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Making Math hAPPen: Exploring Math iPad Games with Sixth Grade Students

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Abstract

Technology is a great resource for teachers. It can enhance lessons, activities, assessment and general functions of the classroom. The use of technology in education can be beneficial, but may present challenges for pre service and in service teachers. Integrating technology in the classroom is the foundation of teaching. However, research on iPad use in the classroom is quite limited. This qualitative research study took place at a K-8 school in Southeastern, Massachusetts. A study group of five sixth grade students was chosen by the classroom teacher. The teacher selected the students by looking at their standardized test scores, class performance, motivation for learning and attitude towards math. Three iPad game apps, "Coop Fractions", "Battle Station" and "Zap Zap Fractions" were selected by the researcher from a variety of math game apps that were previously rated by pre service, classroom, and technology teachers, as well as university math educators. Each of the apps focuses on comparing fractions and ordering fractions and decimals on a number line. Each student interacted with the apps in twenty minute time spans. The researcher and the classroom teacher observed the students interacting with the apps. The sessions were audio and video recorded. Data was collected using observation, anecdotal records and video. Time sampling was used to collect, code, and analyze student behaviors. The results of this study may help teachers develop strategies to effectively incorporate iPad game apps in their math instruction as a means to improve standardized test scores, class performance, motivation for learning and students' attitude towards math. It may also help teachers in their role as learners, constantly working to improve their craft.

Literature Review

Teachers are challenged by their obligation to standards based instruction and to implement a successful system of teaching, assessing and grading that will ensure students meet their educational goals based on grade level and content. Teachers are given national as well as state mandated math standards that they are expected to teach and have their students master by the end of each school year. One of the more difficult pieces to this that goes hand in hand with educational success is keeping students engaged with innovative lessons. This is where technology can be one of the most important parts of current educational craft.

Technology is something that is becoming prevalent in our society's daily life. It fills our media reports, conversations and has now infiltrated our classrooms. Technology has become a crucial piece of our education system, revolutionizing instruction, assignments, presentations and the daily functionality of the classroom. Its integration is growing rapidly and in all subjects in our schools. The current generation of students is so accustomed to using technology in their daily lives. Using technology comes naturally to these students. These students will most likely need to use technology in their future careers, so it only makes sense to incorporate these tools into the learning process now (Ingraham, 2013).

According to Zhang, Trussell, Gallegos & Asam (2015), "technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning". Technology allows for students to learn independently and without the help of a teacher, with limitless options for the exploration of new knowledge. Students can communicate with peers across the

world through blogs and social media, learning about culture and other places along the way. Aside from independent exploring, students can create artifacts and convey their knowledge in unique and engaging ways like webpages, discussion forums, etc. (Hickey, 2014) as well as practice new concepts with math game apps. Technology also allows teachers to make a richer variety of content available to students more so than traditional methods of instruction or the use of books and printed material. It allows for new methods of assessment and the ability to save student artifacts for future use (Hickey, 2014). Technology gives students the chance to develop flexibility in their thinking and stimulates their imagination (Bhagat & Chang, 2014). It allows them to focus on decision-making, reflection, reasoning and problem solving, opening many new doors in education while helping students meet their educational goals in a fun and interactive way (Ingraham, 2013).

The iPad has been linked to improvements in academic performance, added instructional flexibility and resource efficiency ("iPad in Education", 2014). Many districts across the nation are implementing iPad programs in their schools and even some one-to-one student to iPad programs. The iPad is becoming a popular classroom tool. Some studies have shown that students are more motivated when using iPads and the quality and standard of student work with iPads is on the rise (Walsh, 2012). iPads have proven to be a great addition to the classroom, giving students the power to acquire and manipulate information at their fingertips and to do so in their own way. The iPad is a "tool to think with" and is revolutionizing classrooms (Johnson, 2012).

Researchers who studied the effects of iPad use in math instruction came to several conclusions. The researchers expressed that not only did the students develop their content knowledge, but also their ability to perform. The iPad allows each student to bring their own skills to each problem and provides a wide variety of learning resources based on student need (Lee & Liu, 2013).

Several schools have integrated iPads into their math instruction. A middle school in Maryland reported one hundred seventy-five percent more students were labeled as "advanced" based on math test scores over three years compared to students at similar schools in their area who were not using iPads ("iPad in Education", 2014). The teachers in this school refer to iPads as a tool that allows students to "stay engaged, create, explore and learn in new ways" (iPad in Education", 2014). Reports from a school district in New York report that students in grades three through seven who scored "proficient" in math on standardized tests increased nine percent from 2012 to 2014. The district commented on the results saying that using iPads increased student engagement in learning as well as their motivation to learn, thus improving their mastery of the content (iPad in Education", 2014). Overtime, several studies and experiments done with iPads in math instruction have proven that, "technology is essential in teaching and learning mathematics [and] it influences the mathematics that is taught and enhances students' learning" (Zhang, Trussell, Gallegos & Asam, 2015).

The increased student performance that teachers have seen when using iPads in their math instruction correlates directly with the iPad's ability to engage users and allow them to interact with mathematical content. Students in this

generation are typically willing to use technology whenever possible (Powell, 2014). Therefore, simply allowing them to play a game on an iPad to practice math content is automatically more appealing than traditional drill and practice.

There are several different methods to evaluate iPad game applications for their use in math instruction. A study done by Cayton-Hodges, Feng & Pan in 2015 focused on rating the apps based on a variety of different categories. The first category evaluates the mathematical content in the app. This research focused on evaluating two parts of mathematical content; its accuracy and its mathematical richness. In most cases, the mathematical content in an app may appear to be accurate, but can sometimes be sacrificed to accommodate a design decision. For example, if the goal of an app is to have users solve equations for an unknown, they must allow the user to multiply both sides of the equation by the same number, as well as divide both sides by a number. In the 2015 study, Cayton-Hodges, Feng & Pan describe an app called DragonBox Algebra, in which the user is not able to do this, thus preventing them from being able to get all solutions to the unknown. In addition to content an app that rates highly in mathematical richness helps the user develop meaning in the content through connecting math topics in many different ways and representations. For example, an app could show an answer to a problem algebraically, graphically, pictorially, etc. to allowing users to look at solutions from many different angles. Mathematical richness also includes whether or not the app asks the users to explain or reflect why specific procedures or strategies work or do not work (Cayton-Hodges, Feng & Pan, 2015).

