

THE IMPACT OF A SKILLS-BASED SOFTWARE ON TEST SCORES

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Abstract

This study used a skills-based online math software to determine its impact on math performance. Students in grade five through grade eight participated in the study. The software was implemented following the winter performance series test. Students were tested again in the spring. Additionally, the study investigated the impact of the skills-based online software on student attitude toward mathematics. Finally, the study examined student perceptions of the skills-based online software. The results showed a positive impact on math performance and students recommended changes to the software to improve engagement. However, there was not a significant relation between math practice using the software and student attitudes toward math. Future research should consider a larger participation, a pretest and a posttest, and mandating the skills-based online software practice for all participants. Practitioners should search for a skills-based online software that meets the needs of student deficits and will provide engaging practice for improving math performance.

Keywords: skills-based software, math performance, student engagement

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Introduction

Background of the Problem

The knowledge students have in mathematics has increased some from 1990 to today (The National Assessment of Educational Progress, 2018). The NAEP has completed math assessments each odd year since 2000 and randomly from 1990 - 2000. Public and private school students in grades four, eight, and 12 were assessed to determine the comparison of math competencies through the years in the United States. Math achievement was divided into three levels: basic math achievement, proficient math achievement, and advanced math achievement. At the basic level, students achieved some mastery of fundamental skills. Students in the proficient level achieved some competency over challenging subject matter. Advanced level students demonstrated superior achievement with challenging subject matter. This report revealed a slight increase in math ability, not a significant increase.

In 2017 the scores for grades four and eight were not measurably higher than the scores reported in 2015. In 2017, school administrators reported that 20% of grade four students performed below the basic level, 32% at the basic level, 39% at the proficient level, and 8% at the advanced level. Also in 2017, 30% of grade eight students performed below the basic level, 36% at the basic level, 24% at the proficient level, and 10% at the advanced. Since a test was not administered to grade 12 in 2017, data was taken from the same test administered in 2015. Thirty-eight percent of students in 12th grade performed below the basic level, 37% at the basic level, 22% scored at the proficient level, and 3% scored at the advanced level (Mathematics Performance, 2018).

The statistics generated by this report show some progress for students in math competency, but not a notable amount of progress. The table below compares the scores from 2005 to 2015 (See Table 1). In 2005, 20% of students fell were below the basic ability level in

math. In 2015, only 18% were considered to be below the basic ability level in math. This demonstrates a 2% increase in ability level for 4th grade students. This data is not enough to prove that the United States is making significant progress in the area of mathematics. In 2005 2% of 12th graders were considered advanced and by 2015 their math ability increased by 1%. Again, this is not a significant increase (See Table 1) (Mathematics Performance, 2018).

Table 1

Percent of Students in levels on The National Assessment of Educational Progress Math Tests

	Below	Below	Basic	Basic	Proficient	Proficient	Advanced	Advanced
GRADE	2005	2015	2005	2015	2005	2015	2005	2015
4	20%	18%	44%	42%	31%	33%	5%	7%
8	31%	30%	39%	36%	24%	24%	6%	10%
12	39%	38%	38%	37%	21%	22%	2%	3%

(Mathematics Performance, 2018, p. 2).

The statistics showed very little change in math knowledge over the course of 10 years. This data could help explain the fact that a rising number of college students were not prepared for college-level math. Colleges across the country are offering remedial math courses for those students with gaps in their math knowledge (Foshee, Elliott, & Atkinson, 2016). Half of all college students take at least one remedial math courses (Scott-Clayton & Rodriguez, 2012). Foshee, Elliott, and Atkinson (2016) addressed this issue in a study using technology-enhanced learning (TEL) for college students who were in need of remediation in mathematics. This study showed that 75% of students who completed the remedial course using TEL, were ready for the first year college-level mathematics course (Foshee et al., 2016). This research presented the knowledge that students unprepared for college level math can be successful through the

intervention of a Technology Enhanced Learning (TEL) course offering math remediation. Math education through technology has been the topic of much research in recent years.

Statement of the Problem

Schools across the country have reported low scores in mathematics. The deficits have the potential to compound each year. Teachers, professors, and researchers have strived to find the best method for engaging students in mathematics in order to expand their knowledge from basic to at least proficient. Academically minded students come with intrinsic motivation and goals for their future. Many students have not developed these characteristics and therefore struggle when learning is difficult (Foshee et al., 2016). Changes need to be made so that more students can fill the gaps in their math knowledge. These changes need to begin in elementary school. When elementary students fall behind, their math deficiencies grow. By the time they are in middle school, the gaps in math ability can be substantial.

Significance of the Study

This study addressed the use of an online skills-based software to bridge the gaps in math knowledge for students in grades five to eight. The research question was: To what extent does the time spent on the skills-based online practice affect a student's math performance?

Technology has been used in the classroom increasingly over the past two decades (Fabian et al., 2018). An increase in usage can be attributed to the increase in accessibility. A classroom with a 1:1 ratio of student to technology can provide a great opportunity for effective learning (Delgado, Wardlow, McKnight, & O'Malley, 2015). Technology access provides a unique resource where the possibilities can be limitless for students in all subjects. The students in this study have consistent access to technology and were able to use the skills-based software when desired.

Theoretical Framework

Behaviorist learning theory postulates that students begin with a blank slate and add to the slate as they respond to a provided stimulus. Learning is determined by the behaviors that can be observed and measured (Good & Brophy, 1990). Learning that is designed to take place using online resources should include the following components: a list of objectives, an assessment, sequential instruction, and feedback (Anderson, 2011). These components will promote learning according to the theory of behaviorism (Anderson, 2011).

Cognitive learning theory focuses on the ability to process information. This theory suggests that learners need to map their own learning to create a deeper level of understanding. For online learning developers, this theory suggests the following strategies: using appropriate visual, audio, color, animation, and graphics in order to draw in the senses; giving prompts for items that students have to memorize; chunking information adequately; promoting deep processing in order to transfer information to long-term memory; providing different learning style instruction; presenting information in different modalities (verbal, textual, visual, etc.); and providing motivation for learners, intrinsic and extrinsic (Anderson, 2011). Additionally, learners should be able to collaborate with other learners and transfer learning to real-life situations.

The software used in this study combines more of the behaviorist theory than cognitive theory. Behaviorist components of the software include a list of skills, skills in order by grade level, assessments with every practice session, and immediate feedback as to whether the answer correct. Among the cognitive theory components needed in technology software, this software includes some color, some animated pictures, and all topics are chunked into one concept for each practice. The software does not include prompts, presentations in different modalities, nor does it promote deep processing.

Review of Research

Effects of Technology on Math Performance.

Technology is more accessible today than in previous decades. The cost of individual devices has reduced with the introduction of chrome books and affordable tablets. Studies have focused on the effects of technology-based learning on achievement. Two review of studies reported more positive learning outcomes than negative or insignificant. Crompton and Burke (2015) reviewed 48 studies researching the impact of mobile learning in mathematics, and 75% of those studies reported positive learning outcomes. Another review took place by Fabian, Topping, and Barron (2018). In this study 31 research documents were reviewed and 77% reported improved student achievement after using mobile technology. Although some studies have shown insignificant results or negative results, the majority of the studies have reported positive results from the use of mobile technology (Fabian et al., 2018).

In a study with 52 sixth and seventh graders there was a growth in performance (Fabian et al., 2018). The students practiced weekly using mobile devices over three months. A technology-enhanced learning (TEL) research study was performed by with 2880 college students in a remediation setting reported a successful results (Foshee et al., 2016). Among these participants, 75% were eligible for college-level math courses upon completion of this one semester program. Researchers claimed that the effective use of technology provided individualized learning and created academic achievement (Foshee et al., 2016).

Low-achieving math students can also be impacted by the use of technology. A study in the United Kingdom included 133 students age four to seven. Apps were used to provide repetition and interactive features to teach math skills (Outhwaite, Gilliford, & Pitchford, 2017). The conclusion from this study implies that low-achieving students attained lasting knowledge from the apps used on portable devices (Outhwaite et al., 2017). However, in a study of 104 fifth

grade students from two different elementary schools in a small rural community, the effects of iPad use during a nine-week time period, showed no significant change in math achievement (Carr, 2012). The researcher suggested that a longer time period and more students might impact a future study results (Carr, 2012). The data overall has helped to shape this new research study. Technology has changed so quickly that continued investigation would provide students the greatest technology-enhanced learning opportunities.

Level of Student Engagement.

Another important component of technology research is to determine the level of student engagement and motivation. Researchers asked designers to create a game that would be engaging and aligned with the instructional goal (Shelton & Scoresby, 2010). It took designers a few iterations and meetings with students from the class to determine the puzzles that would motivate students and engage them in the game. The purpose of this study was to develop software that offered students input into the components that engaged them in the game. Interactive fiction was added to the instruction so that students could interact with the characters. Designers focused on providing basic skills training and used student input to add more components to the interactive fiction (Shelton & Scoresby, 2010). This study may impact the way game designers are taught moving forward.

As student interest in mathematics and STEM related careers has waned, educators have researched to find motivating, engaging tools for math education (Okita & Jamalian, 2011). Some mediums such as computer-based math games and technology-implemented manipulatives have provided a boost for student engagement (Okita & Jamilian, 2011). One motivating factor has been providing a narrative along with the technology-based practice (Okita & Jamilian, 2011). In one study engagement correlated positively with self-efficacy (Ocumpaugh, San Pedro, Lai, Baker, & Borgen, 2016). Students in this study were more confident when

information was engagingly presented (Ocumpaugh et al., 2016). Finally, being successful in math should encourage students to complete more problems, develop confidence in math, and lead more students to consider careers in mathematics and STEM.

Attitude Toward Mathematics.

Some research has suggested that students had a more positive attitude toward mathematics after using technology-based learning options for practicing math skills. One study about fractions revealed that students liked fractions more after using a fraction video game available on iPads (Riconscente, 2013). Students also showed an increase in the perception of their math ability after using participating in a Technology Enhanced Learning study. (Foshee et al., 2016). A study that used three groups in this way: brain training video game for one group, brain training techniques for a second group and a third control group with no training (Miller & Robertson, 2010). The group with the video game intervention improved in global self-esteem but not in other areas of self-esteem and self-confidence (Miller & Robertson, 2010). Most recently a study showed a modest improvement in math test scores after technology-based intervention, but saw no increase in the students' attitudes toward mathematics (Fabian, Topping, & Barron, 2018).

