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Shannon Tesch
Northwestern College - Orange City

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Math Technology: Assessing the Educational Value of a Supplemental Practice Program

Shannon Tesch

Northwestern College

Abstract

The purpose of this action research project was to determine if the use of a supplemental computerized math practice program increases student achievement in the fractions domain for fifth graders. Two fifth grade math classes received the same classroom instruction. However, one class also utilized a computerized program three times per week for 20-30 minutes over a six-week period. Data was collected through quantitative pre- and post-assessments, quantitative survey questions, and qualitative student responses. Analysis of the data collected suggests that using the supplemental computerized math program, Front Row Education, in addition to regular classroom instruction, increases student achievement in the fractions domain at the fifth grade level.

Keywords: technology, achievement, fractions

Math Technology: Assessing the Educational Value of a Supplemental Practice Program

Educational technology is a big part of twenty-first century schools. Teachers are asked to incorporate technology into numerous curricular areas. Many schools have created new technology positions to aid teachers in the implementation of technology practices into classroom instruction. Math is one of those curricular areas in which schools are pushing for more technology integration. There are many online math programs that teachers can use to supplement classroom instruction. Some are free, while others cost money. Most math textbook companies have a companion online math practice program. The researcher aimed to find out if these online math programs actually increase student achievement.

In the fifth grade Common Core, the fractions domain is a major area for students to master. Many students often struggle with achievement in this domain. As Pitsolantis and Osana (2013) decided, "fractions are one of the most difficult of the elementary school math topics to teach and learn in ways that are meaningful" (p. 18). Teachers are always looking for ways to supplement instruction to help students. The focus of this research is to determine if the use of an online math program as a supplemental resource in the fifth grade classroom increases student achievement and learning outcome mastery in the fractions domain.

Literature Review

Teachers across the country are looking for ways to supplement and individualize instruction and practice, especially when it comes to mathematics. Technology provides a variety of opportunities for this type of differentiation. Are these supplemental programs effective? Joubert (2012) concluded that this is a tough question to answer because of the variety of ways in which teachers and students use the math technologies. Some schools find the programs to be effective, others do not.

Lagrange and Kynigos (2013) also found this to be a difficult question to answer, but for a different reason. They found that supplemental programs vary significantly from one to another, which makes it difficult to group them all together into one math program category. Some programs are game-based, while others are content-based. Some programs are more effective at lower grades, while others are meant for upper grades. A study by Zhang (2014) came to a similar conclusion. Although Zhang was generally in favor of computerized math programs, the study focused on one particular math gaming website that data showed to be ineffective in increasing student learning.

A study conducted by Chen, Liao, Cheng, Yeh, and Chan (2012) supported math technology, especially in the form of mathematical game play. Students who participated in digital mathematical games were highly motivated to achieve mathematical goals—and enjoyed doing it! The enjoyment part should come with little surprise. Students enjoy playing computer games—even educational ones. Other studies have been published that support the use of computerized math programs. Zhang, Trussel, Gallegos, and Asam (2015) studied math apps and their impact on student achievement. They concluded that the use of the math apps "improved student learning and reduced the achievement gap between struggling students and typical students" (p. 32). Those are definitely two goals for math teachers everywhere. In their study on computer-assisted instruction, De Witte, Haelermans, and Rogge (2015) concluded that working with a computerized math program is effective and can even lead to higher test results. They found this especially true for students needing to catch up on learning outcomes.

Cayton-Hodges, Feng, and Pan (2015) looked at what makes an effective computerized math program, specifically tablet-based apps. Mathematical content, instruction, and practice were key, of course. However, in order to engage students, there needs to be a gaming aspect as

well. The difficult part for app developers is to find that balance between rigor and fun. Too much rigor and too little fun will turn students off. Too little rigor and too much fun will engage students, but with little quality learning taking place. LeSage (2012) adds that web-based video clips, such as those from Khan Academy, can help engage students and give them the extra instruction they need to progress in their master of learning outcomes.

