

St. Catherine University

SOPHIA

Masters of Arts in Education Action Research
Papers

Education

5-2020

Identifying Opportunities and Challenges of Using Prodigy Math in a Sixth Grade Math Classroom

Corryn Lyons

Follow this and additional works at: <https://sophia.stkate.edu/maed>

Identifying Opportunities and Challenges of Using Prodigy Math in a Sixth Grade Math
Classroom

Submitted on May 7, 2020

In fulfillment of final requirements for the MAED degree

Corryn Lyons

Saint Catherine University

St. Paul, Minnesota

Advisor: Sarah Hassebroek

Date: May 7, 2020

Abstract

In a traditional sixth-grade math classroom, many teachers start off the school year by reviewing fifth-grade math topics, usually covered at a fast pace. During this review period, it became obvious that a large portion of students was significantly far behind with their mathematical skills and could benefit from scaffolding and support. The purpose of this action research study was to analyze how Prodigy, an online mathematics intervention system, used in combination with interventions, could be implemented effectively in a sixth-grade math classroom to improve student achievement in mathematics. Throughout this action research, data was collected from surveys, Prodigy placement and test scores, and teacher observations. On the two units completed, an average of 83.45% of students either increased or stayed the same on their numbers and operations skills. Prodigy placement test data revealed that 82.3% of students either improved a grade level or stayed the same. More research should be conducted in the future to determine how to fully engage students by creating stronger buy-in. In addition, English Learner students may need additional help while playing Prodigy, due to Prodigy's lack of language support.

Keywords: Prodigy, mathematics, interventions

Navigating through the 21st century might appear to be a daunting task for many, with endless Instagram notifications, Facebook group requests, and text messages. Despite how overwhelming it may seem, most middle school-aged students face that task with ease and grace. Technology is a daily part of their life, with a portion of students receiving their first cell phone during middle school. With this technology, teachers are faced with a choice: discourage it or embrace it to engage their students. As a sixth-grade math teacher in an inner-city, high-poverty school, I struggled with getting my students engaged in math. At the start of the 2019 school year, our school experienced substantial growth in the number of English Learner (EL) students we serviced, which left a higher portion of students needing additional support. Following the first few weeks of the school year, with more students being underprepared than usual, I decided to explore different online intervention programs to bring technology into my classroom in a meaningful way.

Even if teachers make a conscious effort to include technology in their classroom, many are faced with an ever-growing challenge: the number of EL students is continuously growing across the nation (“1 in 4 Students,” 2018). Educating such a high number of EL students has the potential to be incredibly rewarding but comes with challenges. Academic language must be established, and image-based representations used in a hands-on way to help students build connections with their previous knowledge. Luckily for teachers, there are a multitude of online resources, many of which tie in visual representations, for them to pull from if they decide to embrace technology in the effort to engage both EL and non-EL students.

With the choice of applications (apps) growing at an exponential rate, there are many educational apps that students and teachers can use both in school and on the go. This style of learning is referred to as ‘gamification of learning.’ Some application developers have created

programs designed for teachers to implement intervention systems, allowing teachers to create individualized education plans tailored to meet each student's needs. However, there is currently little research about these types of applications that allow teachers to create a learning experience like this for students. Teachers become overwhelmed by choice and lack of time in determining which application is best to serve the needs of their students. Analyzing such data could help teachers decide which apps to use in their classrooms and which to leave out.

Theoretical Framework

The constructivist theory suggests that when faced with learning new material, students and adults alike are more likely to accurately absorb information when that information starts with enactive or action-based representation, followed by iconic/image-based representation, then symbolic/language-based representation (Bruner, 1966). Without hands-on and visual experiences working with beginning algebra expressions and equations, pre-adolescent students might not be able to fully grasp the fundamental concepts of inverse operations in order to solve for variables. This theory contains clear ties to the subject of mathematics in the middle-grades setting.

Another theoretical framework situated at the heart of this action research is Connectivism. In the 21st century, technology can be integrated into multiple portions of a child's education. Siemens and Downs (2005, 2010), founders of the connectivism theory, explored the notion that with the creation of the Internet, multiple avenues for learning opened for students. Multiple code-learning, blogging, and learning intervention sites exist to help students throughout their learning experiences. Prodigy, an online mathematics intervention system, uses a combination of image and language-based mathematical representations to keep students engaged while learning and mastering math concepts. The way that Prodigy presents

information to users closely relates to the constructivist theory due to its use of images and symbols to practice math concepts. Should students incorrectly answer a question, Prodigy offers a written and visual explanation as to how to arrive at the correct answer. Prodigy uses number lines, counting cubes, visual representations of three-dimensional shapes, and color spinners to help students visualize mathematics concepts. With the use of these visuals, Prodigy combines mathematics and Connectivism to form an online learning experience for students.

