third question in the Likert scale questionnaire, how interested students were in the work, determined how emotionally engaged students were (Figure 3). Seventy percent of students agreed or strongly agreed to being interested in the work when digital games were used. Sixty-two percent of the students were interested in the work during paper and pencil reviews.

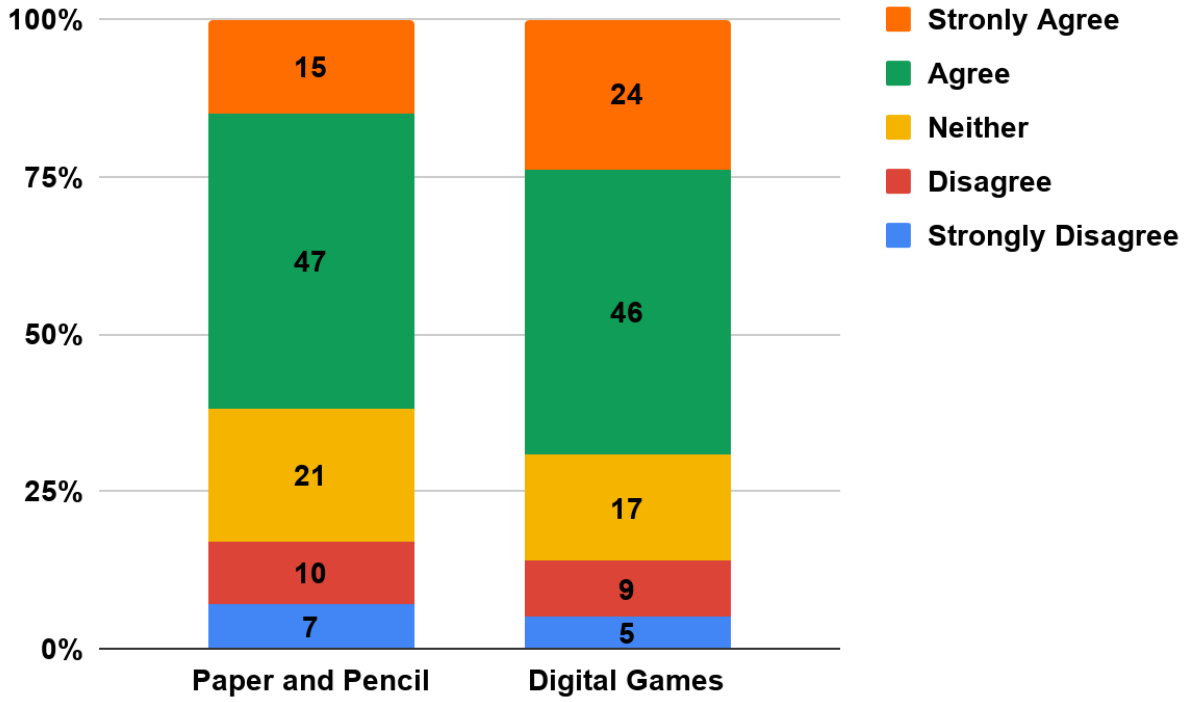

Figure 3. Likert scale questionnaire percentage of answers for the statement "I was interested in the work."

At the end of the study, students took a questionnaire about what they liked and did not like about each style of review. Common likes and dislikes for both styles of review are listed in Table 4.

Table 4
Common Likes and Dislikes About the Different Styles of Review From Students

	Likes	Dislikes
Paper and Pencil	Easier to show work/more organized (18) Easier (4) Easier to check answers (2) No computer/Wi-fi to deal with (2) Can go back (2)	Boring (6) Nothing (4) Not as fun (4) Longer (4) Messy/Run out of room (3) Hand hurts (2) Don't know how you did right away (2) No choices/Not multiple choice (2)
Digital Games	Fun (28) Faster (6) Easier (6) Competitive (3) More interesting (3) Instant feedback (2) Go at own pace (2)	Nothing (9) Hard to show/keep work organized (6) Timed/Makes you go faster (4) Can't go back (2) Wi-Fi Lag/Froze (2) To stressful/competitive (2)

The most common like (18 students) for paper and pencils reviews was that it was easier to show work and keep the work organized. The most common like (28 students) for digital games was that they were more fun. "Fast" and "easy" were some other frequent likes for digital games (6 students). The Likert scale showed that students were more interested during digital games and, from this questionnaire, 52% of students found them to be more fun.

In fact, multiple students described paper-and-pencil style reviews as "boring" (6 students). Similarly, student responses of "nothing", "not as fun", and "longer" each had four indicators for paper-and –pencil style reviews. For digital games, "nothing" was indicated nine times and "hard to show and keep work organized" was indicated five times. The more common dislikes of "nothing" for digital games and "boring" and "not as fun" for paper and pencil shows that students truly are more interested when playing digital games.