A second category in this study that was used was evaluating the mode of interactions, which contributes to the users motivation to continue using the app. A variety in the way a question is asked and the layout in which possible answers are presented largely contribute to the interest and motivation a user has in a math app. This can include users having to use manipulatives and drag and drop their answers, graph their answer or choose from a list of given answers. It is also important for apps to ask questions in different forms like short answer, fill in the blank, multiple choice, etc. (Cayton-Hodges, Feng & Pan, 2015). Including variations in several aspects of a math application is motivating to the users and peaks their interest in continuing to use the app.

In addition, the feedback an app outputs is also an important category of math apps. Feedback can be examined in several different ways; its relevance to the content, its timeliness, and the types of feedback given. It is important that the feedback an app does give is relevant to the users' performance and relates to the content. The feedback should be timely so the reader knows exactly what the feedback is referring to. Timely feedback might also encourage students to practice or play the game more than once in a siting. This is less likely to happen with traditional practice methods because it is harder for students to get feedback quickly with paper and pencil methods (Zhang, Trussell, Gallegos & Asam, 2015). Presenting the feedback in a variety of ways is also important to engage the user, meaning the app should present positive feedback when a problem is answered correctly in addition to notifying the user for an incorrect answer. The more rewarding and exciting the feedback is, the more motivated and interested the user

is to continue to use the app. Each of these categories are important aspects to a successful, interesting and mathematically meaningful app.

The development of math apps is still in its beginning stages and there is limited research about how to best integrate iPad apps in math instruction. The expectations that teachers have for the ability to use iPads in their classroom are sometimes unrealistic (Cayton-Hodges, Feng & Pan 2015).

iPads are proven to be beneficial to students in the classroom in a variety of ways. They greatly improve student engagement and interest, thus resulting in better quality work and increased learning. The purpose of this study is to examine students' behaviors as they use iPad apps and analyze the behavior patterns. This study will compare the behaviors of the same students interacting with several different apps, as well as to compare behavior patterns of multiple students using the same app.

Methodology

Setting:

This study took place at a K-8 school in a city in Southeastern, Massachusetts. This district is home to about 100,000 residents and there are 17,000 students in grades Pre-K-12. The district is a Title 1 district. The school in which this study was conducted services approximately 1,200 students in grades Kindergarten through grade 8. Most students in the school are African American, White or Hispanic, roughly 61%, 18% and 15%, respectively. Approximately 55% of students are considered economically disadvantaged, about 7% are considered students with disabilities and 22% of students are English Language Learners.

In the sixth grade class from which the study group was chosen from, there were twenty-eight students. There were twenty girls and eight boys in the class.

Participants:

From this class, five students were chosen as the study group. These students were chosen by the classroom teacher based on their standardized test scores, class performance, motivation for learning and attitude towards math.

In this particular district, all students in the sixth grade take the same performance test at the end of each unit. These tests assess their progress in the sixth grade curriculum and the scores are compared to students across the district. The students in this district also take the Partnership for Assessment of Readiness for College and Careers (PARCC) test that is administered by the state of Massachusetts. There are five levels that students can be placed in based on their PARCC results. If a student scores in level one, they have not met expectations. A student scoring in level two partially met expectations, a level three, approaching expectations, a level four met the expectations and a level five the student has exceeded the expectations.

This class of twenty-eight students are that highest performing sixth graders of all one hundred sixth graders in the school. However, the five students, three girls and two boys chosen by the classroom teacher to participate in this study are the students that are slightly below grade level in math.

Student A is quiet and shy but participates in class discussions on occasion. This student follows instructions and completes work but can sometimes be unorganized and lose assignments. Student A struggles with test taking and math is

not their strongest subject. The average test scores for the three units thus far in sixth grade is a 71. In fifth grade, Student A took the PARCC Assessment and was deemed a level three, indicating that the student is “approaching expectations”.

Student B is very hard working, quiet, shy and typically likes to work on their own, but has no problem socializing with other students at times. Student B occasionally voluntarily participates in class discussions and offers answers to questions. Their average test scores for the three units thus far in sixth grade is an 85. In grade 5, Student E attended school in another district, which did not administer the PARCC assessment.

Student C is quiet and soft-spoken but will volunteer and participate in class. Student C is hard working and is not afraid to ask questions in class, something that the teacher encourages of all students. Student C has averaged an 87 on the three unit tests thus far in grade six. In fifth grade, Student C took the PARCC Assessment. Based on the results of the exam, Student C was deemed to be a level three, indicating that they are “approaching expectations”.

When called on, Student D will answer questions in class but does not typically volunteer in class discussions. However, they always follow instructions and often finish work early. Student D has a unit test average of a 78 thus far in sixth grade. In fifth grade, Student D took the PARCC Assessment. Student D was placed in level four, indicating that the student met the expectations.

Student E can be shy and reserved throughout instructional time but is also very animated. Sometimes Student E participates in class but is typically quiet and focused, doing their work. Thus far in sixth grade, Student E has a unit test average

of an 82. In grade 5, Student E attended school in another district, which did not administer the PARCC assessment.

Procedures:

The researcher is a student teacher in this class and was placed there by her university. After an initial meeting with the classroom teacher, it was determined that the study would begin while the students were working on a unit focusing on fractions. The researcher and the classroom teacher then discussed the topics that students often had trouble with and selected one topic; ordering and comparing fractions and decimals. Therefore, all apps reviewed by the researcher for use with the students focused on comparing and ordering fractions and decimals.

The researcher researched different math apps that focused on comparing fractions and ordering fractions and decimals. Eight apps were selected, downloaded, and reviewed: Coop Fractions, Zap Zap Fractions, Oh No! Fractions, Pizza 1, Fraction Lite, zMath Fractions, Zap Zap Math and Battle Station.