Review of Literature

In today's mathematics classrooms, students strive to grow towards meeting or exceeding academic expectations, since many of their teachers aim to support their learning in a multitude of ways. Despite teachers working their best to help the children in their classrooms, America's students continue to underperform on a national level. The National Assessment of Educational Progress (NAEP) released their 2017 results, which stated that in math, only 40 percent of fourth-graders and 34 percent of eighth-graders were "at or above proficient" (NAEP, 2017). When considering this data, a question arises about how students can be better prepared, especially in the earlier grades, when they learn foundational skills that apply to upper-level mathematics classes. With the technology that is available to teachers, there are now math programs aligned to both state and national Common Core standards that allow students to practice their skills online. Programs such as IXL, Prodigy, Ascend Math, and others allow teachers to pick and choose which skills students should focus on to fill academic gaps, as well as offer challenges to those students who might require them. Through the use of these programs, students gain experience working with technology while simultaneously focusing on their math foundations.

At the core of many online math intervention programs, there is a desire to create a learning experience that is a combination of visual, auditory, and, when appropriate, kinesthetic learning opportunities. When discussing the theory of multimedia learning, Mayer (2005) explains that meaningful learning can take place when information is presented to students in a multitude of ways, especially when visual examples combine with verbal explanations. Ioannou, Rodiou, and Iliou (2017) agreed with Mayer and researched combining images with spoken words in a math class. Two groups of students were assessed on triangles; one group's assessment provided written words, and the other's used spoken words, or narration, in addition to written words. Ioannou et al.'s reflection was that the group who had access to both the images and spoken word performed better on the recall test than the written only group (2017). Combining the different learning styles and tailoring interventions to meet individual student needs can be useful in the challenge of optimizing learning (Chew, 2016). Schools and teachers that seek out different online intervention programs might have this information in mind while comparing their options.

Some intervention programs not only focus on combining different learning styles but also help students engage with math on a deeper level than a traditional learning environment might offer. By integrating technology into interventions, students are encouraged to be fully engaged with their learning, collaborate with others, and learn to use the feedback they immediately receive to push their improvement (Kieger, Herro, & Prunty, 2012). Ketterline-Geller, Chard, and Fien (2008) discussed the importance of using high-quality interventions that embody the following characteristics: inclusion of visual representations of math problems, clear directions, opportunities to reflect, formative assessments for both teachers and students, as well as "peer-assisted learning" (p. 35). This information contains close ties to Bruner's constructivist

theory, due to the nature of students benefiting from said visual representations. Following the use of Knowing Math (Ma & Kessel, 2003), which is an intervention that focuses on small-group instruction, researchers stated that the group of students observed in the study ended up performing at a higher level on the math assessment than the control group of students.

In their article about online intervention use, Van den Heuvel-Panhuizen, Kolovou, & Robitzsch (2013) discussed the National Council of Teachers of Mathematics standards for math (NCTM, 2000) and how the standards included the use of technology in a math classroom. Incorporating technology into a classroom allowed students to enhance their learning on a more individualized basis, especially if the online intervention used was adaptive. Prodigy is an example of a program that was built to be completely adaptive, changing to meet individual student needs. Prodigy is a “game-based learning platform” that allows teachers to create lessons and assignments aligned to specific skills that students might need to improve on (Prodigy, 2019). Such a program aims to combine the characteristics that Mayer stated that intervention programs should have: a combination of visual and auditory stimuli for students with engaging academic experiences.

Although Malley, Jenkins, Wesley, Donehower, Rabuck, and Lewis (2013) claim that there are limited quantitative studies about online math interventions, a few researchers have stepped out to be the first to conduct investigations about this topic. One of the few research projects completed was organized by Zhang, Trussel, Gallegos, and Asam. Zhang et al. (2015). They explain that there are a plethora of different apps for teachers to choose from to bring into their classroom, one of which is Splash Math. Splash Math (StudyPad, 2012) is an app that is used on phones and tablets that is math-centered. The main goal of the app is to provide K-5

students with a game-feeling experience that helps them learn or master math skills. There is also an accompanying app for parents that lets them see their child's progress and skill level.

Zhang et al.'s study compared a control group of students who did not have access to online interventions to a group of students who used Splash Math, along with two other interventions (Motion Math Zoom and Long Multiplication). 3 Pre- and post-tests were completed focusing on varying math topics. Although the control group did improve from pre-test to post-test, the intervention group improved significantly more. Assessment 1 measured a 23% growth, assessment 2 measured a 20% growth, and there was a 15% growth for assessment 3 (Zhang et al. 2015). Through the use of Splash Math, students improved their math skills while working with technology.