Purpose of the Study

This research focused on a math skills-based software and the impact this practice had on test scores. More emphasis has been placed on designing educational games that are focused on the content that is needed to meet math skill deficits (Shelton & Scoresby, 2011). The software in this study, *mathgames.com*, is content based. The teacher assigned practice sessions to all students or to individuals. Skills are listed by grade level and by topic. Games are also available on this software that support the deficit skills. The practice assigned to students during this study met their individual needs based on the winter standardized test results.

Research Questions

1. To what extent does the time spent on the skills-based online practice affect a student's math performance?
2. To what extent does the skills-based online practice improve student attitude toward math?
3. How did students perceive the skills-based online practice?

Methods

Research Design

This research study was a mixed method study that included quantitative data gathered from standardized tests, skills-based online practice, and a survey of student attitudes toward math. The qualitative data was collected from interviews and a survey about student engagement in the math practice sessions. A mixed method design works well when research includes data with scores such as test scores and open-ended question surveys (Creswell & Guetterman, 2019). This research evaluated data from the quantitative perspective and the qualitative viewpoint. Quantitative data was evaluated to determine the impact of a skills-based software on test scores and student attitude toward math after the technology intervention. Qualitative data has been reviewed to understand student level of engagement with the software.

Students began the study with the winter Scantron performance series test. Following the test, students were assigned practice sessions using the skills-based online software, *mathgames.com*. All practice sessions in class were mandatory, while practice sessions at home were voluntary. This presented the study with a difference in the level of participation. A median split technique was applied to split the students into three groups based on their levels of practice: low, middle, and high. Students were divided into three groups depending on how many questions they answered. Students in the low group answered between 0 – 330 questions

using the skills-based software; students in the medium group answered 331 – 750 questions; finally, students in the highest group answered between 751 – 7914 questions. The percentage of correct answers on the questions students completed on the skills-based online software ranged from 57% correct to 98% correct. Dividing this number into three groups of similar size, there were 13 students who scored between 57%-79%, 13 students who scored between 80%-89%, and 12 students who scored between 91%-100%.

After the fall Scantron Performance Series test, students were assigned a target goal. The target goal was determined by a standard level of improvement and was different for each student. The NPR, National Percentile Ranking, is the national norm group for each student based on the student's grade in school and his/her scaled score. The scaled score uses the Rasch model to estimate a student's ability independent of his/her grade in school. All three scores were used to determine what impact the skills-based software had on these scores. The Target Goal, the NPR, and the Scaled Score were compared to the three groups of students, low, medium, and high number of questions answered and the percentage of correct scores answered on the practice sessions. A math attitude survey was also completed and compared to the level of practice and the percent correct on student practice sessions.

Student participants were invited to take a survey answering questions about their interest in the skills based software and how the software could be improved. Nineteen students also participated in an interview where they were asked several questions which are listed on the Student Interview Protocol, Appendix E. The surveys were recorded, transcribed, and coded for common themes.

Participants and Sampling

The study included students from a private elementary school that provides education for students in grades Pre-K3 to 8. Students in grades 5 to 8 were included in the study. During the study there were 213 students in the school. One third of the students at this school had scored below the National Percentile Rank of 50% on the fall performance series test. The participants included in the study had a range in ability from below grade level to above grade level. Many of the students were from middle-income families, however some students attend the school on scholarship and some students come from higher income families. Participants in the study ranged in age from 10-13. This school also accepts students with special needs that were within the school's ability to accommodate. Some students had physical disabilities while others could be diagnosed with attention deficit, dyslexia, tactile sensitivity, oppositional defiance, etc. The student population included the following: Caucasian, Hispanic, African American, and Asian.

The study included nine fifth grade students, 13 sixth grade students, eight seventh grade students and 8 eighth grade students for a total of 38 participants. There were 22 girls and 16 boys in the study. Caucasian students totaled 75% of the school's population, 23% were African American and 2% were Hispanic. Of the 38 students, one student was native to France and English was her second language. Sixty-nine percent of the students in the study were placed in upper level math classes at the school.

Research Setting

A religious school opened for students in kindergarten through 4th grade. In 1957 the community added a second story to the school building and students were accepted up through eighth grade. The administration of the school has included lay people in the Catholic Church. Teachers have come from a variety of Christian denominations. During the 2018-19 school year there were 213 students of whom 71% are Catholic. A non-partisan organization, AdvancedEd,

accredited the school whose teaching staff included 23 full time teachers, two part time teachers, and 4 teacher aides. The staff included one certified math teacher who taught fifth grade through eighth grade students, and one certified elementary teacher who taught math for third and fourth grade students. Pre-Kindergarten through grade two were also taught math by certified teachers.

The software utilized in the study, *mathgames.com*, provided individual skill practice for pre-kindergarten through 8th grade (See Figure 1). The math skills included in the software range from counting numbers to advanced algebra skills. Each practice session has the number of questions selected by the teacher (10 to 50 questions). The teacher assigned practice sessions for individuals or entire classes. Practice sessions were recorded and included the following data: accuracy, number of questions attempted, and the time spent on task. Students and teachers observed each student's report to evaluate progress. Games were also provided for additional practice of each skill (See Figure 1).

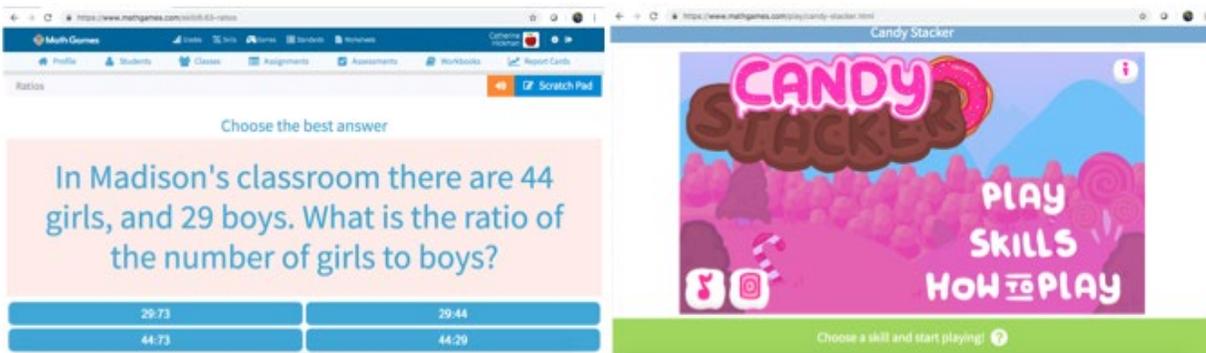


Figure 1, Mathgames.com Skill Practice Screen (left), Mathgames.com Game Screen (right).

Mathgames.com offered many of the components recommended by the behaviorist learning theory. Students were assigned practice sessions based on information they have previously learned which offers the sequential component. The software also provided immediate feedback for correct and incorrect responses. Intervention was individualized to meet the student's math deficit based on the winter performance series test. Another benefit was the

immediate assessment for students and teachers. During interviews and surveys the students answered questions about what they liked and disliked about to the software.

Instrumentation

Performance Tests.

Students take the Scantron Performance Series standardized test. This test provided data concerning individual achievement over time. The baseline data for this research was the winter test. The performance series testing provided statistical data using a variety of numerical results. The following numerical data was used for this study. The National Percentile Ranking, NPR, compared the student with the norm sample group within the same grade level (See Figure 2). The Scaled Score, SS, included a student ability rating based on the Rasch single-parameter computer adaptive model. The change in data was evaluated using the Scaled Score and the NPR from the winter test and the spring test. The annual target goal for each student were also used to determine the success of the intervention.