The effects of reviews on cognitive engagement and student motivation.

The second part of the research question this study addressed was how motivated students were during the two different styles of reviews. Motivation is defined as a person's desire and actions to reach a goal or complete a task (Bakar et al., 2010). Cognitive engagement is a student's motivation and effort to being challenged and seeking help when needed (Chang et al., 2016). If a student is motivated to complete a task, hopefully, he or she will seek help when it is needed.

Two statements on the Likert scale questionnaire were designed to determine whether students were challenged and motivated to ask for help during the different types of reviews. The first statement asked students to rate the challenge-level of the review. The second statement asked students to share how often they asked for help. Students' responses to the two statements when using both styles of reviews are shown in Figure 4. Seventy-seven percent of the students agreed or strongly agreed that they were challenged when using paper- and pencil-style reviews. However, only 60% agreed or strongly agreed that they had asked for help. More students, 79%, agreed or strongly agreed that they were challenged when using digital review games. However, only 52% of the students agreed or strongly agreed that they had asked for help when participating in these reviews. Students felt more challenged with digital games, but were more willing to ask for help when doing paper and pencil style reviews.

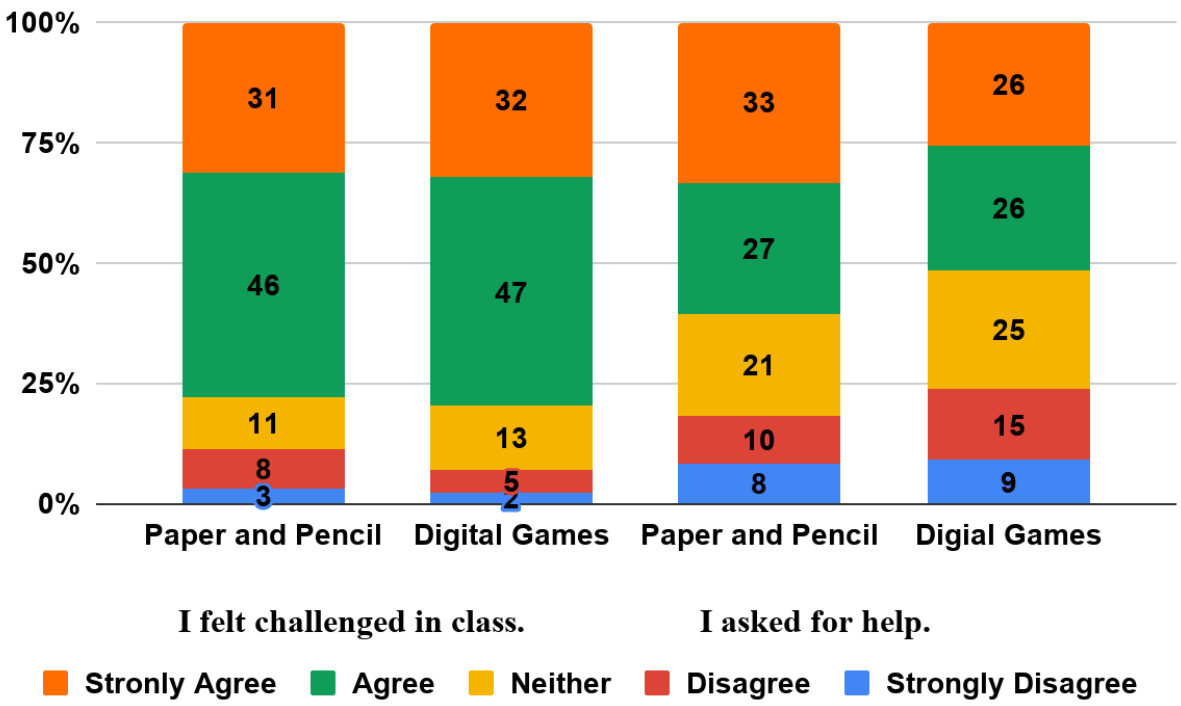

Figure 4. Likert scale questionnaire percentage of answers for the statements "I felt challenged in class" and "I asked for help."

The students were ready to be challenged by digital games thus displaying cognitive engagement. This was also noted in the teacher journal when students' showed determination to succeed by repeating the activity to better their score. Students used the instant feedback on whether a question was right or wrong to answer each question again. The fact that fewer students admitted to asking for help during digital games indicates that self-motivation and problem-solving skills also played a significant part.