When considering bringing an online intervention into their classroom, a teacher has many things to consider.

- Does the program align with the standards that students are expected to master before the end of the year?
- Is the intervention engaging in a way that combines different learning styles appropriately?
- What kinds of data are produced by this program, and how could it be used to inform how the students are educated?
- What are the costs associated with adding these programs to the current curriculum?
- Do the interventions detract from social interactions that would be happening without their use?

There are multiple intervention programs and apps that address and answer all of these questions. However, it ultimately falls into the hands of the teacher to explore them and take them for a trial

run to determine which one, or perhaps a combination of multiple resources, might be best for their students.

Methodology

This action research study used a combination of pre and post-surveys, student test scores from Prodigy, a visual online math intervention program, teacher-created individually tailored interventions, and teacher observations to triangulate data. The survey that students completed aimed to gather information about students' attitudes towards math. Pre and post-assessments were assigned on Prodigy to determine student ability level with various numbers and operations standards. These tests were also used to find potential areas for student improvement with these same standards.

The population for this action research study was sixth-grade students at an upper elementary school in an urban setting in the Midwestern United States during the second semester of the 2019-2020 school year. The sample of students included seventeen sixth-grade math students, consisting of ten females and seven males. Of these seventeen students, twelve had been identified by the school as English Learner (EL) students.

At the beginning of the research project, students were given a 'Math Attitudes' survey (see Appendix A) focused on their general feelings in regards to math. More specifically, students were asked if they liked doing math, if they thought they were good at it, if they thought math was important, and if they believed they were able to see themselves using math outside of school. In addition, there were questions about previous Prodigy use, if they looked forward to playing Prodigy in school and at home and if they thought Prodigy helped them understand math.

Following the completion of the survey, students started playing Prodigy both at home and school. After about an hour of answering questions, Prodigy assigned an approximate grade level for each student based on skills already mastered during the hour of play. Using a data recording tool, the teacher analyzed the placement test results to determine missing skills following up by assigning questions and games based on those missing skills. Data from these placement tests revealed that students needed the most support with fractions and decimals. Two two-week units were formed, the first unit being fractions, and the second was decimals, and the process for each unit was identical. Students were assigned a pre-test on Prodigy that tested their fraction or decimal skills. After receiving the results of the pre-tests, students met one-on-one with their teacher to go over their scores, in addition to questions they answered incorrectly. Meeting with all of the students took about two days. For the rest of the two weeks, the teacher met with students in groups of three or four to go over fraction/decimal vocabulary (numerator, denominator, reciprocal, carrying, placeholder, etc..), practice problems, and give informal assessments as practice quizzes. During individual work time, students worked on Prodigy, which used visual representations and hands-on learning experiences to build mathematical skills. Throughout this process, observational data was collected about which students seemed to be making progress while others needed more support (see Appendix B). After receiving the interventions, the students completed a post-test on Prodigy for the topic in which they received an intervention. The post-test contained topics and questions similar to those found on the pre-test. These steps were then completed for the decimals unit. Once the students finished the two units, they completed a second placement test on Prodigy. They also filled out a second 'Math Attitudes' survey reflecting on the same concepts as the first one completed. The

teacher then combined all of this data to reflect and analyze how the use of Prodigy impacted their students' math experiences and academic achievements.

Analysis of Data

This action research considered how the use of Prodigy, an online math intervention system, could be used in combination with tailored interventions to improve sixth-grade student achievement in mathematics. Throughout the research process, four information collecting tools were used to triangulate data: a 'Math Attitudes' survey, pre and post-placement tests on Prodigy, pre and post-tests on numbers and operations standards, and teacher observations. The data collection period for this action research lasted five weeks.

At the start and end of the five weeks, students completed a 'Math Attitudes' survey which presented the following ten statements:

- I like doing math.
- I am good at math.
- I believe that math is important.
- I can use math outside of school.
- I look forward to using Prodigy in school.
- I look forward to using Prodigy outside of school.
- I believe that Prodigy helps me understand math.
- I have someone at home to help me with math.
- I have done well in math in the past.
- I look forward to learning in math.

Students responded to each question by shading in one of five possible emoji faces: very sad, slightly sad, neutral, slightly happy, or very happy. For data analysis purposes, I assigned each of these emojis a numerical value of 1-5, respectively.