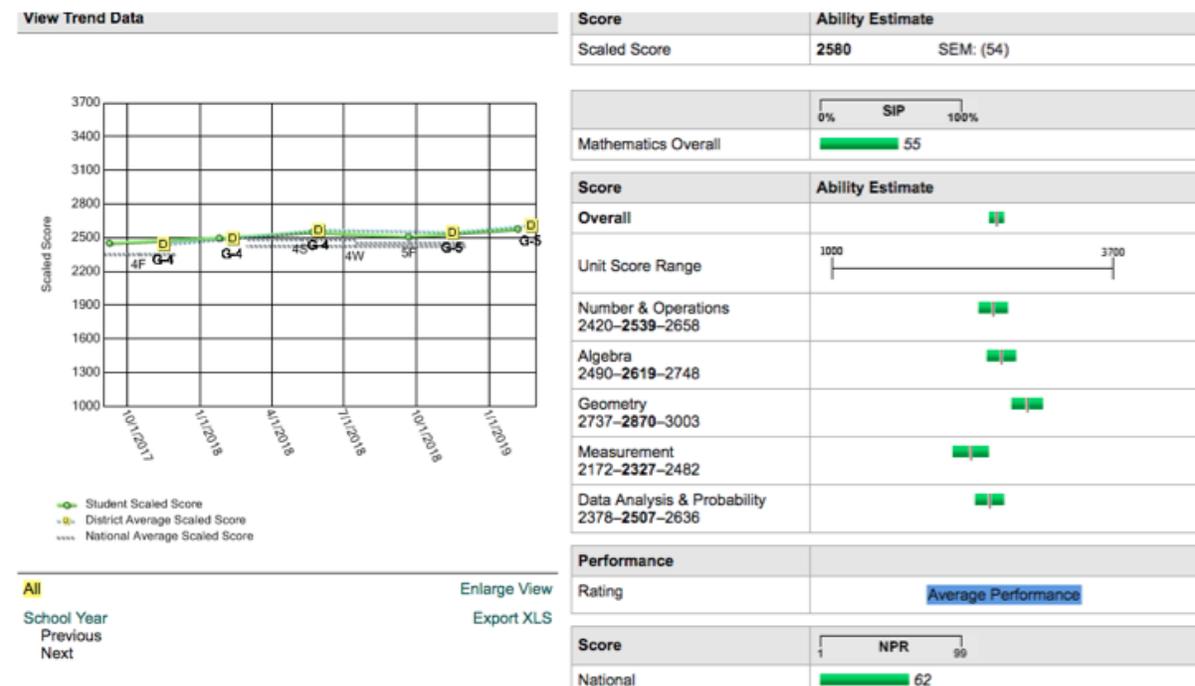


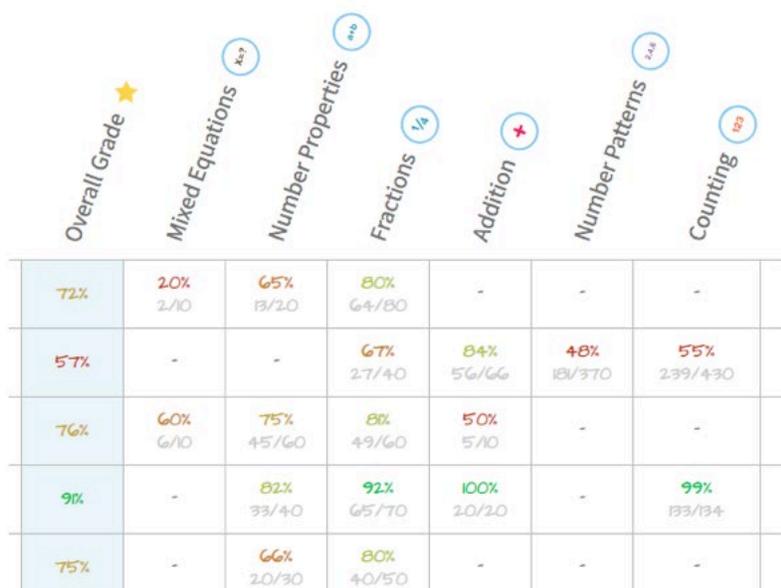
Figure 2. Performance Series Report (scaled score over time, SIP score, score by unit, & NPR).

Attitudes survey.

The attitude survey was adopted from Yaser (2014). One change was made to question 3. “I enjoy fiddling with maths in my free times,” was changed to “I enjoy exploring math in my free time”, (Yaser, 2014). The survey was administered through qualtrics.com. It was a Likert scale using the following: always, most of the time, about half of the time, sometimes and never. Student attitude toward math was compared to the number of questions answered on the skills-based online software and the score students received on the practice. The survey questions are located on Appendix D.

Skills-based online software

The skills-based software provided data for review. The software collects data on each student’s practice (See Figure 3). The number of sessions completed was recorded for each student and their mean score for the practice sessions. Students were divided into three groups, those who completed few sessions, those who completed more sessions, and those who



completed the most sessions. Students were also divided into three groups based on their mean scores for the practice sessions. Comparisons were made using the change in scores from the winter test to the spring test.

Figure 3. Mathgames.com Score Data Page showing the percent correct on various skills.

The student survey also included open-ended questions about their impression of the skills-based practice on *mathgames.com*. Students were then invited to participate in an interview related to their interest in the software. This provided detailed responses to questions about the practice sessions, features of the software that students like and dislike, confidence in math after completing the practice sessions, and technical issues or challenges with the software. The student survey was distributed electronically through *qualtrics.com* and evaluated using SPSS. The interviews were taped, transcribed and coded to find common themes. The interview questions have been included in Appendix E. All data has been evaluated based on the focus for the study: the impact of a skills-based software on test scores, student attitude toward math and ability in math, and software improvement needed for better student engagement.

Procedures

The participants in the study took the winter scantron performance series test at the beginning of February. After the test students were assigned practice sessions during the next 12 weeks. The spring test was given in May. Following the spring test, students were invited to complete a questionnaire. The student survey included math attitude questions and questions about their interest level in the software (see Appendix D). Thirty-seven students completed the questionnaire. Students were also invited to participate in an interview about the software and how they might change the software. Nineteen students participated in the interview (see Appendix F). All data was compiled and evaluated to determine the outcomes of the study.

Data Analysis

To determine the outcome of the study, data analysis included reports available through SPSS and coding of student interviews. Data to support the purpose of the study was evaluated in three categories: test results before and after the study, math attitude scale, and how to improve the software to increase engagement. This information provided quantitative data

results and qualitative data results. Each comparison has been evaluated to determine new information about the impact of the skills-based intervention.

Quantitative Data.

Time spent on the skills-based online practice impacting test scores and math performance.

Students were divided into three groups based on how many questions they completed on the skills-based software with approximately the same number of students in each group. An ANOVA test was performed to determine if the level of practice (low, medium, and high) impacted achievement of the target goal for each student. An ANOVA test was also run to determine the impact of students who scored lower, better, or the highest on their skills-based software practice sessions, compared to the change in scaled score from the winter to the spring standardized test. An ANOVA test was run to determine the three levels of practice compared to each student's NPR for the spring test.

Skills-based online practice and math attitude.

An ANOVA test was run to determine the relationship between a student's math attitude and their level of practice (low, medium, or high). This test was intended to determine if the amount of time spent practicing using the skills-based software had an impact on a student's attitude toward math. An ANOVA test was also run to analyze a relationship between a student's attitude toward math and the mean score on the skills-based online software.

Qualitative Data.

Student perception of the skills-based online software.

Thirty-seven questionnaires were completed asking students about their interest level in the skills-based software and what improvements would make the software more engaging. These open ended questions provided significant knowledge about the likes and dislikes of

students in relation to math software. Students were invited to participate in an interview asking questions about the software and changes that would increase student engagement. There were nineteen participants in the interviews. Interviews were transcribed and assessed for common themes.

Results

Quantitative Results

Time spent on the skills-based online practice impacting test scores and math performance.

Level of practice to target goal achievement.

Student activity level within the skills-based software was compared to their target goal achievement for the school year. Three out of 13 students in the low group met their annual target goal for the 2018-2019 school year. This represents 23% of the students in the low group. Six out of 13 students in the middle group met their annual target goal. This represents 46% of the middle group students. Lastly, nine out of 12 students in the highest group met their annual target goal. This represented 75% of the students in the highest group. A one-way between-subjects analysis of variance (ANOVA) was performed on meeting each student's target goal for the year as a function of the levels of the level of practice (low, middle, and high) using the skills-based online practice. There was a significant difference on the target goal among practice levels, $F(2, 35) = 3.787, p = .032$. The group of students who completed the most number of practices sessions also had the most number of students reach their math target goal for the year.

Level of practice to scaled score.

The difference in the scaled score from one testing cycle to the next testing cycle demonstrated a student's gain or loss in math knowledge. The scaled score was compared to the level of questions students completed on the skills-based online practice. A one-way between-

subjects analysis of variance (ANOVA) was performed on the scaled score as a function of the level of practice (low, medium, and high) using the skills-based online practice. There was not a significant difference on the scaled score among practice levels, $F(2, 35) = 2.621, p = .087$.

In looking at the data related to the change in scaled score for the spring semester, students who completed the medium number of questions answered raised their scaled score the least, a sum of 492 points. The students in the low group collectively raised their scaled score 606 points. The highest group had one less student, however they dramatically raised their combined scaled score a total of 1,286 points. The highest group raised their scaled score more than the other two groups combined. However, the ANOVA test showed that there was not a significant difference on the scaled score among the practice levels, $F(2, 35) = 2.621, p = .087$. This suggests the students who completed the most number of practices were not in the group that raised their scaled scores the most.

Level of practice to NPR.

A one-way between-subjects analysis of variance (ANOVA) was performed on the NPR of each student as a function of skills-based online practice. There were 3 levels of practice (low, medium and high). There was a significant difference on NPR among practice levels, $F(2, 35) = 5.986, p = .006$. The middle and high groups mean NPR scores were within 4 points of each other. Students in the middle and high groups had higher NPR scores, $F(2, 35) = 5.986, p = .006$. The group of students who completed the highest number of practice sessions also had the highest NPR scores. This shows that more practice using the skills-based online software helped students raise their National Percentile Rank.

Percent correct on practice to scaled score.

The one-way between-subjects analysis of variance (ANOVA) was performed on the scaled score as a function of the levels of correct answers (low, medium, and high) on the skills-

based online practice. There was not a significant difference on the scaled score among levels of correct answers $F(2, 35) = .601, p = .554$. This presents the least significant comparison of data. The middle group of students scored between 80-89% on their practice, raised their collective scaled score 1,094 points. Therefore, the groups of students who scored the best on their practice sessions did not raise their scaled scores the most. There was not a causal relationship between the percentage correct on practice and the number of points students raised their scaled score on the Scantron Performance Series testing.

Percent correct on practice to NPR.

The one-way between-subjects analysis of variance (ANOVA) was performed on the NPR as a function of the percentage of correct answers on the skills-based online practice. There was a significant difference on the NPR among score levels, $F(2, 35) = 5.871, p = .006$. When the score on practice sessions were compared to the NPR, a significant result was found, $F(2, 35) = 5.871, p = .006$. This demonstrated a significant difference from the comparison of the level of practice and the scaled score. The scaled score was a personal individual score based on each student's previous test and their improvement on the next test. The NPR was based on a student's level using their scaled score, their grade, and the average pool of students in that same grouping. The difference in the type of data might have explained the two very different results.

Skills-based online practice and math attitude.

	Question	Mean	SD	Variance
1	I enjoy solving math problems whenever I see them.	2.85	1.10	1.22
2	I feel happy when dealing with mathematics.	2.95	1.11	1.24
3	I enjoy exploring math in my free time.	3.89	0.87	0.77
4	I like math topics so much that I've started thinking about everything mathematically.	3.84	1.24	1.54
5	I like to practice math.	3.00	1.23	1.51
6	I think math courses are very enjoyable and fun.	2.54	1.15	1.33
7	I'm so bored in math class.	4.00	0.94	0.89
8	I think math is a very boring class.	4.32	0.96	0.92
9	I study math only to pass the course.	3.46	1.39	1.92
10	Math is the course I fear most.	4.08	1.30	1.69
11	I am annoyed by the fact that math is a course consisting of symbols and formulas.	3.95	1.29	1.67
12	I believe that the knowledge I get in math class will be useful in life.	2.08	1.24	1.53
13	I believe what I learn in math will work for me.	2.03	1.07	1.14
14	I think I will need math in my work life in the future.	1.81	0.94	0.88
15	I think that math has an important place in my daily life.	2.47	1.26	1.58
16	My friends think that I am successful at math.	2.67	1.18	1.39
17	I see myself as a successful student in math.	2.30	1.14	1.29
18	I am not a model student in math.	3.69	1.17	1.38
19	I think I am a good student in math.	2.35	1.17	1.36

Table 2. *Attitude Survey Questions Results (mean, standard deviation and variance).*

Level of practice to attitude toward math.