In order to qualify to be rated, the app had to be free with no constraints on number minutes or turns that could be taken in one day. Because of this, the apps available to use in the study were quite limited. The apps that appeared to be the most interactive and user friendly were typically not free.

Of the eight apps, the researcher chose four to be rated by two pre-service teachers, two math educators, two higher education math professors, two technology teachers and two math curriculum directors using a likert scale (Appendix A). The likert scale assessed the apps' mathematical content, user interactions and engagement, feedback and versatility.

The results showed that the top three apps were Battle Station, Zap Zap Fractions and Coop Fractions, respectively. These were the apps that were used by the students in the study.

Summary of the Apps

Coop Fractions:

Coop Fractions has a variety of activities that focus on different fraction estimation skills. In the app, you can choose to estimate different types of fractions and between an "easy level" and a "hard level". The app asks you to estimate both proper fractions and improper fractions.

Once you choose your level, the game begins. A fraction pops up on the screen and it is your job to slide the nest along the number line to properly estimate the decimal form of the fraction. You have ten seconds do so, or the chicken throws the egg automatically. If the nest is not under the egg, the egg explodes on the number line and you earn no points. The goal is to estimate the fraction as quickly as possible and as accurately as possible in order to earn the most points. Each game includes ten questions and it gives you a score and the number of eggs hatched (or fractions estimated) at the end of each game.

Zap Zap Fractions:

Throughout this game, user interacts with a variety of fractions and fraction problems. The theme of this app is space. As questions pop up on the screen, you must properly answer them. If you answer them correctly, your spaceship sends out a laser and shoots an asteroid. The goal of the game is to survive for one-minute increments at a time. If you do not answer the questions properly, the asteroids stay

floating in space and can eventually hit you, and end your game. At the end of the game, you are given a numerical score and a ranking that depends on the accuracy of your responses.

The questions vary and can include pictures in which the user must select the fraction of the shapes that are shaded or a place on a number line where the user must match the fraction. The app also includes improper fractions.

Battle Station:

Battle station is an app that is similar to the game battleship. There are different places you can go to on the island and each place covers a different math topic. Only two of the places are unlocked in the free version of the app. In the fraction section of the app there are 6 levels. The first level starts with estimating the locations of fractions on a number line. The app prompts you with a fraction that the enemy number is "spotted at". The goal is for the user to place the battleship in the correct place on the number line. For the first few levels, there are several different benchmark fractions between the 0 and the 1, along the number line and as the levels get harder, the benchmark fractions disappear. When the user places the battleship a rocket comes and shoots at the ship. Then, the app displays whether it was a hit or a miss and gives a percentage for accuracy. If it was a hit, the user earns a coin. If it was a miss, they can try again and after the second miss, it shows the user the right answer. If the user gets 5 misses, the level is over and the user either passes the level and moves on or has to repeat the level to earn the level. There are 10 questions, or rockets per round. The goal of the app is to continue to unlock levels and earn coins.

The students then interacted with each of the three apps in twenty-minute time intervals, which took place in three different sessions. The app interactions were followed by a brief, informal interview with each student. The researcher asked the students their overall thoughts about the app, if they liked it, whether it was entertaining, if the content was too easy, too hard or just right, about the goal and reward system of the overall app and the process in which the user changed levels in the app (Appendix C).

The number of students working in a session at a time varied between either two or three students. Each of the sessions occurred at the end of the school day in a fairly private hallway outside of the classroom.

During each session, the researcher observed, took notes and recorded student activity and the time of the activity on the behavior checklist (Appendix B). While the students interacted with the apps, the researcher was focusing on their behaviors, levels of focus, interest, etc.

Following the three sessions, the videos were analyzed using time sampling and behavioral coding. The behaviors the checklist tracked included, students' bathroom use or any request to leave their seat, behaviors that show excitement in using the app or refusal to use the app. The checklist tracks any comments the students may make while using the app and anytime the student may interact with the researcher.

There were seven defined behaviors that were tracked using the checklist. The first behavior tracked anytime the student asked to leave their seat to get a

tissue, a drink, go to the bathroom, etc. The second behavior, being unfocused, was defined as anytime the student was staring into space, looking away from the iPad at their neighbors or passersby, asking the researcher questions that were unrelated to the work or any other distracting behavior. The third and fourth behaviors included the student making a comment about not wanting to use the app or refusing to use the app altogether. The fifth behavior, showing enthusiasm, was defined as any excited body language the students might make, happy, shocked or surprised facial expressions, etc. If students showed or explained something to the researcher in an excited tone or manner, this was tracked under behavior number six. Behavior number seven, reacting positively to the app, was defined as a student making a positive comment while using the app or an excited sound effect that the students might make while playing. Behaviors one through four were considered to be negative behaviors, whereas behaviors five through seven were labeled as positive behaviors.

After all of the sessions were completed, the videos were reviewed. The researcher completed the behavior checklist again while re-watching the film and revisited the original notes. The behaviors were then sorted into the appropriate category on the behavior checklist. The observations were then reviewed by another researcher and were cross-analyzed for validity. The data was then analyzed comparing the results from student to student as well as from app to app.

Findings

Coop Fractions

While interacting with Coop Fractions, Student A showed a variety of behaviors. Some of these behaviors included laughing and smiling. In the interview, after interacting with the app, Student A said they enjoyed the app and found it pretty entertaining. However, Student A said that if they had to continue playing the game for much longer, that it is likely that they would have become bored. They felt as though the math content was right at their level and was not too hard or too easy. They also said that they liked that they were able to change the levels in the app on their own and even repeated some levels by choice. Overall, Student A wished there was a larger reward and goal system to the app that allowed them to earn something greater and more exciting upon completion of levels.

While interacting with Coop Fractions Student B showed similar behaviors. Student B displayed enthusiasm and was very interested. Student B was fairly expressive and most of their incidences of enthusiasm were facial expressions. In the interview, Student B said they liked the app. They thought that it was cool because if you did not get a question right an egg would crack, but if you answered the question correctly that the egg would hatch and you would save the chick. They said that it was entertaining at first but then got boring after a while because it continued to do the same thing. Student B liked being able to change the levels on their own and that they could switch around from level to level at their own pace. They felt the math was at an appropriate level for their abilities but that they wished there was a larger goal to work towards in playing with the app.