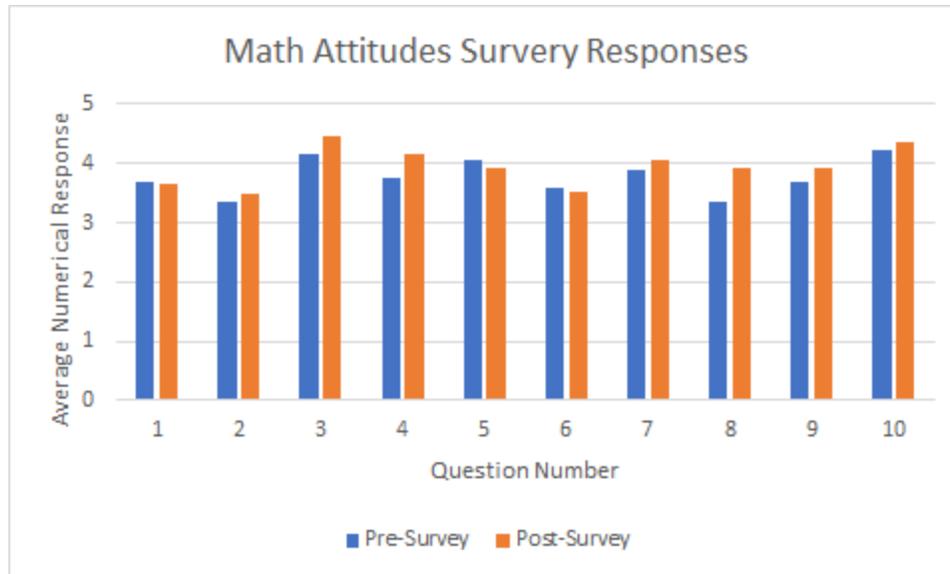


Figure 1. Student survey averages.

Overall, there was an improvement in student responses across most survey questions. The exceptions were questions five and six, both of which asked students about their attitudes towards using Prodigy both in (2.7% decrease) and out (1.7% decrease) of school. It is not surprising that these two questions saw a decrease in student ratings. During the weeks of this action research, some students were not as motivated to play Prodigy as others were. The question that saw the highest increase (almost 15%) in student responses asked students if they had someone at home to help them with math. Such an increase in this question is intriguing. Due to a large portion of these students being English Learner students, it is possible that students did not fully understand or comprehend this question when they took the survey. However they also had the questions read aloud to them. A possibility is that as these students become more fluent in English, they might be bringing their learning home to parents, and engaging their parents with their learning. As the year progresses, students might feel more comfortable approaching their parents for help with different subjects. After the pre-survey was completed, student placement tests designed by Prodigy were started.

At the beginning of the five-week research period, students were given a Prodigy Math login. Upon logging in for the first time, Prodigy had all users complete a placement test to assign an approximate grade level based on individual students’ current math skills. This placement test assessed students in five domains: (1) operations and algebraic thinking, (2) numbers and operations in base ten, (3) fractions, (4) measurement and data, and (5) geometry. Based on the results from their placement test, Prodigy then listed the approximate grade level that was most representative of the difficulty of skills that students had mastered. Figure 2 below shows a student whose placement test resulted in a fourth-grade level. Although this student was successful in fifth-grade numbers and operations in base ten, they had not yet mastered a significant portion of the fourth-grade standards.

GRADE & DOMAIN	RESULTS	EXPAND
Grade 3: Measurement and Data	⚠️ 2/5 Correct	▼
Grade 4: Operations and Algebraic Thinking	⚠️ 2/4 Correct	▼
Grade 4: Number and Operations in Base Ten	✅ 4/5 Correct	▼
Grade 4: Measurement and Data	⚠️ 0/2 Correct	▼
Grade 4: Geometry	✅ 4/5 Correct	▼
Grade 4: Number and Operations - Fractions	⚠️ 3/6 Correct	▼
Grade 5: Operations and Algebraic Thinking	⚠️ 0/2 Correct	▼
Grade 5: Number and Operations in Base Ten	✅ 4/5 Correct	▼
Grade 5: Geometry	⚠️ 0/4 Correct	▼
Grade 5: Number and Operations - Fractions	⚠️ 1/3 Correct	▼

Figure 2. Example placement test results.

Throughout the research process, Prodigy took all questions answered by students and added their responses to their placement test results, meaning the grade level assigned to a student was fluid and could be increased or decreased at any moment based on students' answers. At the end of the five weeks, students completed another placement test to determine whether their overall grade level had increased or decreased. Students were placed into one of three categories based on their results: increased in grade level, decreased in grade level, or stayed the same in grade level. Seven students out of the seventeen (41%), saw an increase of one or more grade levels, seven students neither increased nor decreased grade levels (41%), and two of the seventeen students (11%) decreased in grade levels. One student did not complete the second placement test, so figure 3 below only displays this one student's first placement test result. This figure shows the difference for each student between their first and second placement test results.