Student attitude toward math was compared to students who completed different levels of practice (low, middle, and high). The one-way between-subjects analysis of variance (ANOVA) was performed on the math attitude as a function of the levels of practice (low, middle, and high) on the skills-based online practice. There was not a significant difference on the math attitude among levels of practice, $F(2, 27) = .236, p = .791$. The Pearson Correlation test confirmed this with the following results, $r = -.024, n = 30, p = .899$. When comparing student attitude toward math with the student scores on their skills-based online math practice, we also find the ANOVA results as follows, $F(2, 27) = 2.432, p = .107$. In this study, the number of questions completed on the skills-based online software did not significantly impact student attitude toward math. A student who completed high numbers of practice sessions did not always have had the best math attitude.

Percent correct on practice to attitude toward math.

An ANOVA test was run comparing student attitude toward math and those who scored low, medium, and high percentages on their practice $F(2, 27) = 2.432, p = .107$. This test showed a somewhat linear graph and would be an indication that students who scores higher on their math practice have a better attitude toward mathematics. However, even though this was linear, the ANOVA test showed the significance level of .107, too high for making a definitive conclusion. Students who scored highest on their practice sessions did not necessarily have the best attitude toward math.

Qualitative Results

The qualitative results have been divided into three categories, (see Table 3). Students said they need a software that will help them learn or reinforce skills. The benefits and helpful means category focused on what students liked about the software or how the software help them. The dislikes were components of the software that were not helpful to students. Finally, the recommendation section gathered information concerning improving student engagement.

Table 3

Interview Results by Broader Topics (benefits, challenges with software, recommendations)

1. Benefits and means that help students	7 topics 38 comments
2. Dislikes, challenges, or drawbacks to the software	4 topics 15 comments
3. Recommended changes for the software	6 topics 15 comments

Benefits and means that help students.

The surveys and interviews present several benefits and means that the software was helpful to students. The brevity of the practice sessions (10 questions) was a positive attribute for many students.

Student 5 says, “I like that there are a good amount of questions, it’s not too little that you could do in 5 minutes, and it’s not too much that it overwhelms you.”

Students also liked the characters in the software.

“I like how the characters are cute and friendly and I like how it is not put into a real scenario,” student 3 related.

“I liked the characters because they made me feel better when I got a question right,” commented student 14.

Many students said that the software helped them learn many math concepts, while other students said the software helped to reinforce what they learned in class.

Student 3 said, “Yes, I do think it was helpful if I was struggling with a skill, it really helped me learn that skill more, progress in skill.”

“I think its more practice, it won’t teach you a lesson. I will get you better at it,” replied student 2.

Dislikes, challenges, or drawbacks to the software.

Several students wanted to know why they got a problem wrong. When a student gets a problem wrong on the software, it immediately reports that the answer was incorrect. If students were shown what they did wrong provides a greater opportunity for learning to occur. The software does not show the correct answer or how to work the problem correctly.

“I kind of want to see what I did wrong. It just tells you what it is wrong and does not tell you why it is wrong,” commented student 6.

Some students found that the game was too sensitive. Sometimes it would select an answer when you were not really choosing an answer.

“It doesn’t let you say submit. If you click on something by accident, it just goes as your answer,” said student 11.

Students were also interested in a pause between questions.

Student 7 commented, “If I were making a game I would give a pause so you could actually see what is going on in the game so you could pay attention to the game too. So a small pause so you can actually think about it.”

Recommended changes made to the software.

Students made several recommendations for changes to the software. One student talked about enhancements that would be more engaging. Avatars appear on many game sites and software including educational software. This student is engaged when having an avatar.

Student 8 said, “I would give you points and I would give you your own character and how many points you get from doing it correct you could use your points to change your avatar.”

Students would also like to see more games on the software.

“I liked the games where there were armies and stuff and castle games,” said student 12.

Student 5 stated, “Mathgames doesn’t have a lot of games on it. It has 16 and most of the games are straight forward, *without* a storyline.”

Many students suggested a help button, hints, or instructional videos.

“Maybe put hints so that students can learn more,” commented student 14.

A submit button was also suggested.

Student 19 said, “When you assigned us practice, and the questions were multiple choice sometimes the game would select an answer itself, and not the correct one. Maybe it was too sensitive.”

When asked about technical issues or challenges, student 11 suggested, “Just the submit button.”

Mixed Method Results

The goal of the study was to learn whether a skills-based online software could positively impact test scores. Students in the study used the skills-based online software to gain knowledge that would help raise their standardized test scores. The study drew on a few additional components: attitude toward math and their likes and dislikes of the software. This educational study has touched on the academic, attitude, and work ethic of students since the practice sessions were voluntary. The student attitude toward math can impact the amount of time a student spends practicing math. Students also presented their likes and dislikes when it comes to online practice. A student’s level of engagement, which was the qualitative data we collected, can impact a student’s attitude toward math or other quantitative data.

The students’ interest in the software could have impacted the outcome of the study. The practice sessions were voluntary therefore students may or may not have completed the assignments. Students who chose to complete more practice sessions were successful in relation to the NPR score and the annual target goal for the year. The engagement level of a math practice software can impact the amount of practice a student is willing to complete. The more a student practices, the more they will accomplish. Math practice that is engaging will encourage students to practice longer.

Discussion

Synthesis of Findings

Time spent on the skills-based online practice impacting test scores and math performance.

There is a positive trend linking the number of math questions answered by students and their test scores (NPR and Scaled Score). The more students practiced using the skills-based online software, the better their scores. This research reinforces the knowledge gleaned from the study of 52 sixth and seventh grade students. Weekly mobile device math practice over three months showed a growth in performance (Fabian et al., 2018). Another study of 104 fifth grade students showed mathematics achievement after the supplemental use of math related resources found on iPads (Carr, 2012). Twenty-one students out of 37 (56%) said that their math ability improved after using the software. During the 19 interviews, 12 students said that they learned many math concepts using the skills-based online software and six students said it was more practice than learning. These are not overwhelmingly positive statistics but they are more positive than negative which corresponds to the overall research about technology intervention for math students. The difference in this research was the software used and the resulting data.

Skills-based online practice and math attitude.

The data in this study did not show a significant relationship between skills-based online practice and attitude toward math. This represented that students who scored the highest on the practice sessions and students who completed the most number of questions were not the students with the highest math attitude as one might expect. A different result came from a study that showed a positive change in student self-confidence and value of mathematics, (Fabian et al., 2018). Findings in this study may have been impacted by the number of participants or by the skills-based online software, *mathgames.com*, chosen for the study.

Student perception of the skills-based online software.

Students are looking for math practice that is engaging. Technology is one medium that can engage students and positively impact achievement (Fabian et al., 2018). It was also determined that low-achieving children who use a tablet for intervention have made significant improvements in their math knowledge (Outhwaite et al., 2017). Additionally, college students have also been successful with technology-enhanced learning to remediate math skills (Foshee et al., 2016). Following the technology-enhanced intervention, 75% of the students were ready for college level math classes. When students were faced with a difficult skill such as fractions, the technology intervention that provided student engagement, a positive attitude toward fractions, and successful achievement would be valuable for all involved stakeholders (Riconscente, 2013). It was difficult to find software with a sufficient blend of content, engagement, and affordability. This study used an affordable skills-based option and students have revealed a few suggestions for the software creators and game developers.

Implications and Conclusion

The data showed a positive trend for test score results based on the three levels: low, medium, and high number of questions answered. This trend was positive in relationship to the change in scaled score, NPR, and meeting their target goal for the year. The group that completed more questions collectively increased their scaled score twice the middle group and more than three times the lower group. The target goal for each individual student's scaled score was reached by 75% of the students in the high number of questions group and only 23% by those in the lower number of questions group. When looking at the scores on student questions answered, the low group also had the lowest NPR. The middle and high group scored within 4 points of each other on their NPR.

Other factors may have contributed to the success of the students who completed more questions. Recognizing that students who completed fewer questions on the skills-based online practice may also have been the low achieving students. The lower achieving student's NPR would likely be lower, their increase in scaled score would be less, and their target goal would also suffer. Some additional components that may have impacted results were: students who studied more during the second semester, students who completed all of their homework assignments during the same time span, the impact of parents on a student's efforts, and students who paid attention to new instruction. Students also have matured through a school year. This could also have impacted test scores. The data, however, indicated that students who have completed a higher number of skills-based online practice sessions should see an increase in test scores.

Student percent correct scores on the skills-based online practice did not indicate a significant impact on the increase in scaled score. There was a higher impact noted in relation to the NPR score. The two different types of test scores could have been the reason for the inconsistency in the results. Almost all of the students scored a C or better on their math practice, 70% or higher. Students who scored 80% or 90% on their practice did not result in a higher change in scaled score.

Student attitude toward math was not linked to their math performance or the increased use of the skills-based online software. Although there was a positive trend, it was not significant enough to support the same findings in other research. One researcher used a math attitude survey before the intervention and at the end of the intervention. Self-confidence, enjoyment, or the value of mathematics increased after a month long intervention using mobile technology (Fabian et al., 2018). The research in this study used the math attitude survey only at

the end of the skills-based online intervention. The results of the survey did not significantly align with math achievement.

The interviews and the responses to the surveys about the software may have indicated that some students may have been trying to please their teacher. Students said they liked the skills-based software because they thought the teacher wanted to hear positive feedback. Some responses, however, were very candid and gave some insight into the likes and dislikes of students. Students were very honest about being bored with math practice. The level of engagement needed to keep students practicing was different for each student, but most were looking for practice that had fun components and that encouraged them with rewards. This information would be useful for those who are intending to write curriculum or create software to engage students.