Based on the literature review, the researcher concluded that using a computerized supplemental math program for fifth graders would have a positive educational outcome. The work is not finished, however. The researcher must now decide which online program to use for this project. The researcher has experience with three popular computerized supplemental math programs: Academy of Math, Sum Dog, and Front Row Education.

Academy of Math starts each student out with a placement test. Based on student performance on the test, each student is given an individualized training program to complete. Students start out each unit with a tutorial to introduce (or review) certain math skills related to the unit. Then, students complete math problems on a puzzle board, with each correct problem revealing a piece of the puzzle picture. When a student completes enough correct puzzles, he or she moves on to the next unit. At the end of the year, students complete the placement test again to see what kind of growth they have made throughout the school year.

Academy of Math has its strengths and weaknesses. The placement test, tutorials, and the individualized training program are definite strengths. The puzzles are motivating for the lower elementary grades. However, by the upper grades, the students are bored with the puzzle format and find it less motivating. In addition, students who test very high on the placement test are given a training program that is too difficult. As a result, those students are often stuck in the same unit for too long and do not progress through the other units of the Academy of Math

program. This often leads to student frustration. Students cannot access Academy of Math from home because it is specific to a school server. Schools also pay an annual fee to use Academy of Math.

Sum Dog lets students play interactive math games against students from around the world. Based on how the students perform during the games, the questions they are to answer moving forward become easier or more difficult. As a result, each student has an individualized math program. As students complete questions or levels, they are awarded virtual coins to be able to spend at a virtual store.

Sum Dog has its strengths and weaknesses as well. The students find the games very engaging and love being able to play against students from around the world. Classrooms can also participate in a Sum Dog contest sponsored by the AEA three times per year. The students are very motivated to win the contest. Sum Dog is free, can be played anywhere there is internet access, and individualizes instruction based on how a student is performing on the math problems within the games (Tomaszewski, 2013). One of the weaknesses of Sum Dog is that it is a little too much gaming and not enough math. There may need to be a better balance between fun and rigor.

Front Row Education is a web-based training program that is aligned to the Common Core math standards and offers individualized math practice for kindergarten through eighth grade students in each of the Common Core mathematical domains. When students log in for the first time, they take an assessment for each domain that helps determine at what standard and level of difficulty each individual student will start at. After completing the assessments, the students start their individualized training program in each domain. As students complete questions or levels, they are awarded virtual coins to be able to spend at a virtual store. The

individualized nature of Front Row is designed to ensure students are working at their own levels for mastery.

Front Row offers many great features. Teachers love that Front Row is based on the Common Core (Gorrell, 2016). Teachers can assign different domains and skills for individual students to complete. This year, Front Row is offering a new feature—direct links to training videos from Khan Academy, which will be a great resource for students and teachers. Teachers receive a weekly report for all students, with details about how they are doing and tips to differentiate instruction and improve their individualized training program. Front Row is also free and can be used at school or at home. Front Row does not have the game format of Sum Dog, making it not quite as popular with students.

After looking in depth at Academy of Math, Sum Dog, and Front Row, the researcher chose Front Row as the web-based supplemental math-training program for this research project. All three programs offer some great things, but the researcher feels Front Row gives students and teachers the best mix of fun and rigor. The researcher especially likes that it is free, can be accessed anywhere, and is based on the Common Core. More importantly, teachers can individualize instruction for each student within Front Row. Assessment can also be differentiated to help each student show what they have learned.

As Michael Scherer (2014), states, "The problem we have in K-12 is we are not engaging the kids because we are not using the things they use outside the classroom inside the classroom" (p. 38). Student interactions with technology contribute to student learning (Cayton-Hodges, Feng, & Pan, 2015). Teachers need to start using more technology in the classroom, and Front Row is a great way to do just that.

Methods

Data Collection

This action research project was conducted in a fifth grade mathematics classroom. At the time of the project, the math class was focusing on the fractions domain of the Iowa Core. There are two sections of fifth grade math taught at the researcher's school, with twenty-one students in each section. Of the students in fifth grade, all but two attend the general math classroom. These two students receive their math instruction in a special education classroom. There is very little variance in the class demographics. The class is predominately white with non-free and reduced lunch status. Five of the forty-one students in the fifth grade receive special education services. Three students receive Title I assistance and one student receives English language support.