Student C was very unfocused when using Coop Fractions. Student C spent a lot of time playing with a necklace, and looking around, away from the app. In the brief interview following the session, Student C said there was nothing they liked about the app and that it was boring. More specifically, they said that they did not like how they asked the questions and how they were formatted. They felt as though some of the levels were easy and some were hard but that they did like being able to control the amount of time they spent on each level and changing it at their own pace. Student C suggested a points or badge system to improve the lack of rewards and goals that Coop Fractions offers.

Student D was unfocused and distracted but did show enthusiasm while interacting with the app. They fidgeted in their seat and tended to put their head down a lot. They also made a lot of confused and perplexed facial expressions. Student D liked the app but thought it was boring because some of the questions were too hard for them and they did not know how to answer them. Student D liked being able to change the levels at their own pace and experiment with them instead of doing so automatically. Student D was not satisfied with the reward system and wanted to be able to earn something bigger for their work on the app.

Student E was very animated and made a lot of comments as they worked, but was not as focused as the other students. They asked to get up and get a tissue, and was unfocused and looking around. However, they did show enthusiasm and some positive interactions and excitement. They were distracted by others and spent a lot of time looking around at others. Student E really liked the fact that when

you answered a question correctly you saved an egg from cracking, thus saving the chick. They felt as though the math was too easy, but also opted not to change levels. Because the level she chose was too easy, they thought the app got boring after a while. They suggested the app give the user less time to answer each question. Student E wished there was more of a reward but really liked the fact that they had to save the chicks, as this was a real world connection and made the game more interesting.

Battle Station

Student A spent a lot of time dancing in reaction to the game as well as talking to themselves and making some comments while working with the app. Student A liked the app and said that some of the levels were just right, while other were a little too hard. Student A said that they liked that they had to get a certain amount of questions correct in order to move on and get to the next, harder level. However, Student A did say they wished there was more of a reward system to earn while they played but specifically noted that this reward system was better than the reward system in Coop Fractions.

With Battle Station, Student B was focused and into the game. Student B spent some time looking off into space and also tended showed some facial expressions while working. Student B said that the app was “cool” but said that it became boring because the app repeated some of the same numbers. Student B did express that they liked that as they continued to move on in the game that the clues disappeared and the levels increased in difficulty as they progressed, but that the

math content was at an appropriate level for their abilities. They said that there was not much of a reward at the end of each level and that there could have been something more motivating to keep their interest.

Student C was not as focused as the other students and spent a lot of time looking over at their neighbor and seeing what the other students around them were doing. They fidgeted in their seat and danced in their chair. Student C did not really like this app because there was not enough guidance on the number line and there were too many missing tick marks. They felt as though there was too much guessing involved and that it was boring because there was too much of the same type of questions. As far as the math content, Student C said that the math was pretty easy. They said that they wished they could have controlled the levels at their own pace instead of having them get harder automatically as the game progressed. In Battle Station, users earned stars as they completed levels but wishes they could have earned a larger prize.

Student D was also fidgety and unfocused in his session with Battle Station. Student D wiggled in their chair, leaned back a lot, leaned on their arm and put their head down, tended to stare off into space and looked at the people passing by. Student D liked playing with Battle Station and liked that they did not show all of the tick marks on the number line so you had to imagine them in your head. However, they said the math was too easy because the questions repeated themselves a lot. Once they got the wrong answer once they knew what to put when you saw that question in the next round. They liked that the app automatically changed levels and

they did not have to do that on their own. However, they suggested the app include more levels and rewards for each level instead of just the star you got for completing a level.

In their session with Battle Station, Student E made a lot of sound effects and distracting noises as well as comments about the app while they worked. Student E was partially distracted by passersbys and asked the researcher questions that were unrelated to the app. Student E felt the app was too repetitive and that is why it got boring. They did not like that they asked many of the same questions and did not vary the questions. They said that the math was easy at first and then got much more difficult because the tick marks on the number line began to disappear. Student E liked that you could earn points and stars for completing levels but wished there was more motivating reward involved.

Zap Zap Fractions

Student A was very active while working with Zap Zap Fractions. Student A was very fidgety in their seat and distracted during this session. However, they were also very excited during this session, reacting positively to things in the app and even sharing things with the researcher. They tended to look around a lot at their neighbors working and at others in the classroom. They were often dancing in their seat while they worked. Student A liked Zap Zap Fractions and said it was fun and entertaining for the entire twenty minutes. They claimed that the math was just about right at their level, but also included some challenging questions. Student A did not like that they did not have direct control of changing the level of difficulty

but did not think that levels of difficulty increased at a pace that was too fast. Student A liked the level report given at the end of each level and said that they would have only wished for a little something more to work for in terms of an end goal or reward.

Student B was pretty mellow and focused during this session but did ask to go to the bathroom with about two minutes left in the session. They spent some time leaning back in their chair and looking around, instead of playing the game. Student B felt as though the math in Zap Zap Fractions was easy but the levels did increase in difficulty as time went on. They liked that the levels got harder as they went because it challenged them more because they couldn't just pick the easiest levels. Although there was not much of a reward system with this app, Student B did like that the app gave them a report at the end of each level and gave them a title rating.

Student C was distracted and unfocused during their session with Zap Zap Fractions. They spent a lot of time zoning out and looking at their neighbors and they were fidgety in their seat. Student C was laughing at some of the things on the app as they played. Student C had trouble initially because they did not understand how to play the game, but as they learned how to play correctly they felt that the app was too basic. They felt that it was repetitive and boring because the math was too easy and you continually had to do the same thing all over again for each level you completed. There was not much of a reward or goal system with this app and

Student C expressed concern that they wished there was an overall prize or big goal to work to at the end of each level.