Many students have access to online math software in the classroom. Math practice software can be found that is free of charge, moderately costly or very expensive. The cost for *mathgames.com* was minimal and provided access to up to 200 students. This software offered practice for most math skills from Kindergarten through 8th Grade. The software did not provide help screens or video lessons when students did not understand the problems. Students also wanted to be recognized for their accomplishments and this software kept a running total of their percentage scores. Students recommended providing an avatar they could name, configure, and provide with embellishments. This appeared to be a great motivator as this was mentioned several times in the interviews and surveys. Future practitioners may consider these topics when choosing a skills-based software.

Limitations and Recommendations

Several limitations were encountered in this study. The size of the population might have impacted the results. If the study had included more students, we may have seen some of the

results with a significance level below 0.05. In addition, the Scantron Performance Series testing is different from the Virginia Standards of Learning testing or the North Carolina End of Grade testing. The Scantron Performance Series individually tests a student to determine their baseline and subsequent tests track their growth. This means that everyone in one grade does not start at the same place on the Scantron Performance Series testing. The results based on the Scantron Performance Series testing may have impacted the overall findings. Finally, in this study students were not required to complete the online skills-based practice. This allowed some students to complete many practice sessions and some to complete few. It provided levels for determining data, but a different result could have been discovered if all students were required to complete the same number of practices.

Due to the limitations, there are three recommendations for further research. Future studies could select a larger setting from which to draw participants in the hopes of gathering a larger population for the study. A better testing indicator might have been the same pretest and posttest at the beginning and the end of the study rather than the scantron performance series test. This would allow the researcher to see a more definitive result in relation to the use of the skills-based online software. The attitude survey could have been given before the intervention and following the intervention. Lastly, it may have shown different results if students were all required to complete the same number of practice sessions. Removing these variables might have demonstrated the likelihood of all students raising their test scores after using the skills-based online software.

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Appendix A, Principal Permission Letter

January 7, 2019

Dear Dr. Brodeur,

I am conducting a study involving the impact of a math skill-based software on test scores. To conduct this study we need the participation of students, grades 5 – 8. The attached “Permission for Child’s Participation” form describes the study and asks permission for parents and their children to participate.

Recent studies have focused on technology, software, and applications and their impact on education. Several studies have researched how the digital medium for learning is viewed by teachers and how teachers integrate computer games in the classroom. One such study showed that applications with better affordances (portability, interactivity, context sensitive, connectivity, individuality and social media) are those that significantly impact learning. This research also discovered that teachers use many applications, even those that do not increase student math ability (Domingo, Garante, 2015). A second study stated that teachers integrate math computer games in the classroom if the games directly improve student achievement. Additionally, digital resources that are easy to use and relevant are more likely to be chosen for classroom instruction. (Callaghan, Long, Es, Reich, Rutherford, 2016).

Math classes can draw on two additional research studies. The first study concluded that using tablets in math class is an efficient use of technology and allows multiple mediums to reach students on the following domains: cognitive, affective-social, and psychomotor learning (Volk, Cotic, Zajc, and Starcic, 2017). The multi-modal interface with touch screens allowed students to transition between visual and abstract representations of a math problem. Most recently a study published in 2018 showed a modest improvement in math test scores but saw no overall increase in the students’ attitudes toward mathematics. “Ultimately, it is the teacher not just the technology that drives the change in the classroom (Fabian, Topping, Barron, 2018). Further research is recommended to determine the settings and circumstances in which technology in its many forms will impact learning and impact students’ attitudes toward learning.

This research will focus on a math skill-based software, and the students’ willingness to complete extra practice. In 2011 the research of Brett Shelton and Jon Scoresby noted that more emphasis has been placed on designing educational games that are focused on the content needed to meet deficits (Shelton and Scoresby, 2011). The software in this study represents the content, skill-based practice that Shelton and Scoresby were talking about. Games are also available on this software that support the skill that is being practiced. What is motivating about this software and what could be improved? Does this software engage the students in the practice? This software can be individually assigned to students for specific gaps in knowledge, providing a direct intervention for students with deficits in specific math skills as. If school systems have the data showing individualized needs and a technology instrument that can target those needs, is that enough to improve test scores? What are the additional factors that impact students’ math knowledge? We have so much to learn about students and what can be done to affect change in math knowledge and ability. The importance of this study is to discover ways to assist students in narrowing the gaps in their mathematical skills.

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The details and procedures are listed below in the Permission for Child's Participation Document. Your permission is required in order to perform the study. Please sign below stating that you give me permission to proceed.

Sincerely,

Mrs. Cathy Hickman

Chick008@odu.edu

chickman@ctkparish.org

757-625-4951

Mrs. Catherine Hickman has permission to conduct this study: **The Impact of Online Math Skills Practice on Test Scores**, at Christ the King Catholic School.

Dr. Terri, Brodeur, Principal

Christ the King Catholic School

Appendix B, IRB Exempt Form Hickman

APPENDIX B
OLD DOMINION UNIVERSITY
APPLICATION FOR EXEMPT RESEARCH

Note: For research projects regulated by or supported by the Federal Government, submit 1 hardcopy of this application and 1 electronic copy to the Institutional Review Board. Otherwise, submit to your college human subjects committee.

Responsible Project Investigator (RPI)

The RPI must be a member of ODU faculty or staff who will serve as the project supervisor and be held accountable for all aspects of the project. Students cannot be listed as RPIs.

First Name: Tain	Middle Initial:	Last Name: Luo
Telephone: 757-683-5369	Fax Number: 757-683-5227	E-mail: tluo@odu.edu

Office Address: Education Building 43rd and Hampton Boulevard #4106

City: Norfolk	State: Virginia	Zip: 23529
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Department: STEM Education and Professional Studies	College: Darden College of Education and Professional Studies
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Complete Title of Research Project: The Impact of Online Math Skills Practice on Test Scores	Code Name (One word): Math
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Investigators

Individuals who are directly responsible for any of the following: the project's design, implementation, consent process, data collection, and data analysis. If more investigators exist than lines provided, please attach a separate list.

First Name: Catherine	Middle Initial: T	Last Name: Hickman
Telephone: 757-286-5671	Fax Number:	Email: chick008@odu.edu

Office Address: 228 College of Education

City: Norfolk	State: Virginia	Zip: 23529
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Affiliation: Faculty Graduate Student Undergraduate Student
 Staff Other _____

First Name:	Middle Initial:	Last Name:
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Telephone:	Fax Number:	Email:
------------	-------------	--------

Office Address:

City:	State:	Zip:
-------	--------	------

Affiliation: Faculty Graduate Student Undergraduate Student
 Staff Other _____

List additional investigators on attachment and check here: _____

Type of Research

1. This study is being conducted as part of (check all that apply):

- | | | | |
|-------------------------------------|-----------------------|--------------------------|---------------------------------------|
| <input type="checkbox"/> | Faculty Research | <input type="checkbox"/> | Non-Thesis Graduate Student Research |
| <input type="checkbox"/> | Doctoral Dissertation | <input type="checkbox"/> | Honors or Individual Problems Project |
| <input checked="" type="checkbox"/> | Masters Thesis | <input type="checkbox"/> | Other _____ |

Funding

2. Is this research project externally funded or contracted for by an agency or institution which is independent of the university? Remember, if the project receives ANY federal support, then the project CANNOT be reviewed by a College Committee and MUST be reviewed by the University's Institutional Review Board (IRB).

- Yes (If yes, indicate the granting or contracting agency and provide identifying information.)
 No

Agency Name:

Mailing Address:

Point of Contact:

Telephone:

Research Dates

3a. Date you wish to start research (MM/DD/YY) 02 / 1 / 2019

3b. Date you wish to end research (MM/DD/YY) / /

NOTE: Exempt projects do not have expiration dates and do not require submission of a Progress Report after 1 year.

Human Subjects Review

4. Has this project been reviewed by any other committee (university, governmental, private sector) for the protection of human research participants?

- Yes
 No

4a. If yes, is ODU conducting the primary review?

- Yes
 No (If no go to 4b)

4b. Who is conducting the primary review?**5. Attach a description of the following items:**

- Description of the Proposed Study
 Research Protocol
 References
 Any Letters, Flyers, Questionnaires, etc. which will be distributed to the study subjects or other study participants
 If the research is part of a research proposal submitted for federal, state or external funding, submit a copy of the FULL proposal

Note: The description should be in sufficient detail to allow the Human Subjects Review Committee to determine if the study can be classified as EXEMPT under Federal Regulations 45CFR46.101(b).

Exemption categories

6. Identify which of the 6 federal exemption categories below applies to your research proposal and explain why the proposed research meets the category. Federal law 45 CFR 46.101(b) identifies the following EXEMPT categories. Check all that apply and provide comments.

SPECIAL NOTE: The exemptions at 45 CFR 46.101(b) do not apply to research involving prisoners, fetuses, pregnant women, or human in vitro fertilization. The exemption at 45 CFR 46.101(b)(2), for research involving survey or interview procedures or observation of public behavior, does not apply to research with children, except for research involving observations of public behavior when the investigator(s) do not participate in the activities being observed.

(6.1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Comments:

The research study is a case study that incorporates quantitative data gathered from a variety of sources, and qualitative data collected from surveys completed by students and parents and interviews with a selection of participants. The quantitative data will include the following: performance series test scores, the number of skill-based practice sessions each student completes, the scores each student receives on these practice sessions, and the amount of time each student spends skill-based games. The qualitative data will include: a survey completed by students in the study, a survey

completed by parents of students in the study, interviews with a strategically selected list of participants. The winter performance series test scores will be the used as the baseline data for this study. Students will be assigned skill-based online practice at Mathgames.com. These assignments are based on gaps that have been identified during the fall performance series test and are assigned individually. Students have been using this website, mathgames.com, to practice skills we have been learning in class and to practice skills that are gaps in knowledge. This is not a new educational practice for students who will participate in this study.