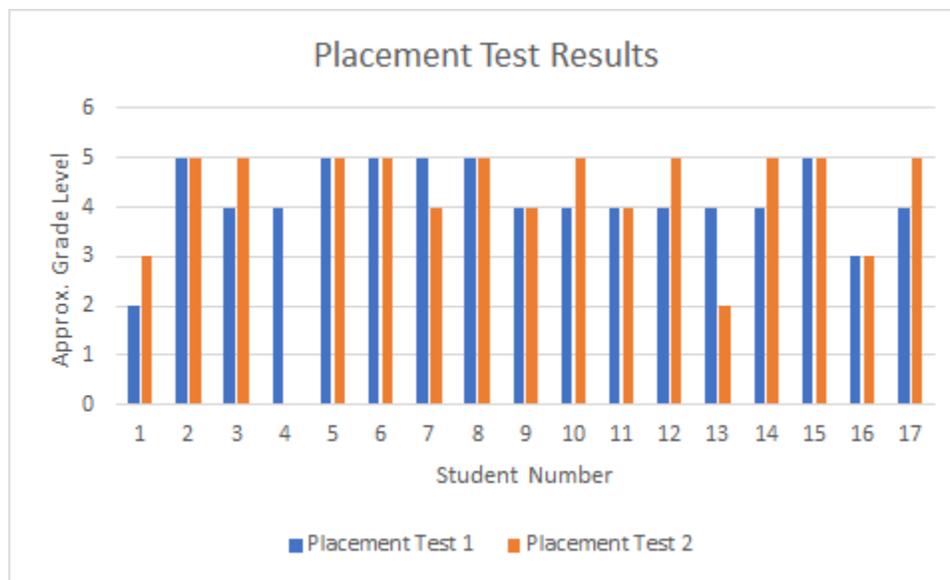


Figure 3. Placement test results for all seventeen students.

Upon the completion of placement test results, students were placed into groups based on the skills Prodigy revealed the students needed the most support with. For example, Figure 2

demonstrated that student three needed extra practice with operations and algebraic thinking, measurement and data, fractions, and fifth-grade geometry. After analysis of original placement test scores, Prodigy’s analysis revealed that every student from the group of seventeen needed additional support in fractions and operations/algebraic thinking. With the discovery of these results, two two-week units were formed, one on fractions and the other on decimals, both weeks had a portion of time spent on how to use these two skills in algebra problems with variables. Throughout these four weeks, there was a portion of students who did not complete the pre-test, post-test, or both, due to attendance issues. For these students, I included the data Prodigy did provide and left their score blank if they did not complete one of the tests.

The first two weeks were spent on adding, subtracting, multiplying, and dividing fractions on Prodigy. At the start of this period, students completed a pre-test on fractions to explore in detail what portions of fractions they struggled with. Figure 4 below shows the pre-test results for student sixteen. Prodigy shows the overall score that this student received, the correct answer, followed by the answer the student submitted. Figure 5 is a portion of a Word document, which was used to keep track of observational data throughout the intervention process.

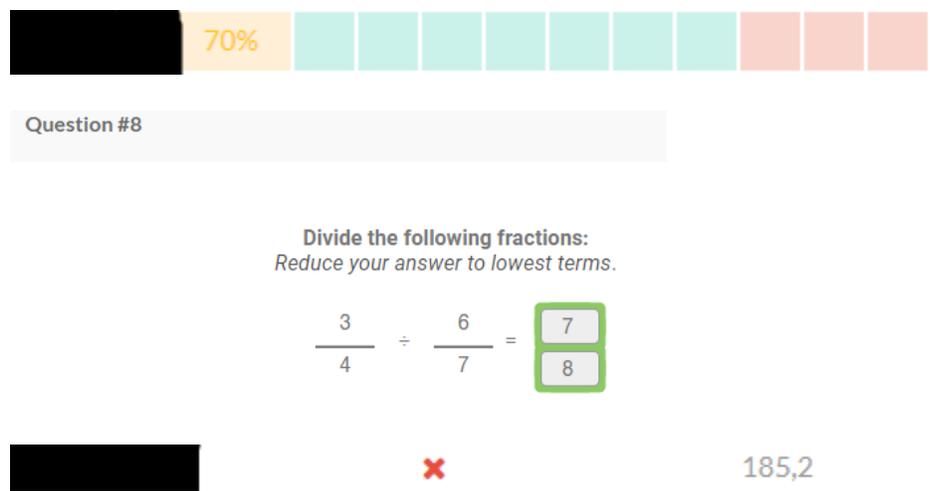


Figure 4. Pre-test results for student number 16.