The final question on the student questionnaire was asked to determine what type of review students preferred and why. Fifty-seven percent of the students preferred digital games, 37% preferred paper and pencil review, and about 6% liked both styles (Figure 5).

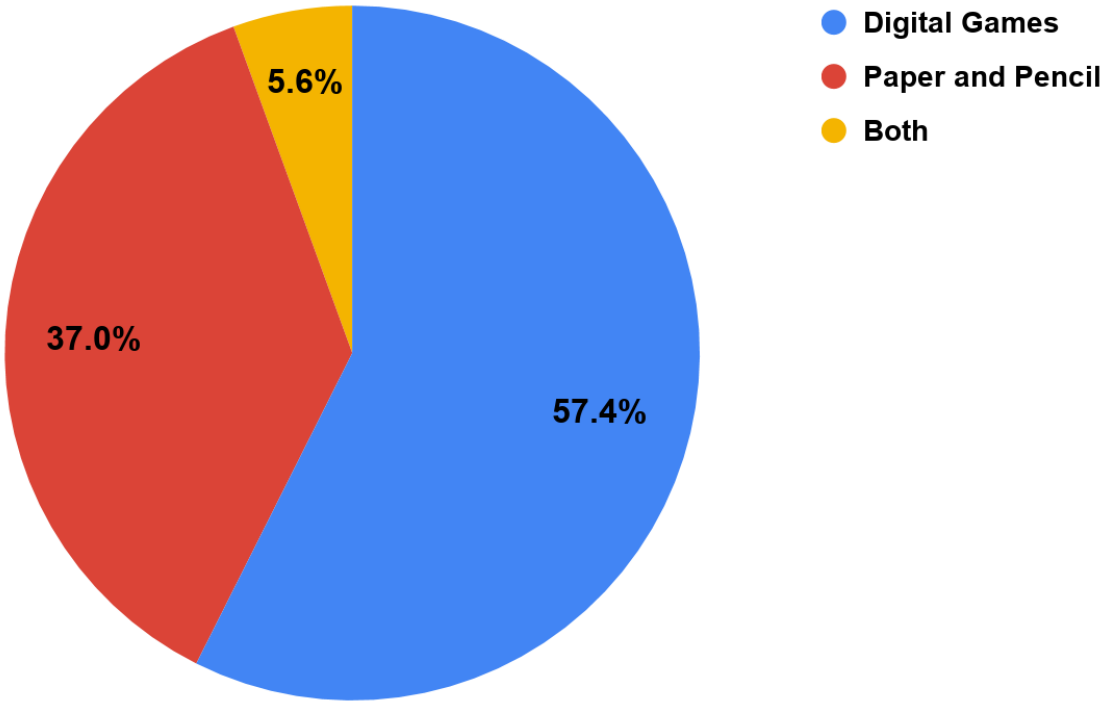

Figure 5. Type of review style students preferred.

In order for students to be motivated or have the desire to complete something, they must want to do it in the first place. With almost 63% of the students preferring digital games or a combination of both, this shows they are more motivated to complete digital games than paper-and-pencil style reviews. This was also evident in their reasoning for why they preferred a certain style of review. Students who preferred digital games suggested that they were more fun, faster, and easier. Students who preferred the paper- and pencil-style reviews claimed that they were easier and there was less pressure when completing them. More students found the fun and faster aspects of digital games more appealing even though students felt both styles of review were easy.

Action Plan

The goal of this action research study was to determine the effect of digital games on students' engagement and motivation in a 7th-grade algebra class. After analyzing the data, several conclusions about the effects of digital games on student engagement and motivation arose. One conclusion is that behavioral engagement decreases the longer students participate in digital games and students are more behaviorally engaged during paper and pencil style review. Many students raced to finish the digital review games, while this did not occur during the paper and pencil style reviews. Together these pieces of evidence show that behavioral engagement of students decreased during digital games.

Despite this decrease in behavioral engagement, there was an increase in emotional and cognitive engagement when using digital games. Students were willing to face the challenge of repeating the digital game to increase their scores. Students also indicated a bigger preference for digital games over paper and pencil reviews. Thus, students showed interest in what they were asked to do and felt challenged by the digital games.

There was not conclusive evidence related to the effect of digital games on students' motivation. Students tended to ask for help more frequently when participating in paper and pencil reviews despite the higher challenge of digital games. However, students did prefer digital game reviews over paper and pencil reviews. Because of this, there was not enough evidence to determine if digital games had a positive or negative impact on students' motivation. Overall, this action research study was inconclusive on whether digital games had a more significant impact on both student engagement and motivation than paper-and-pencil style reviews. Specific aspects of student engagement, both emotional and cognitive aspects, were

positively impacted by digital review games while behavioral engagement was negatively impacted.