In their session with Zap Zap Fractions, Student D spent a lot of time leaning back in their chair and stretching, looking around at others and zoning out into space. Student D also was very expressive, laughing a lot at the app and making facial expressions. Student D liked that there was a time limit with this app and that you had to answer the questions pretty quickly or you would lose the level. They said they were entertained throughout the session and that the math content was at their appropriate level. They also liked that the app changed levels automatically as they worked and he did not have to do it themselves. However, Student D wanted a greater reward or goal to work towards at the end of each level.

In the session with Zap Zap Fractions, Student E asked to use the bathroom once, but was pretty focused and worked throughout the session. When they were unfocused, it was usually because they were staring into space. Other times, Student E was very involved and animated, making comments as they worked. Student E liked that with Zap Zap Fractions you had to destroy the meteors trying to hit you by answer the questions correctly and that if you answered too many incorrectly in the one minute they gave you, you were knocked out of the sky. They were entertained the whole time and the math was fairly easy for them. They did not see much of a change in difficulty as they continued to play with the app but liked that it changed as they progressed. They enjoyed the score report at the end with their level name

and accuracy percentage. The level names included titles like, “fraction master” and other silly titles that reflected their performance in the game.

In total, Student A recorded forty-two behaviors across all three apps. There were a totally of twenty instances of being unfocused, accounting for 47.62% of all their behaviors. They recorded nineteen incidences of showing enthusiasm, accounting for 45.24% of their total behaviors. They showed the researcher something on the iPad one time, accounting for 2.38% of all behaviors and reacted positively to the app twice, accounting for 4.76% of all total behaviors.

In total, Student B recorded twenty behaviors across all three apps. There was one instance of asking to go the bathroom and leave their seat, accounting for 5% of all behaviors, eight instances of being unfocused, accounting for 40% of all behaviors and eleven times in which Student B showed enthusiasm, accounting for 55% of all total behaviors.

Student C recorded forty-eight behaviors across all three apps. There was a total of thirty-six times in which they were unfocused, accounting for 75% of their total behavior. They showed enthusiasm ten times, which was 21% of all their total behaviors. They also reacted positively to the app twice, accounting for 4.2% of all their total behaviors.

Student D totaled forty-three behaviors across all three apps. Student D was unfocused 62.8% of the time, or a total of twenty-seven times. Student D showed enthusiasm sixteen times, accounting for 37.2% of all their total behaviors.

Student E totaled sixty-five behaviors across all three apps. They asked to leave their seat twice, accounting for 3.08% of all behaviors. They were unfocused twenty times, accounting for 30.77% of all total behaviors. They showed enthusiasm thirty-nine times, accounting for 60% of all total behaviors. They showed the researcher something in an excited manner once and reacted positively to the app three times, accounting for 1.54% and 4.62% of the time, respectively.

All Students and Apps:

Student E was most active across all three apps, Activity is defined as a student performing any behaviors, whether it be positive or negative. In total in all three sessions, Student E was the most active out of all five students. Student B was the least active across all three of the apps.

Coop Fractions was the application that elicited the least amount of behaviors, across all seven behaviors (Appendix B). It also elicited the least amount of enthusiastic behaviors, proving that Coop Fractions was the least engaging app of the three. Battle Station elicited the second most behaviors and had the same amount of enthusiastic behaviors as Zap Zap Fractions, which both elicited more enthusiasm than Coop Fractions. Zap Zap Fractions prompted the most amount of behaviors by all five students. Zap Zap Fractions also had the most incidences of students being unfocused. The most common behavior among all of the students and all three of the apps was being unfocused. The second most common behaviors was showing some sort of enthusiasm. The next most common behavior was

reacting positively to the app, followed by students asking to leave their seats and students showing the researcher something on the app in excitement.

Conclusions

During the initial search for the apps it was discovered that very few free apps on ordering and comparing fractions and decimals exist. Many of the apps cost money to download or have a free version that only allows users to play with the app for a certain amount of time or a certain number of levels a day before it cost money. Of the apps that were entirely free, many of them lacked an aesthetic appeal, any type of variance in how they posed the questions, or any type of reward or goal system. This is a major issue because of the budget cuts schools across the nation are facing. Many teachers are now responsible for buying many of their own basic supplies for their classrooms and do not have any extra funds to spend on apps for iPads. One of the largest and most common issues that the students expressed in their informal interviews was that all three apps lacked a motivating and exciting goal and reward system. This is likely attributed to the fact that all of the apps were downloaded and used at no cost.

Upon the original review of the apps, it was predicted that Coop Fractions, the lowest rated app, would be the least engaging of the apps, followed by Battle Station and the highest rating app, Zap Zap Fractions would be the most engaging. These predictions proved true as Coop Fractions had the least number of positive behaviors with thirty-three, followed by Battle Station with thirty-five and Zap Zap Fractions with thirty-six.

The activity varied greatly from student to student and app to app, with no

one student proving to be consistently the most active throughout all three of the apps. The variety in results and lack of consistency from student to student and across all three apps indicated that it is hard to predict the behaviors that certain apps could elicit. However, after using these apps in twenty-minute time spans with five different students it can be concluded that these apps would not hold students' attention for use in an extended period of time throughout a long time span, as almost all of the students expressed boredom at some point while using all three apps.

Another conclusion that can be drawn from the data is that students' behaviors are largely dependent on the individual. There are many other variables that are difficult to control and measure, such as mood, surroundings, time of day, etc. However, it was seen that certain apps may prompt certain behaviors more frequently than other behaviors.

In conclusion, it is difficult for teachers to find free quality math apps that will motivate students to use them over a long period of time. However, teachers should continue to search for quality apps and share them with friends and colleagues to help more teachers incorporate math game apps into their instruction. Teachers should search for content specific apps and align them to specific units to help reinforce student learning while studying those topics. These apps may not always be suited for use throughout the entire school year and would most likely be best suited for use throughout a specific unit.

Limitations

While this study yielded interesting results, because of the small sample size, limited conclusions can be drawn. Each student showed both negative and positive interactions while interacting with the selected apps. If this study was conducted with an entire class of students, more data could be collected and analyzed, which might lead to different patterns among students' behaviors. The way this study was designed, only apps that were free of charge were used. This limited some of the more engaging apps that are available. Another limitation was the fact that the researcher had to work around the students' schedule. Each student completed their sessions at different times due to scheduling conflicts and/or absences.