The focus of this action research project is to determine if the use of the online math program, Front Row Education, as a supplemental resource in the fifth grade classroom, increases student achievement and learning outcome mastery in the fractions domain. Two fifth-grade math classes participated in this project. One fifth grade class was provided only the regular classroom instruction. The other fifth grade class was provided the same classroom instruction, but also regular (three times per week for 20-30 minutes each time) supplemental individual practice with Front Row, the free online math program. When utilizing Front Row during this math unit and research project, these students were only allowed to access the fractions domain for practice. Three data collection methods were employed to determine the value of Front Row. The first method involved a pre-assessment at the beginning of the fractions unit and a post-assessment at the completion of the fractions unit. The two assessments could then be compared to determine if there was more of an increase in student achievement from the

pre-assessment to the post-assessment in the class that utilized Front Row than in the class that did not. The second data collection method was a survey given at the end of the fractions unit to the class that worked with Front Row. The survey asked questions related to the students' feelings towards Front Row and a self-assessment of its impact on their learning within the fractions domain. The third data collection method consisted of informal observations of the students while they were working on Front Row.

A mixed method of data collection that incorporated both quantitative (pre- and post-assessments and the first student survey question) and qualitative (the second student survey question and informal observations) data was chosen for a couple of reasons. Quantitative data collection in the form of pre- and post-assessments made the most sense as comparing the results of the assessments gave empirical evidence of the impact that Front Row had on student achievement. At the same time, student survey data was valuable in determining if the students had a growth mindset about the connection between Front Row and student achievement.

Findings

Data Analysis

There was some researcher bias during this project. The researcher is a big proponent of technology use in the classroom. In addition to classroom teacher duties, the researcher serves as the elementary school's technology integrationist, helping teachers incorporate technology into their instruction and assessment. The researcher also believes that online math programs, such as Front Row, are a great way to supplement math instruction and increase student achievement. Despite the researcher bias in the research project, the data collection methods were fair and unbiased.

Quantitative data analysis. The first quantitative data collected came from the fractions pre-assessment given to students before instruction started for the fifth grade fractions unit. The pre-assessment consisted of twenty math problems involving addition, subtraction, multiplication, and division of fractions. Some problems were in number sentence format, while others were in word problem format. The pre-assessment problems were modeled after the problems found on the Smarter Balance standardized assessment. The students took the pre-assessment through a Google Form on Google Classroom. The control class that would not receive the Front Row supplementation had an average score of 7.42 correct questions out of 20 on the pre-assessment. The experimental class that would receive the Front Row supplementation had an average score of 7.5 correct questions out of 20.

Six weeks later, at the end of the fractions unit, both classes took the post-assessment through a Google Form on Google Classroom. The post-assessment was the same as the pre-assessment. The control class with no Front Row supplementation had an average score of 9.63 correct questions out of 20 on the post-assessment. That is an average improvement of 2.21 correct questions from the pre- to post-assessment. The experimental class with Front Row supplementation had an average score of 13.95 correct questions out of 20 on the post-assessment. That is an average improvement of 6.45 correct questions from the pre- to post-assessment.

After taking the post-assessment, the experimental class took a short survey about their Front Row experience. When asked if they enjoyed using Front Row, 68.4% of the students stated that they either strongly agreed or agreed. When asked if Front Row has helped them become better at solving fraction problems, 68.4% of the students stated that they either strongly agreed or agreed.

Qualitative data analysis. This same survey also included some qualitative data. The researcher asked the students what they liked and disliked about Front Row. The answers were varied, and can be found in the appendix. Informal observations also provided qualitative data to the researcher. At the beginning of the fractions unit, students in the experimental class were excited to utilize Front Row on their Chromebooks. However, by the end of the unit, many students were not as excited, possibly even bored, to use Front Row in class. The combination of quantitative and qualitative data, and their analysis, provided evidence of measureable changes in student achievement during the fifth grade fractions unit.