Week 1 Notes

Day	Activities	Notes
M	Pre-test, individually meet with students to review scores.	Large EL concern with student 13-read through questions and checked for comprehension/vocabulary (minimal)
T	Pre-test, individually meet with students to review scores.	#1 needs vocab support follow-up. #11 can explain process but needs practice with reciprocals. #15 needs help with reducing/finding GCF to reduce fractions.
W	Intervention Group: Students 1, 8, and 13	Reviewed fraction vocab. IXL J.1-J.3 as a group. Requesting independent Prodigy/IXL work. Independent IXL: K.1, L.3
Th	Intervention Group: Students 15, 11, 3, and 4	Reviewed fraction vocab. Practiced reciprocals, fraction problems of all operations. IXL J.1, J.3, K.1, K.6, L.1, L.5 – students will complete unfinished work independently.
F	Intervention Group: Students 7, 12, 16, and 2	Practice fraction problems of all operations. IXL J.1, J.3, K.1, K.6, L.1, L.5 – students will complete unfinished work independently. Student 7 requested to make tutorial videos for IXL problems.

Figure 5. Teacher observation notes for week one.

At the end of the two weeks, students completed a fractions post-test with questions similar to those they answered during the pre-test. It was at this stage of the action research project where student motivation was a factor that may have impacted data results. For each post-test, there was a portion of students that did not complete any questions; therefore, they did not provide any data. For these students, the scores that they did provide are included in visual graphs but are excluded from percentages in categories.

Based on the results of their post-test, students were placed into one of three categories: improved, stayed the same, or decreased. Out of the thirteen students who completed both the pre and post-tests, seven increased in score (53.8%), four stayed the same (30.8%), and two

students (15.4%) decreased. Interestingly, both of the students who decreased in score were English Learner (EL) students. Prodigy does offer text-to-speech accommodations for all of its questions and material, but perhaps these two students did not take advantage of this feature for their post-tests. Student 13 is particularly alarming since they scored a zero on both the pre and post-test. Throughout the research process, teacher observations noted that this student appeared to be semi-engaged and interested in Prodigy, but testing data and general classroom data showed that this student was severely below grade level.

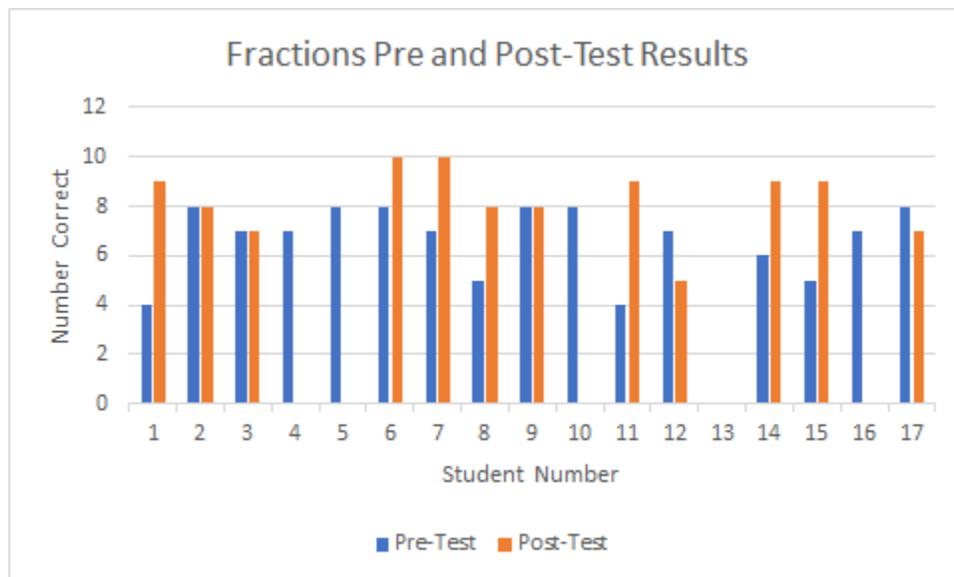


Figure 5. Pre and post-test results for fractions.

The second two-week unit completed was focused on the second most common needed area of improvement found from the placement test results: operations and algebraic thinking with an emphasis on decimals. The first week was organized identically to the first week of the fractions unit. Students completed a pre-test to measure where they needed more support. After the pre-test was completed, I met with students, again one-on-one, to discuss their scores in detail, and we went over which questions they got incorrect. Students were then placed into groups of three or four for intervention meetings where they worked on fundamental vocabulary,

completed practice problems, extensions, or worked on IXL practice. Figure 6 below displays the results from the pre and post-tests about decimals. Based on their scores, students were again placed into one of three categories: improved, stayed the same, or decreased. Unlike the previous fraction unit, all seventeen students completed both the pre-test and post-test. Eleven of the seventeen students (64.7%) increased in score, two (11.8%) stayed the same, while four students (23.5%) students decreased.