Appendix A

Math iPad Apps Scoring Rubric

Rater: _____ *App Name:* _____

Publisher: _____ *Recommended Grade Level:* _____

Math Concepts: _____ *Standards:* _____

1. The math in the app is completely accurate.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

2. The app prompts users to reflect on mathematical strategies and make connections among different representations of fractions and decimals.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

3. The app encourages students to think about fractions and decimals in a variety of ways and encourages the use of problem solving skills.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

4. The app includes different levels of difficulty to choose from or automatically increases difficulty as problems are completed.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

5. The app appeals to many different types of learners and the questions asked and possible answers vary in style.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

6. The app includes some sort of positive reward or has a goal for the user to meet.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

7. The app has an engaging setup and graphics that are interesting and motivating to the user.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Appendix B

Student iPad Interaction Checklist

Student Name:

App Name:

Date: Time:

Behavior	Frequency (#)	Time Behavior Occurred (minute #)	Comments
Asks to use bathroom or leave seat			
Unfocused in using app			
Makes comment about not wanting to work with the app			

Refuses to use app or leaves before time is up			
Makes comment about how fun the app is or shows enthusiasm			
Shows another student or teacher something from the app in an excited manner			
Reacts positively when they answer a question correctly or completes a level			

Overall Comments:

Activity:

Appendix C

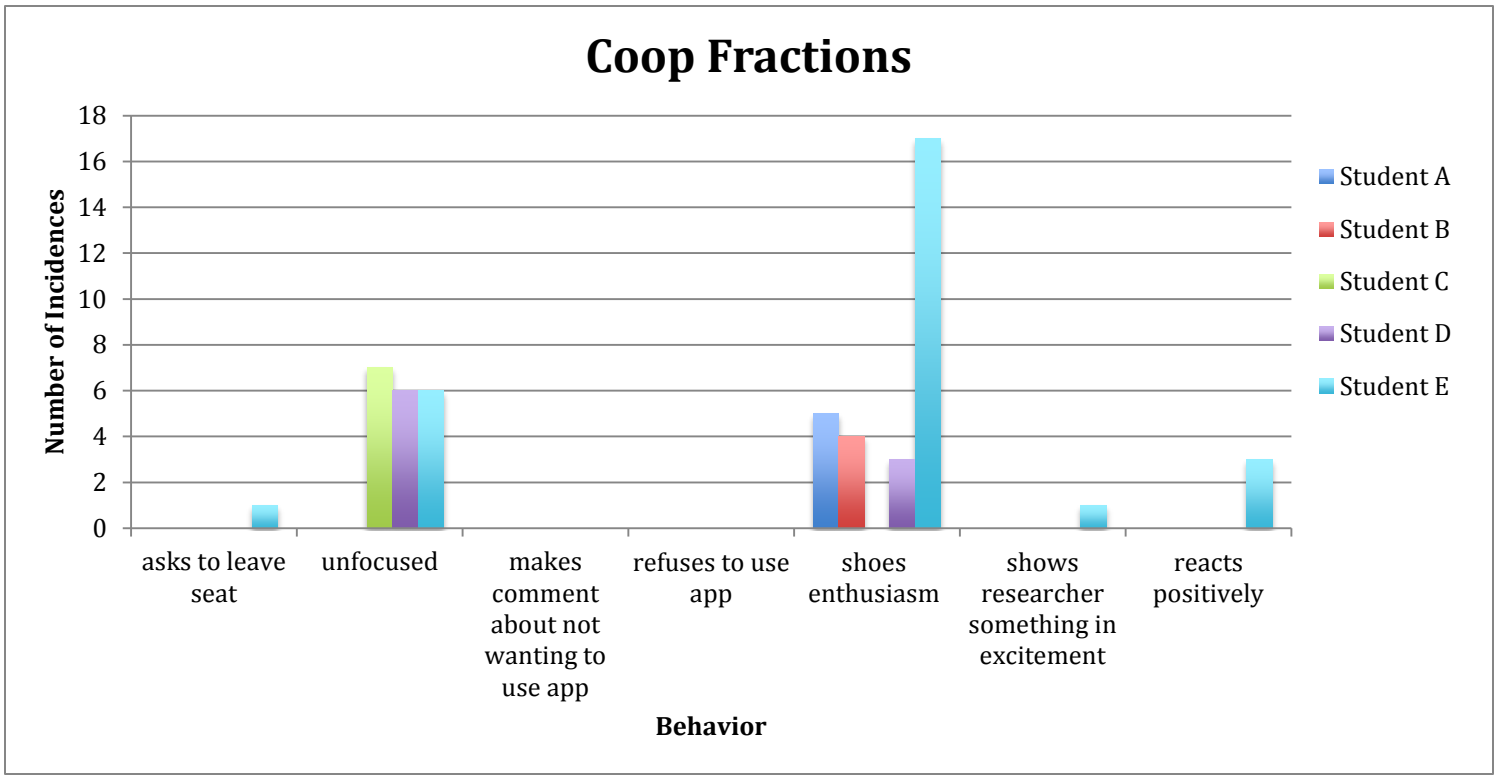
Interview Questions:

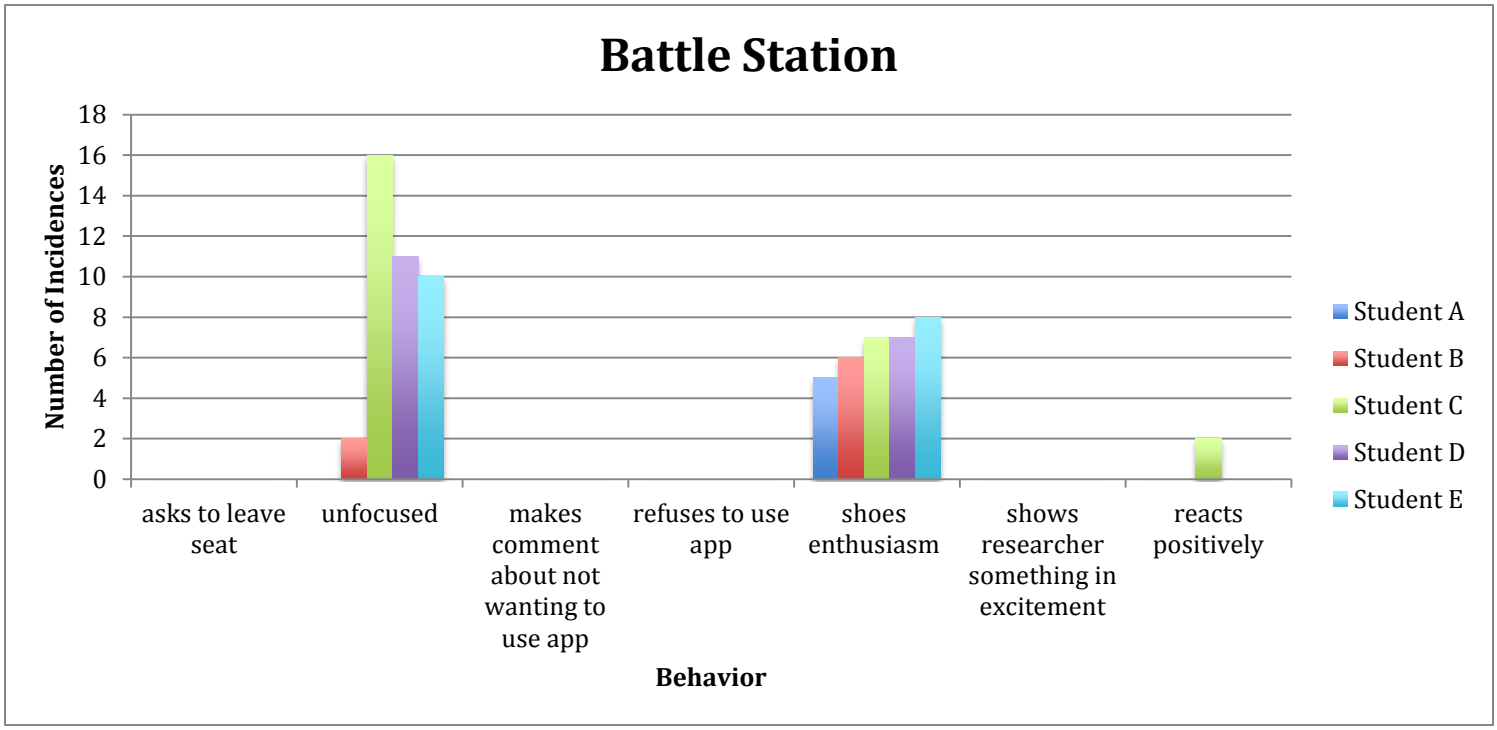
1. What do you think of the app?
2. Did you like playing with the app? What did you like about it?
3. Was the app boring or entertaining? For the whole time? Part of the time?
4. Was the math in the app too hard, too easy or just right?
5. Did you like being able to (or not being able to) change levels on your own?
6. What did you like/not like about the reward/goal system in the app?