Discussion

Challenges with Data

The researcher used multiple methods of data collection in order to provide data that was reliable and valid. However, the data collection methods still could raise some questions. For example, why was the class that had a slightly higher average score on the pre-assessment chosen as the class to receive the Front Row supplemental practice? Was this class chosen to ensure a positive outcome on the research question? This class was chosen to be the experimental class before the pre-assessment was conducted, with the main reason being scheduling. The class chosen as the experimental class was going to have more time to devote to Front Row than the other class would have. As a result, it made perfect sense to set the two classes up the way the researcher did.

Another question that could be asked about the data is whether one class is stronger academically than the other class. If the experimental class was actually a stronger class to start, then the results could be expected to favor and support the research question. Before the research project was started, the researcher looked at classroom data to determine if one class

was stronger than the other class. The researcher determined that the two classes were very similar in academic achievement, thus making the data collection valid and reliable. The pre-assessment proves this true. Although there was a difference in average score between the two classes, the difference was very small—0.08 of a point.

There is, of course, the chance that Front Row did not account for the difference in post-assessment average score. Perhaps the experimental group received advanced instruction to account for the improved average score. The researcher made certain that both classes received exactly the same classroom instruction. The only difference between the two classes was the use of Front Row for the experimental group.

Conclusion

The findings gathered from the collected data suggest that using the Front Row computerized math practice program to supplement fifth grade fractions instruction had a positive and significant impact on student achievement. Front Row should be used weekly to provide students with ongoing supplemental fraction practice. The survey and qualitative data suggest that the researcher may have overused Front Row (three times per week, 20-30 minutes each time), thus losing its effectiveness. This may vary from class to class, so teachers should use their own judgement when deciding how often to utilize Front Row for students.

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Appendix A

Pre-Assessment and Post-Assessment Questions

1. Find the sum: $2\frac{1}{3} + 3\frac{1}{2}$

2. Find the product: $2\frac{2}{3}$ x $3\frac{3}{4}$

3. Find the difference: $7\frac{1}{6} - 5\frac{2}{3}$

4. The Martinez family went on a road trip. They drove $72\frac{1}{2}$ miles on the first day and $83\frac{2}{3}$ miles on the second day. Which of these is a reasonable estimate for how far they drove during the two days?

5. Find the area of a rectangle whose dimensions are $\frac{2}{3}ft\ x\ \frac{3}{4}ft$.

6. How will the product of $2\frac{3}{4}$ x $\frac{3}{8}$ compare to the number $2\frac{3}{4}$?

7. A race involves bicycling $25\frac{1}{2}$ miles and running $6\frac{3}{4}$ miles. How long is the race?

8. Compute the following quotient: $\frac{1}{8} \div 2$

9. Find the quotient: $20 \div \frac{1}{4}$

10. There is $\frac{1}{4}$ of a birthday cake left in the refrigerator. Eight friends want to share the rest of the cake equally. What fraction of the entire cake will each friend get?

11. A jug contains $2\frac{3}{4}$ liters of water. Two-thirds of the water is poured out of the jug. How much water is poured out?

12. Ms. Yama is providing transportation for her students to go skiing this weekend. She needs to know which sized van or bus to reserve. Out of her 30 students, $\frac{2}{5}$ of her students are planning on going skiing. How many students will be going?

13. A fifth grade volleyball team scored 32 points in one game. Two-eighths of those points were scored in the second half. How many points were scored in the first half of the game?

14. Susan's homework was to practice the piano for $\frac{3}{4}$ of an hour each night. How many minutes each night did she practice?