 X (6.2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; AND (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Comments:

This research study will use data collected from each student through the software, Mathgames.com. Students will also be asked to keep a tally of time they spend playing additional games on the website related to the skills assigned them each week. All assignments will be individually determined based on the gap in skills as identified by the Scantron Performance Series test in January. Students who choose to participate will not receive any special benefits (extra credit on their grades, financial compensation, preferential treatment). Students who do not choose to participate will still receive the weekly assignments, however, their scores will not be used in the study. Student names will not be used in the study. Each student will be identified by a code rather than a name. All data and participant information will be kept confidential. The data will be destroyed after the research has finished by deleting all the files from the computer and permanently deleting from the Recycle bin.

Before analyzing student data, we will assign a code for each student's data file, remove the identifiers and replace the student's name with the numerical code. A paper copy of this document will be kept in the records closet that is locked and kept confidential by the office manager. This document will be destroyed at the end of the study.

The electronic files where we keep the research data will only be saved in password-protected personal computers to which only the researchers have access. The data will be destroyed after the research has finished by deleting all the files from the computer and permanently deleting from the Recycle bin.

All responses will be confidential and only aggregated or agglomerated test results and survey data will be published. Pseudonyms will be used to present qualitative data.

 (6.3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if:

(i) The human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

Comments:

<p>___ (6.4) Research, involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. Comments:</p>
<p>___ (6.5) Does not apply to the university setting; do not use it</p>
<p>___ (6.6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture. Comments:</p>

Human Subjects Training

7. All investigators (including graduate students enrolled in Thesis and Dissertation projects involving human subjects) must document completion of the CITI Human Subject Protection course.
 (Attach a copy of all CITI Human Subject Protection completion certificates.)
 Date RPI completed Human Subject Protection training: 10/10/2017

<p>PLEASE NOTE:</p> <ol style="list-style-type: none"> 1. You may begin research when the College Committee or Institutional Review Board gives notice of its approval. 2. You MUST inform the College Committee or Institutional Review Board of ANY changes in method or procedure that may conceivably alter the exempt status of the project.
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<p>Responsible Project Investigator (Must be original signature)</p>	<p>Date</p>
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Appendix C, Student Recruitment Letter

MATH SOFTWARE STUDY

My name is Mrs. Cathy Hickman. I work at Christ the King Catholic School as a Math teacher and am a student at Old Dominion University.

I am asking you to take part in a **research study** because I am trying to learn more about math software and how it impacts standardized test scores. I want to learn about the types of math practice students your age like and if that practice can help you learn more math skills and improve your test scores.

All students (***participants in the study and non-participants in the study***) will be assigned math practice from the website mathgames.com. This is the website that we have been using in class and for home assignments. Each student will be assigned practice based on missed questions from the winter scantron test. All students will also be asked to keep a log of the amount of time you play games and the name of the game on this website. These practice sessions are voluntary. They are not required and are not graded. Students will not receive any direct benefits from participating in the study.

If you agree to participate in the study, you will be asked to complete a survey about the practice sessions. It will take approximately 10 minutes to complete the survey. Your name will not be used in the study.

Participant Responsibilities:

1. Practice using the website (you can complete as many practice sessions or none at all)
2. Keep a log of games you play (I will give you the form)
3. Complete a survey (approximately 10 minutes of your time)
4. Some students will be invited to participate in an interview with the Mrs. Hickman to answer questions about the study. (10 minutes)

You do not have to be in this study. No one will be mad at you if you decide not to do this study. Even if you start the study, you can stop later if you want. You may ask questions about the study.

If you decide to participate in the study all personal information will be private. The number of practice sessions, scores, game log and survey will be labeled with a number code instead of your name.

Signing here means that you have read this form or have had it read to you and that you are willing to participate in this study.

Signature of subject _____

Subject's printed name _____

Signature of investigator _____

Date _____

Appendix D, Student Survey

Student Survey

Start of Block: Default Question Block

Q1 Answer each question based on your attitude toward math.

	Always (1)	Most of the time (2)	About half of the time (3)	Sometimes (4)	Never (5)
1. I enjoy solving math problems whenever I see them. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I feel happy when dealing with mathematics. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I enjoy exploring math in my free time. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I like math topics so much that I've started thinking about everything mathematically. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I like to practice with math. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I think math courses is very enjoyable and fun. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. I'm so bored in math class. (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I think math is a very boring class. (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. I study math only to pass the course. (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Math is the course I fear most. (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. I am annoyed by the fact that math is a course consisting of	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

symbols and formulas. (11)					
12. I believe that the knowledge I get in math class will be useful in life. (12)	<input type="radio"/>				
13. I believe what I learn in math will work for me. (13)	<input type="radio"/>				
14. I think I will need math in my work life in the future. (14)	<input type="radio"/>				
15. I think that math has an important place in m daily life. (15)	<input type="radio"/>				
16. My friends think that I am successful at math. (16)	<input type="radio"/>				
17. I see myself as a successful student in math. (17)	<input type="radio"/>				
18. I am not a model student in math. (18)	<input type="radio"/>				
19. I think I am a good student in math. (19)	<input type="radio"/>				

Q3 What did you like about the practice sessions? Check all that apply.

- They only had 10 questions. (1)
 - All of the questions were the same topic. (2)
 - The questions were clear and easy to understand. (3)
 - I liked getting the correct answer. (4)
 - Other (10) _____
-

Q7 What did you dislike about the practice sessions? Check all that apply.

- The practice is boring. (1)
 - Know why I got the question wrong. (2)
 - The questions were too hard. (4)
 - The practice sessions were too long. (5)
 - Other (6) _____
-

Q4 How would you change the website to make it more appealing to you, if you were the designer of www.mathgames.com?

Q5 My math ability improved after using this software.

- Strongly Agree (1)
 - Agree (2)
 - Neither Agree or Disagree (3)
 - Disagree (4)
 - Strongly Disagree (5)
-

Q6 In your own words, describe your experience with the practice sessions from www.mathgames.com.

End of Block: Default Question Block

Appendix E, Student Interview Protocol

Student Interview Protocol

Time of Interview	
Date	
Place	
Interviewer	
Interviewee	
Position of Interviewee	

- a. **PURPOSE:** The purpose of the study is to discover if online math practice targeting gaps in learning will help to increase math test scores.
- b. **INDIVIDUALS AND SOURCES:** Students in grades 5 - 8 will use online practice related to their gaps in math knowledge after completing the winter standardized test (Scantron Performance Series). The software that will be used is mathgames.com. We will end the study when the standardized test is administered in May.
- c. **CONFIDENTIALITY:** Students' names will not be used and their data will be given a code rather than a name. All documents will be stored in a locked closed and kept confidential by the office manager and destroyed at the end of the study.
- d. **TIME:** This should take 10-15 minutes.

Questions

1. In your own words, describe your experience with the mathgames.com.
2. What would you change about the practice on mathgames.com?
3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?
4. If you were designing the math practice software, what would you do differently?
5. How much do you think you learned using the practice on mathgames.com?
6. Did you play games on the software? If yes, what games did you like and why did you like them?
7. Were there technical issues or challenges when using the software for math practice?

Appendix F, Interview Transcriptions

INTERVIEW TRANSCRIPT**Student 1**

1. In your own words, describe your experience with the mathgames.com.

Math games is a really cool website. What you might think is fun, there are a lot of things that are fun, there are these little games where you can choose your grade and choose what type of skill, yeah, skill you want to do. You can actually play it, it is kind of addicting. If you keep on playing it over and over again it makes you smarter and it can actually help. You can also get assignments from the teacher and that's also fun to do too, because it is challenging and its like playing the game like a quiz.

2. What would you change about the practice on mathgames.com?

I wouldn't really change anything. It is kind of good how it is.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I liked how you can unlock the next levels. When you finish one level of questions and they say how good you did, then you can go the next level, then go to the next level, until you finish 4 sets, then its actually fun.

4. If you were designing the math practice software, what would you do differently?

I would probably add more games. There are enough games and I have played a lot of them, and they are like, I don't know how to say it, kind of slow. I think adding on new games then having children play it and they would be so excited. Probably adding more games.

5. How much do you think you learned using the practice on mathgames.com?

Probably a lot. Sometimes I use it at home and it helps me practice for a test sometimes and it helps me to focus on what we did in class. Sometimes I would do a kahoot on what our test will be on but before that I would go on math games and practice because I think it is more helpful.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

Yeah, there is this one game that came out it is called Viking Queen something. I just played the game and didn't care about the title. That's just one that I played. I forgot the other one. There are other games and they are also new, but they are getting old because they were new a long time ago. They were out in March. I just want to play the new ones now.

7. Were there technical issues or challenges when using the software for math practice?

Not really. I never experienced any but I remember my brother was playing this game and he is in 4th grade but there are things that he did not learn in 4th grade and he has to go to the things that are in the 3rd grade. So whenever he has to go over and over. So he has to clicking it until he wins the game. Then he goes on another game and practices the same skill. I say if you just want to practice you could just challenge yourself and pick other skills, like don't do all multiplication, do subtraction or addition instead of doing multiplication over and over again.

INTERVIEW TRANSCRIPT

Student 2

1. In your own words, describe your experience with the mathgames.com.

I enjoy mathgames. I like the graphics but I feel like some of the games are really boring, they didn't have like a fun setup. But we are also used to super fun games without any education, so when we change that into having to learn something, that kind of makes it less fun.

2. What would you change about the practice on mathgames.com?

No, I liked those, I wish that sometimes you could press enter so sometimes you have to click something like your are moving and you have like a mouse and you tap it too hard as you are going, it sometimes thinks you clicked that and then you get the answer wrong. "You have trouble getting it right because the game thinks you are picking an answer that you didn't pick. It is too sensitive when you touch it" Yes

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I liked the, like the practices?, "yes", I liked the simplicity, like it is not super extra you just have your problem. The drawing part, the eraser doesn't work, so if I draw on it, I can't. But it resets for each question, but if I do something wrong you have to just cross it out, scribble over it instead of erasing it, even though there is an eraser. You select the eraser and it doesn't erase.

4. If you were designing the math practice software, what would you do differently?

Again, I would have a confirm button so when it thinks that we want to select something and we are just moving the mouse around. "I see what you are saying, so you can tell me if this is what you are thinking, When you have your hands near the device, it accidently clicks on a button you don't want to or you might, can you explain that better for me". So, you know how on a laptop,

you know how it has the touch pad, sometimes when you are moving the cursor around to select another answer, it thinks you are trying to select that answer. Sometimes we get it wrong, but if we had a lock in button or like a confirm button. You could click on one a wrong answer, then change it and click on the right answer and click a confirm button.