Knowing one style of review does not increase both student engagement and motivation; a blended practice of both styles is needed. By incorporating both styles of review into classroom instruction, a teacher will be able to meet the needs and desires of all students. This could be done in multiple ways. One way could be by alternating the use of digital reviews and paper-and-pencil reviews, so all students get to use both throughout the year. Another way could be by offering both styles of review to students during each lesson. The latter option would allow for more student choice and would give each student the style of review they prefer, however it would take more planning and time for the teacher. The advantage of using a program like Quizizz is that many reviews have already been created. Teachers can use these quizzes or take questions from a variety of premade quizzes to make one that matches the content being studied. This would eliminate some of the work required with implementing both types of review for each lesson. A third way would be by incorporating a gaming aspect into a paper and pencil review. This could be done a variety of ways; for example, allowing students to shoot a basket if they get the correct answer or rolling a dice to determine how many points they get for getting a question correct.

After concluding this study, it became evident that further research is needed to determine which style of review would increase student engagement and motivation the most. The data collected was focused more on student engagement rather than motivation. More student-specific data is needed to determine how digital games affect students' motivation. The Likert scale questionnaire and student questionnaire were both anonymous. If identifiers were added, the Likert scale questionnaire responses could be analyzed based on each student and how

their self-ratings changed from week to week. Also, starting and ending the study with a similar student questionnaire that has students rate each style of review would allow for a comparison of what they preferred and how that changed at the end of the study. Even keeping track of how long and how often students are off-task could help determine how digital games affect student engagement and motivation.

More research could also be conducted to find out if other digital games have different effects on student engagement and motivation. While researching ways to effectively integrate digital games into a classroom setting, multiple web platforms were discovered. Each of these platforms has its own set of positive and negative components that could impact students' engagement and motivation.

Other variables of this study that could be analyzed more closely are how digital games affect different genders or how they impact student achievement. While conducting this study, more boys were off task during paper-and-pencil style reviews. Data could be collected to determine if digital games engage one gender more than the other. It would also be interesting to examine how digital games affect student achievement. Engaging students in a mathematics review is just one step in helping them achieve success. Determining if and how digital games influence a student's performance in an algebra class would help determine whether they are beneficial or not.

Further research could also be conducted to determine how digital games impact student engagement and motivation in subjects other than mathematics. Many students commented that they liked paper and pencil reviews because they allowed them to show their work and keep it organized. Mathematics can require a series of steps to solve a problem, thus causing a need for room to do so. Other subjects (i.e., social studies and science) focus more on vocabulary and

events thus not needing extra space. Reviewing these items with digital games could be easier and have a different impact on student engagement and motivation compared to a mathematics class.

The overall experience of incorporating both digital games and traditional paper and pencil reviews was invigorating and empowering. The study indicated that neither style of review impacted both student engagement and motivation. Instead, a balanced approach using both styles of review is most beneficial for students. Therefore, as new advancements in technology are made, the results of this study suggest that digital reviews need to be moderately integrated into the middle school mathematics classroom by blending them with traditional reviews to meet the needs of students.

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Appendix A
Likert Scale Questionnaire

Lesson:_____ Date:_____

How would you rate yourself on the following statements?

1. I worked hard in class today.

○	○	○	○	○
strongly disagree	disagree	neither	agree	strongly agree

2. I worked the whole class period.

○	○	○	○	○
strongly disagree	disagree	neither	agree	strongly agree

3. I was interested in the work we did today.

○	○	○	○	○
strongly disagree	disagree	neither	agree	strongly agree

4. I felt challenged in class today.

○	○	○	○	○
strongly disagree	disagree	neither	agree	strongly agree

5. I asked for help when I needed it.

○	○	○	○	○
strongly disagree	disagree	neither	agree	strongly agree

Appendix B

On and Off Task Observation From

Observing Teacher_____ Date:_____ Using Digital Games: YES or NO

Time	# On Task	# Off Task	Observations (on & off task behaviors)
5 minutes			
15 minutes			
25 minutes			
35 minutes			
45 minutes			

Appendix C

Teacher Reflection Journal

Date:_____ Lesson:_____

What type of review did I provide for students today?

Did this review seem to work for all of the students?

What successes did students have?

What challenges did students have?

Appendix D

Student Survey

* Required

What did you like about using paper-and-pencil reviews? *

Your answer

What did you NOT like about using paper-and-pencil reviews? *

Your answer

What did you like about using digital games to review? *

Your answer

What did you NOT like about using digital games to review? *

Your answer

What type of review would you prefer to use, paper-and-pencil or digital games? Why? *

Your answer