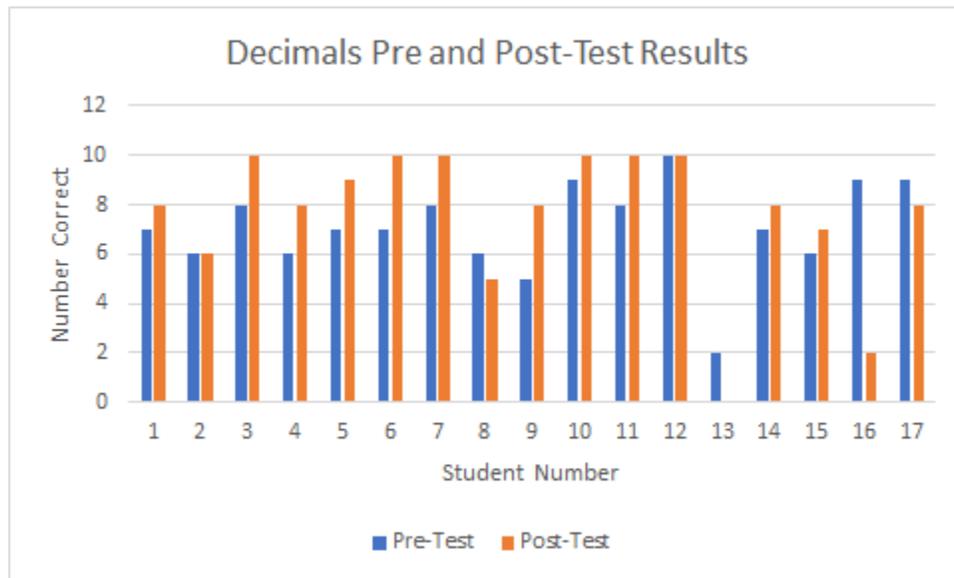


Figure 6. This figure displays pre and post-test scores from the two-week decimal unit.

At the beginning of this action research, I was curious about if and how Prodigy implementation would have an impact on English Learner (EL) students. EL students made up eight of the seventeen total participants. Below, figure 7 displays EL results for both of the two-week units and compares pre-tests to post-tests. During the fractions unit, only one student saw a decrease in their score, while the rest either stayed the same or increased, and the results were the same for the decimals unit as well. However, EL student number 8 (number 13 out of all students) did not see the same amount of progress that other students experienced.

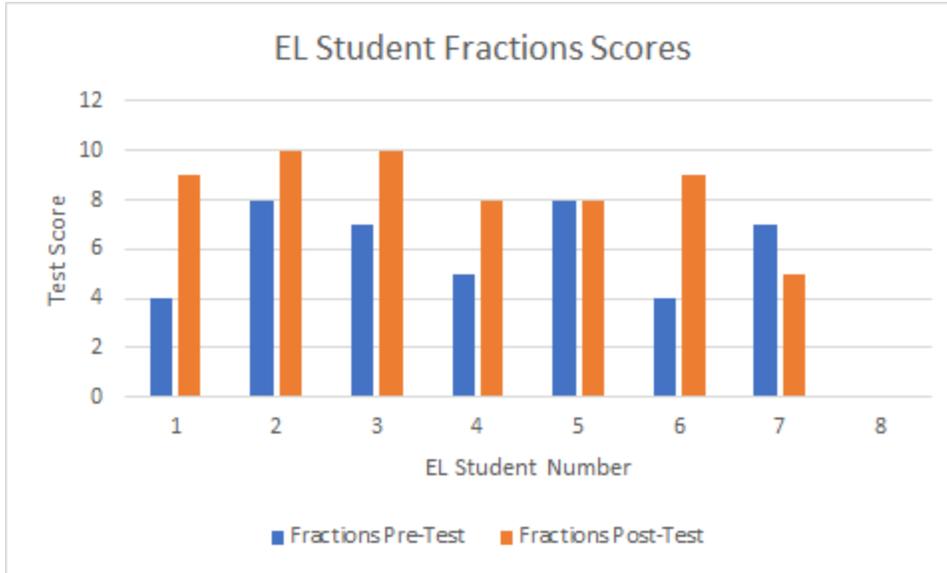


Figure 7. Fractions pre and post-test scores produced by EL students.