5. How much do you think you learned using the practice on mathgames.com?

I think its more practice, it won't teach you a lesson. It will get you better at it.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

I think most of the games, there were some that go too fast and you couldn't think, if it was a really hard question and you have like 2 seconds to answer it and you would always get it wrong. Then some are too easy too, like you get as much time as you want and it is not a super hard questions. "Not a balance between the two?" There are some games that I think are fun and so are at my level.

7. Were there technical issues or challenges when using the software for math practice?

Sometimes it just wouldn't load. I would have good internet and I would check other sites to see if the internet is o.k. and I had perfect internet, but it still wouldn't load and I would have to restart it. Sometimes it wouldn't load the questions, it would load the answers but not the question. So you have to wait

INTERVIEW TRANSCRIPT

Student 3

1. In your own words, describe your experience with the mathgames.com.

I do like mathgames.com because the teacher can assign the lesson based on what you have learned in class and you can practice at home. It has games you can practice for fun, because you teacher can give you an assignment and after you complete the assignment you still want to practice that, you have the games and you can choose whatever games you want and you can still have that same concept. I like that and also how the games progress, they get harder when you go along and that really helps. So when you know something and it really helps 'when the problems' get harder and harder, you know what I mean. One think that is kind of confusing is to find what you want to practice in the games. It like has different categories, but if you want to learn something specific, I don't know if it's in the games or in that category. Also, some of them, it has like these letters and they are supposed to stand for something, but I do not know

what they stand for. “They are codes that stand for probably standards of learning.” I didn’t know that and it got kind of confusing because some of the games would have a code and I didn’t know what they meant.

2. What would you change about the practice on mathgames.com?

Maybe some tools that can help you. Like maybe before you start you could see a little helping video to remind you how to do the problems, and if this is something an assignment that you really have to struggle with, if it had a video that would help you. I do really like how you can draw on the screen for the math problem. That’s really helpful, but a video would really help and maybe some tools like a calculator on the screen and you could pull the calculator on the software itself.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

Yeah I like how the characters are cute and friendly and I like how it is not put into like a real scenario.

4. If you were designing the math practice software, what would you do differently?

Maybe, I think like achievements you could earn. You could try to set a goal when you get on, like a daily limit, how long for each day and achievements so you would work up to those achievements.

5. How much do you think you learned using the practice on mathgames.com?

Yes, I do think it was helpful if I was struggling with a skill, it really helped me learn that skill more, progress in a skill.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

There was this one game I thought was really weird, you are feeding the person a lot and once you answer a certain number of questions it barfs. The little person gets bigger and bigger and then it barfs, I was like what the heck is this game Caitlin. I saw the bombs, what’s happening to this guy. It gets bigger and bigger, then and it goes back to its original size. That game was like oh geez.

7. Were there technical issues or challenges when using the software for math practice?

No. It loads pretty fast and that’s good.

INTERVIEW TRANSCRIPT**Student 4**

1. In your own words, describe your experience with the mathgames.com.

It was good. Some of the games were too easy, but overall with the different skills, when you press 6th grade, then you press fractions and decimals. Some of the games related to these topics were weird, they just kept on going. Some of them I did not want to keep playing the games, but some of them were more challenging. Then there was a game called candy stacker, and I kept on getting it right and it kept on going. "So it got harder?" Yeah sort of.

2. What would you change about the practice on mathgames.com?

I don't know. I do remember practicing the skills and then getting to play the games.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I thought it was really creative, but this one game when the questions got really harder, they would all just start shooting at me. Then I thought it was something with the internet, but it wasn't. I thought the characters and the themes were good.

4. If you were designing the math practice software, what would you do differently?

Maybe a little more challenging, maybe more three-D, maybe two player games.

5. How much do you think you learned using the practice on mathgames.com?

I remember how to do fractions, multiplying and dividing fractions. I forgot how to do decimals and I practiced that and one skill was rounding and I did some of that.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

They were o.k.

7. Were there technical issues or challenges when using the software for math practice?

When it go more challenging and more faster, it would come really fast and you wouldn't have time to answer the questions. Then you would die. The internet and the wifi could be a challenge. Then one time I tried to quit a game and it kept going.

INTERVIEW TRANSCRIPT**Student 5**

1. In your own words, describe your experience with the mathgames.com.

Mathgames is pretty good, I learn a lot. It helps me a lot. I sometimes find that most of the questions on the games you need a calculator. It is not stuff you could do in your head. That's the only problem I have with it.

2. What would you change about the practice on mathgames.com?

Sometimes I would change the questions because it is confusing what it is asking you to do.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I like that there are a good amount of questions, it's not too little that you could do in 5 minutes, and it's not too much that it overwhelms you. It is a good amount of questions. It takes you a lot of work but it's not an overwhelming amount of questions.

4. If you were designing the math practice software, what would you do differently?

Maybe more games, a lot of games. Mathgames doesn't have a lot of games on it. It has 16 and most of the games are straight forward and also more of a story line.

5. How much do you think you learned using the practice on mathgames.com?

Yep. I think I have learned a lot practicing on Mathgames.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

No

7. Were there technical issues or challenges when using the software for math practice?

Sometimes it takes a long time to load. Sometimes it could be the wifi.

INTERVIEW TRANSCRIPT**Student 6**

1. In your own words, describe your experience with the mathgames.com.

So mathgames has kind of worked well for me. But I kind of get annoyed with it sometimes.

One thing, I have to wait for the next problem since they shoot a laser or something. Also with the choices for math, when I go to math 6 part, most of it is too hard for me.

2. What would you change about the practice on mathgames.com?

I don't think anything for the practice session, but I kind of want to see what I did wrong. It just tells you that it is wrong and does not tell you why it is wrong.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I don't really like the character.

4. If you were designing the math practice software, what would you do differently?

I would like to show them what they did wrong. "Having help screens or something like that."

Yes

5. How much do you think you learned using the practice on mathgames.com?

Math games is kind of review for me. I don't think I learned from it. If I go and explore the games you can play, if its too hard for me, they won't tell me what I did wrong so I won't know how to do it. "You have it more readily available because you practiced it but not because you learned it on math games." Yes.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

There is this Candy Stack game I really liked but I don't like how you have to wait with the question. Since I like to answer it quickly where you answer, answer, answer. Then you have to wait for it to shoot a laser or something, then do your next answer. "So you get bored in the middle." Yes.

7. Were there technical issues or challenges when using the software for math practice?

Not really. Probably just the internet problem, but not with the game.

INTERVIEW TRANSCRIPT

Student 7

1. In your own words, describe your experience with the mathgames.com.

It's a good learning website for math and it helped me understand problems and if I'm at home and I don't understand what a problem is, I could ask my mom and she could help me and then I'll get it. Then the math problems are put into like fun games so it helps you so it is in a game format not just a learning format and you can do math problems, then it plays the game, then you

do a math problem, then it plays the game. It's a great learning experience for people who might not know something or need help on a certain subject.

2. What would you change about the practice on mathgames.com?

So the questions are kind of easy and sometimes they are hard. For the questions, if they are hard and I don't get it, there might be like a skip button and there is no help. You either get it wrong or right. If you really don't get it and there is no one who can help you, there should be something that will let you skip that question and move on to like an easier question. "You are saying if there is no one to help you, you want to skip that one so you are not counted wrong." Or like something you can click on like on Prodigy you can click on hints so you can understand how to do the problem.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

The characters are good help it, and the characters are the ones doing stuff in the games, they are not just sitting there telling you if you are right or wrong, they are actually playing the game. "Do you like how they look, do you like the colors, do you like the graphics?" Yes

4. If you were designing the math practice software, what would you do differently?

The questions are in order. As soon as you are done with one, you go to another so you are trying to go really fast. If I were making a game I would give a pause so you could actually see what is going on in the game so you are not always just looking at the math questions and you could pay attention to the game too. So a small pause so you can actually think about it.

5. How much do you think you learned using the practice on mathgames.com?

I learned a lot about fractions and converting them to decimals and decimals to fractions.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

I didn't like the games that were dragging on and on and on. One of the games, math invasion, you gain gold from the questions and you can use that gold to upgrade your stuff. It's not exactly dragging because there are new questions and new opponents. You can upgrade all of your stuff and I kind of like those.

7. Were there technical issues or challenges when using the software for math practice?

Last night I was playing Viking queen defense on math games and I've played it on math games before and it has upgrades like math invasion. I played one round and it said that the game had ended as soon as I finished that one round.

INTERVIEW TRANSCRIPT**Student 8**

1. In your own words, describe your experience with the mathgames.com.

I think mathgames is really helpful because there are a bunch of tests that I've taken that I've used mathgames to help me study

2. What would you change about the practice on mathgames.com?

No, I don't think so

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I liked that the questions were in different levels. "So if you got all of the questions right or felt good about them, you could go to the next level". Yes

4. If you were designing the math practice software, what would you do differently?

I would give you points and I would give you your own character and how many points you get from doing it correct you could use your points to change your avatar. "So you would have a character that you would keep throughout and you would get to change it based on how well you did." Yes

5. How much do you think you learned using the practice on mathgames.com?

I know I learned about data where you have the graph and how many people did this and how many people did that. I learned this last night when I did my homework. I learned a lot about mixed numbers and all of that.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

Not yet

7. Were there technical issues or challenges when using the software for math practice?

No.

INTERVIEW TRANSCRIPT**Student 9**

1. In your own words, describe your experience with the mathgames.com.

I liked playing the games and sometimes I completed the assignments as well.

2. What would you change about the practice on mathgames.com?

I would change that you have to get them all correct to get a 5 star, I feel like you could get at least 1 wrong to get a 5 star, so I don't think that is fair because everyone is trying their hardest and are trying their best and they get one wrong because they make a simple mistake they don't get 5 stars.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

The characters are funny and I liked the games and the fact that you can choose what level you are. If you want to play fast you choose a smaller level and if you want to choose actual math facts you can choose your level.