15. Three-fifths of the 30 students were boys. How many students were girls?

16. Before Jack and Jill fell down the hill, they ate one-fourth of a dozen cookies. How many cookies were left over?

17. $\frac{11}{12} - \frac{2}{3}$

18. $51\frac{1}{2} - 13\frac{3}{4}$

19. $7\frac{1}{2} \div 2\frac{5}{8}$

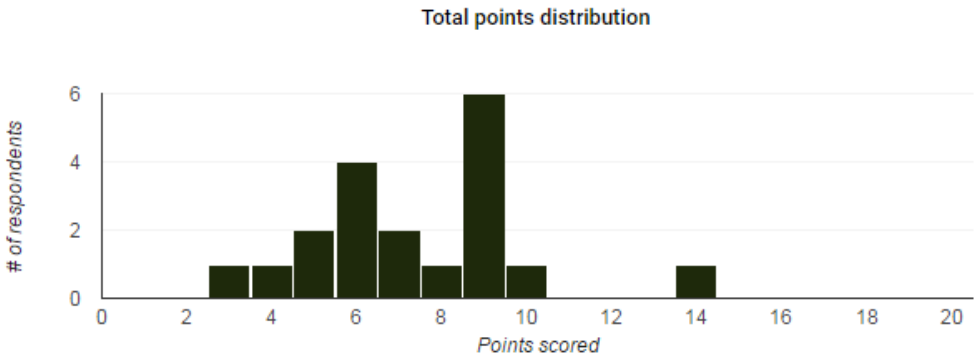
20. $\frac{7}{12} \div \frac{1}{12}$

Appendix B

Pre-Assessment Results

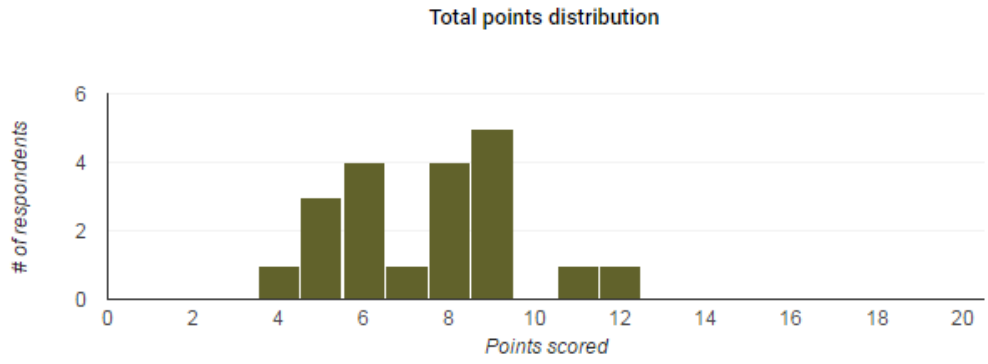
Pre-Assessment Results for the Control Class