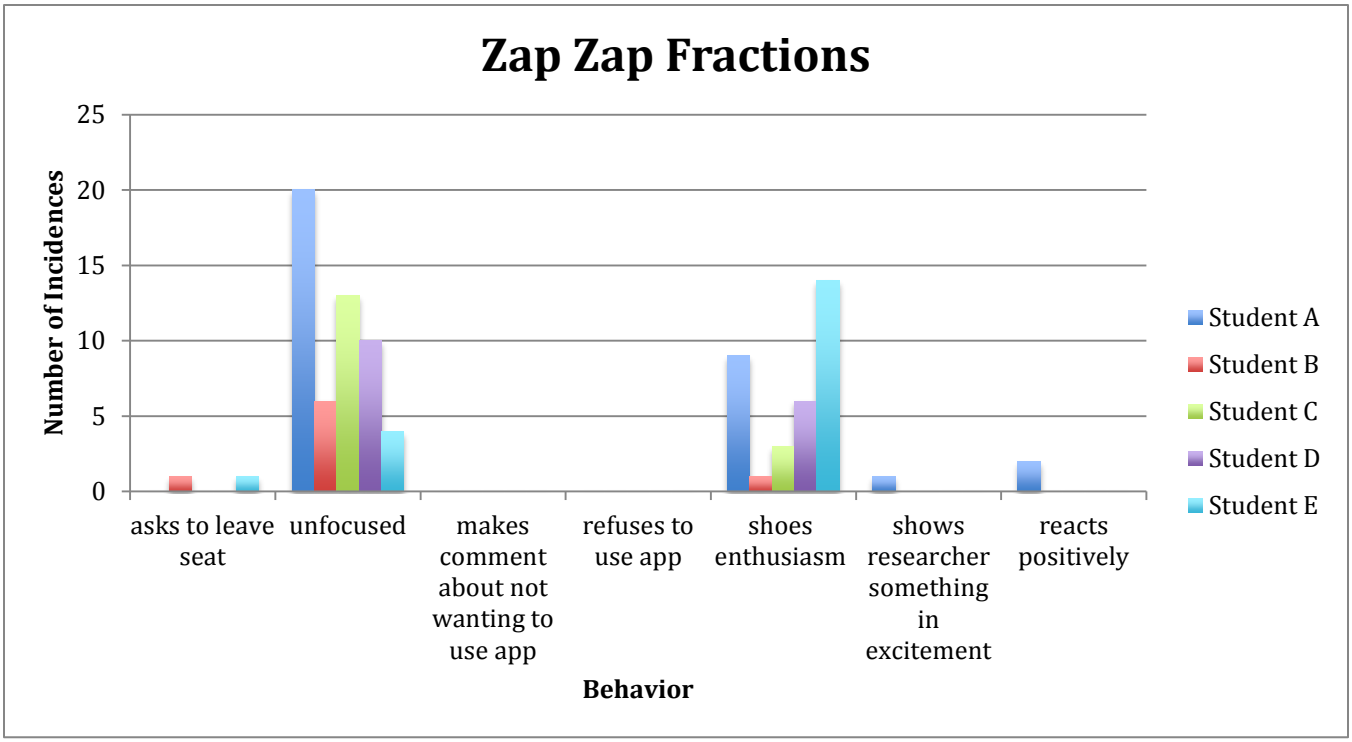
Appendix D

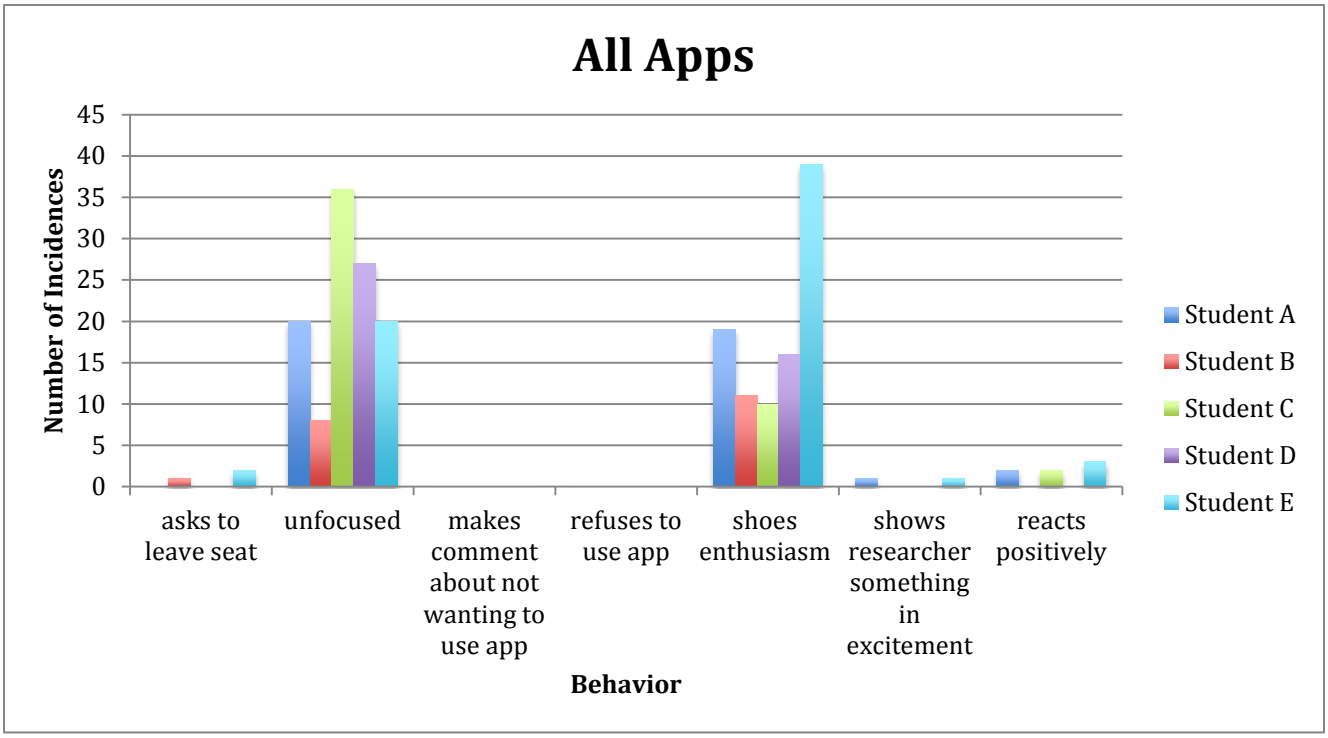
The table below indicates the results after examining the video clips of each student.

COOP FRACTIONS						
Behavior	**Student A**	**Student B**	**Student C**	**Student D**	**Student E**	**TOTALS**
1	0	0	0	0	1	1
2	0	0	7	6	6	19
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	5	4	0	3	17	29
6	0	0	0	0	1	1
7	0	0	0	0	3	3
TOTALS:	**5**	**4**	**7**	**9**	**28**	**53**
BATTLE STATION						
Behavior	**Student A**	**Student B**	**Student C**	**Student D**	**Student E**	**TOTALS**
1	0	0	0	0	0	0
2	0	2	16	11	10	39
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	5	6	7	7	8	33
6	0	0	0	0	0	0
7	0	0	2	0	0	2
TOTALS:	**5**	**8**	**25**	**18**	**18**	74
ZAP ZAP FRACTIONS						
Behavior	**Student A**	**Student B**	**Student C**	**Student D**	**Student E**	**TOTALS**
1	0	1	0	0	1	2
2	20	6	13	10	4	53
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	9	1	3	6	14	33
6	1	0	0	0	0	1
7	2	0	0	0	0	2
TOTALS:	**32**	**8**	**16**	**16**	**19**	91


Coop Fractions
Number of Incidences
18
16
14
12
10
8
6
4
2
0
asks to leave seat
unfocused
makes comment about not wanting to use app
refuses to use app
shoes enthusiasm
shows researcher something in excitement
reacts positively
Behavior
Student A
Student B
Student C
Student D
Student E


Battle Station
Number of Incidences
18
16
14
12
10
8
6
4
2
0
asks to leave seat
unfocused
makes comment about not wanting to use app
refuses to use app
shoes enthusiasm
shows researcher something in excitement
reacts positively
Behavior
Student A
Student B
Student C
Student D
Student E


Zap Zap Fractions
Number of Incidences
25
20
15
10
5
0
asks to leave seat
unfocused
makes comment about not wanting to use app
refuses to use app
shoes enthusiasm
shows researcher something in excitement
reacts positively
Behavior
Student A
Student B
Student C
Student D
Student E


All Apps
Number of Incidences
45
40
35
30
25
20
15
10
5
0
asks to leave seat
unfocused
makes comment about not wanting to use app
refuses to use app
shoes enthusiasm
shows researcher something in excitement
reacts positively
Behavior
Student A
Student B
Student C
Student D
Student E

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