4. If you were designing the math practice software, what would you do differently?

I don't know

5. How much do you think you learned using the practice on mathgames.com?

When I do the assignments it is mainly reviewing me and when I did statistics I learned more about graphs

6. Did you play games on the software? If yes, what games did you like and why did you like them?

There are two games that I like. There is one with a little knight, a zombie knight, that's the icon. The other one has a monster head and I think it is from monster math. I also liked Viking queen defense. It has waves and you have 2 people to help you. I like the waves. This is like zombie Knight is kind of like Viking queen defense, but you can level up your weapon and the other people around you and you can change your weapon and upgrade your port. In the defense games you cannot do that. In the Monster game, you complete 5 questions and you get 1 extra soldier to fight the battles and every time you get a question right it heals one of your injured soldiers. "What is a wave?" A wave is how much monsters come at you at once.

7. Were there technical issues or challenges when using the software for math practice?

Depending on your wifi, its pretty smooth, but if you have bad wifi, it takes forever to load.

INTERVIEW TRANSCRIPT

Student 10

1. In your own words, describe your experience with the mathgames.com.

I like some of the games, but some of them are either too hard or boring. I like a lot of the games. I think its kind of fun.

2. What would you change about the practice on mathgames.com?

I guess if we were able to go back and look what we did wrong with our answer to learn how to fix it.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I like the colors and the questions. I think 10 is like a medium amount, not too many or too little.

4. If you were designing the math practice software, what would you do differently?

I would like it to be very colorful. I would keep it at 10 questions, but I would also like to be able to go back to see what I did wrong on a question.

5. How much do you think you learned using the practice on mathgames.com?

I think on a scale of 1-10, I would give it a 7.5. We learn a lot of this in class and this is a review. After you go over it in class it goes over it again with the practice which is extra learning.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

I didn't have a particular game I liked, but one game had something to do with rounding fractions and I liked that one. I played it 3 times.

7. Were there technical issues or challenges when using the software for math practice?

Not really. I just liked the software.

INTERVIEW TRANSCRIPT

Student 11

1. In your own words, describe your experience with the mathgames.com.

It actually helped me a lot and I liked the games.

2. What would you change about the practice on mathgames.com?

I like how it shows what you got wrong and that there was a limited number. Sometimes the count seemed wrong. It doesn't let you say submit. If you click on something by accident, it just goes as your answer.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

4. If you were designing the math practice software, what would you do differently?

I would make more games. Games would be in categories for different grades. I would like games where you can make your own questions.

5. How much do you think you learned using the practice on mathgames.com?

It actually helped me, I don't really know how to explain, but it helped me with sentences, word problems.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

No

7. Were there technical issues or challenges when using the software for math practice?

Just the submit button.

INTERVIEW TRANSCRIPT

Student 12

1. In your own words, describe your experience with the mathgames.com.

My favorite things to do on mathgames is the games for multiplication and division and sometimes with fractions. The things I disliked is that it glitches sometimes and I click the right answer, but it says that the answer is wrong.

2. What would you change about the practice on mathgames.com?

I would have more questions.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I liked the characters and stuff.

4. If you were designing the math practice software, what would you do differently?

More pictures or more word problems. If there are word problems I like it, but really short ones.

5. How much do you think you learned using the practice on mathgames.com?

Quite a bit of information.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

I liked the games where there were armies and stuff and castle games. I didn't like that there weren't enough characters.

7. Were there technical issues or challenges when using the software for math practice?

No, just the one we talked about already.

INTERVIEW TRANSCRIPT**Student 13**

1. In your own words, describe your experience with the mathgames.com.

It is pretty good. It helps me a lot. Sometimes when you have to divide something and sometimes I'm not sure how to do that. "When you type in a division problem you have to put in a slash symbol and that's confusing." Sometimes if its multiplication and then I put an x there and then put the number next to it and not a space then it counts it wrong.

2. What would you change about the practice on mathgames.com?

Not really

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I liked that it was 10 questions so you didn't have to go further, waste your time.

4. If you were designing the math practice software, what would you do differently?

Better iconics or characters

5. How much do you think you learned using the practice on mathgames.com?

I think I learned more than I would have. When you go over answers in the homework I would learn more. I would be able to answer questions without putting it on paper.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

I liked Math Jungle, and Kingdom something. I liked the characters. I liked that the math problems were not that hard, they were basic.

7. Were there technical issues or challenges when using the software for math practice?

No

INTERVIEW TRANSCRIPT**Student 14**

1. In your own words, describe your experience with the mathgames.com.

I think mathgames is fun and I think it is good to help me learn.

2. What would you change about the practice on mathgames.com?

There are some questions when you assign us assignments, there are some questions I don't know so if there could be helpful directions, help us solve them.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I liked the characters because they made me feel better when I got a question right.

4. If you were designing the math practice software, what would you do differently?

Maybe put hints so that students can learn more. I thought the practice was fun.

5. How much do you think you learned using the practice on mathgames.com?

I did learn a lot and it helped me with the earlier studies because those showed up before.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

I liked the cat wars and it had positive and negative practice. I liked that it is fun and that it tests how good you are at a skill.

7. Were there technical issues or challenges when using the software for math practice?

No. It's fun

INTERVIEW TRANSCRIPT

Student 15

1. In your own words, describe your experience with the mathgames.com.

It has helped make math more fun, but it is hard to keep up, if I'm busy and the assignments are due. I might not know that we have assignments because I don't check it all of the time.

2. What would you change about the practice on mathgames.com?

Maybe offer the answer to the question if you get it wrong so you might could see how you got it wrong.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I liked how it showed you your progress, like total, if offered rewards to keep up your progress.

4. If you were designing the math practice software, what would you do differently?

Differently from mathgames, I would add the answers to the questions if you get a question wrong.

5. How much do you think you learned using the practice on mathgames.com?

When I was struggling on things it helped me get a sense of what to do. When there was a quiz or a test coming up and we would practice on mathgames, I played it and got it wrong, then I would get it right, I would ask why did I get that right, then I would understand better.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

Yes. Some of them seem a bit simple, they would always want you to do it fast enough to advance your skill. They all seemed the same.

7. Were there technical issues or challenges when using the software for math practice?

No

INTERVIEW TRANSCRIPT

Student 16

1. In your own words, describe your experience with the mathgames.com.

I like the math games. They are fun and they do engage but the instructions are weird sometimes. But they are overall fun.

2. What would you change about the practice on mathgames.com?

I think it should give you some hints as to how to solve the problems.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I like how there are 10 questions, but I don't like that there are multiple levels, that's a lot to do.

4. If you were designing the math practice software, what would you do differently?

I would keep the 10 questions and give a hint as to how to solve the questions and I would not include levels or maybe like 2 levels.

5. How much do you think you learned using the practice on mathgames.com?

A lot, it reminded me of how to do things that I was about to forget, so that helped me to remember it.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

I played one or two, but I mostly focused on the assignments.

7. Were there technical issues or challenges when using the software for math practice?

Not really. I didn't experience any lags unless the wifi was bad at the school.

I really liked mathgames, but I really wish there were some hints.

INTERVIEW TRANSCRIPT

Student 17

1. In your own words, describe your experience with the mathgames.com.

I was really fun. I liked the games. They really helped me and I'm going to use it a lot.

2. What would you change about the practice on mathgames.com?

No, I think it was good.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I liked the characters. When you get it wrong they would show the characters. Or when you get 5 right in a row. The questions were pretty good too, they asked hard questions to make you think.

4. If you were designing the math practice software, what would you do differently?

I think I would do less questions and make them harder so you would have to think more. I would have more characters and as you level up, you could earn things.

5. How much do you think you learned using the practice on mathgames.com?

A lot. Some stuff I already knew, but some stuff that I did know, it increased it.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

I played a couple of them. I mostly did the assignments, but I played some games. I liked the graphics. They were really cool.

7. Were there technical issues or challenges when using the software for math practice?

No.

INTERVIEW TRANSCRIPT

Student 18

1. In your own words, describe your experience with the mathgames.com.

I think it was fun and when used it before a test or a quiz and it really helped me learn the vocabulary words, get me to understand problems that I might have with a special section of the chapter.

2. What would you change about the practice on mathgames.com?

I think that they are telling us whether we got it right or wrong right after the question, I think for me, it would be better to get your results at the end.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I think the 10 questions is not to much or too little.

4. If you were designing the math practice software, what would you do differently?

I think that all of the grades are compacted all together and I thought that maybe at the website there should be a different site for each grade instead of having them all together. So when I sign on it was have just 8th grade math on my site since I am in 8th grade and 7th grade would work on the 7th grade skills.

5. How much do you think you learned using the practice on mathgames.com?

Yes, when it wasn't clear in my head when we did it in class and practicing made it more clear.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

No, I was more into the practice sessions.

7. Were there technical issues or challenges when using the software for math practice?

No not really.

I liked when we went back to do them the same assignment over, the questions were not the same. They would be a little harder or a little easier.

INTERVIEW TRANSCRIPT

Student 19

1. In your own words, describe your experience with the mathgames.com.

Overall I think it was a good experience, but there were a few issues. When you assigned us practice, and the questions were multiple choice sometimes the game would select an answer itself, and not the correct one. Maybe it was too sensitive. But a lot of the games were fun and it was good practice.

2. What would you change about the practice on mathgames.com?

I think that the practice overall. I really don't understand the point of the stars at the bottom of the screen. And fixing the accidentally selecting the wrong answer would help.

3. What features did you like on mathgames.com (10 questions per session, immediate results, characters that appeared, etc.)?

I liked that you could complete 10 questions, it was not too much or too little. I liked the multiple choice more than when you had to fill it in yourself. You could be off a decimal and get it wrong.

4. If you were designing the math practice software, what would you do differently?

I don't think I learned any new topics, but I think it help reinforce topics that I already knew.

5. How much do you think you learned using the practice on mathgames.com?

I think that I would have it so you are answer more questions. The 10 questions sessions were good but you were always doing the same thing. When you were answering questions on the same topic, they were very similar types of questions. They were all very similar.

6. Did you play games on the software? If yes, what games did you like and why did you like them?

I played just a few, mostly I did the practices, but the games I played I really liked.

7. Were there technical issues or challenges when using the software for math practice?

I didn't have any issues. Sometimes the games would crash but that was my wifi.