Average	Median	Range
7.42 / 20 points	7 / 20 points	3 - 14 points



Pre-Assessment Results for the Experimental Class

Average	Median	Range
7.5 / 20 points	8 / 20 points	4 - 12 points

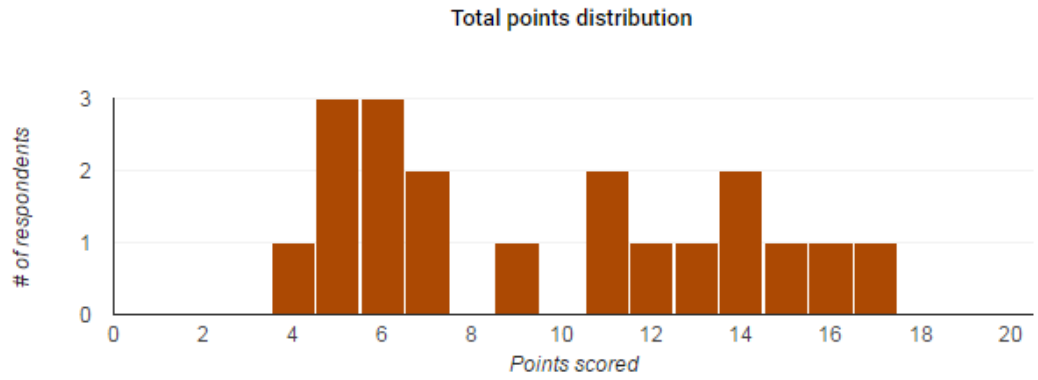


Appendix C

Post-Assessment Results

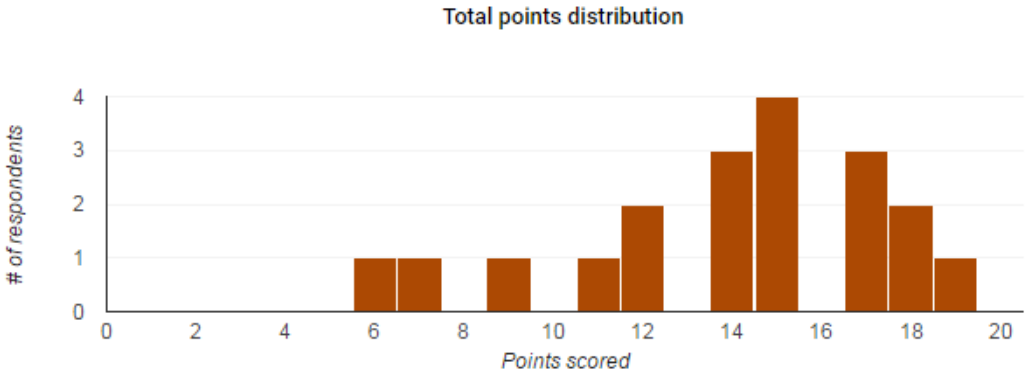
Post-Assessment Results for the Control Class

Average	Median	Range
9.63 / 20 points	9 / 20 points	4 - 17 points



Post-Assessment Results for the Experimental Class

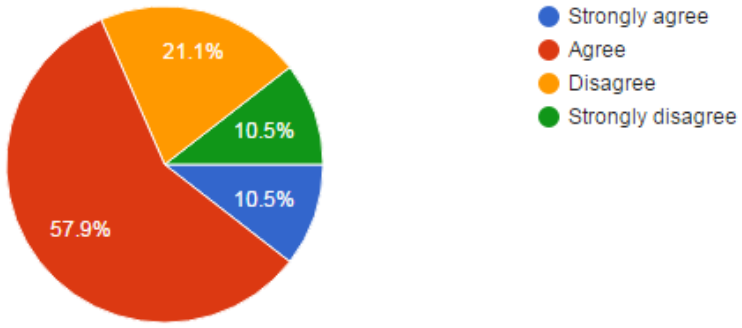
Average	Median	Range
13.95 / 20 points	15 / 20 points	6 - 19 points



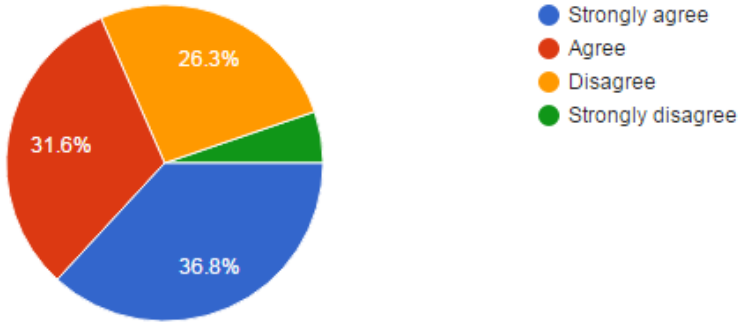
Appendix D

Front Row Survey Results

I enjoy using Front Row Math. (19 responses)



Front Row Math has helped me become better at solving fraction problems.
(19 responses)



Appendix E

Front Row Survey—Student Response Questions

What do you like about Front Row?

- That you can get coins and buy things
- I like going to the store and fraction review.
- That we have a store where we can buy stuff for our animals
- It helps me become better at solving math problems.
- It helps me learn skills I didn't know.
- It helps me with my math.
- It helps people at a young age learn their math, and teaches them how to do it correctly.
- The fact review
- It helps me solve problems in my head.
- I like that there is a leaderboard, because I am competitive.
- On fact fluency, it helps me learn my facts faster.
- Reviewing math problems

What do you dislike about Front Row?

- That you can't use a calculator
- Sometimes it gets boring.
- You can't go to the store at all times.
- It isn't very fun.
- The time limit on the store
- Doing fractions all the time
- The hard questions