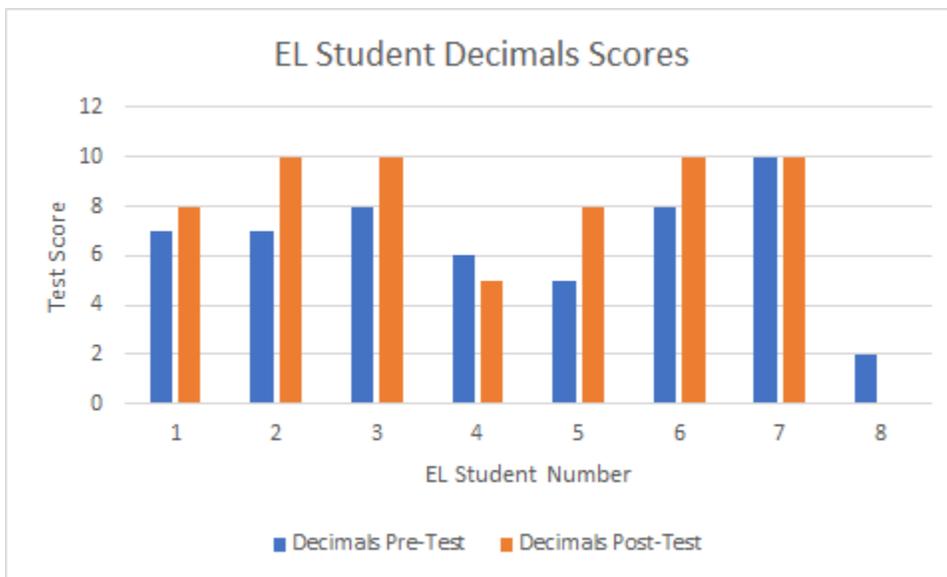


Figure 8. Decimals pre and post-test scores produced by EL students.

Conclusion

The purpose of this action research study was to analyze how Prodigy, used in combination with interventions, could be used effectively in a sixth-grade math classroom to improve student achievement in mathematics. Based on the findings of this action research, the following conclusions were drawn:

- Used in combination with individualized interventions, Prodigy, overall, did help students increase their overall math skill set. Fourteen out of the seventeen students either stayed at the same grade level or increased grade levels on their Prodigy placement tests. Considering the short duration of research, as well as Prodigy's measurement of all mathematical domains, staying at the same overall grade level is considered a success, due to in-depth interventions only covering fractions and decimals.
- Used in combination with individualized interventions, Prodigy, overall, did help students increase their operations skills involving decimals. Fourteen students saw an increase or stayed the same in their unit test scores, while three decreased.
- In the decimal test, the highest student growth was 3 points (30%), and the average growth was 1.28 points (12.8%)
- Used in combination with individualized interventions, Prodigy, overall, did help students increase their operations skills involving fractions. Eleven students saw an increase or stayed the same in their unit test scores, while two decreased (there were four students who did not complete the post-test). The students who did not complete the post-test were not included in the average growth calculation.
- In the fraction test, the highest student growth was 5 points (50%), and the average growth was 2.4 points (24%).
- Based on the pre and post-research math feelings survey, Prodigy did seem to have an impact on the way students felt about math and how it connects to their lives. The only questions that saw a substantial decrease asked students to rate how excited they were to use Prodigy both in and out of school.

Recommendations

Based on the findings of this action research, there is evidence to suggest that Prodigy can lead to an improvement in decimals and fraction skills, specifically for EL students. Pre and post-math surveys also showed an increase in mathematics confidence levels with the majority of students. However, there are aspects that a teacher should consider before fully implementing Prodigy in their classroom. How will the teacher create student buy-in with playing Prodigy? Student buy-in was one of the biggest challenges with this action research. There were students who were not as motivated to play Prodigy as others were. Overall, Prodigy helped keep students on level or advancing, but some students lost motivation. It is difficult to gauge effectiveness if a portion of students is not playing Prodigy either in school or at home. In addition, if this portion of less-motivated students improved their math scores without playing as much Prodigy as others, it is difficult to explain what might have caused that growth. Perhaps those students had older siblings at home helping with separate math assignments, or maybe students sought out help on the Internet, but not from Prodigy specifically.

Secondly, how will English Learner students be supported? Prodigy does offer text-to-speech accommodations for all students, but simply being read a question does not help scaffold a student to being on grade-level material. A teacher should have a system in place to assist EL students with vocabulary support and supplemental materials (manipulatives, word walls, extra practice problems, etc...). In this action research, through the use of hands-on learning with visual supports for students, through the Constructivism lense, Prodigy was shown to make a difference in student numbers and operations test scores, but further research is needed to explore how it can be best implemented to support all students while encouraging them to be fully motivated and engaged with their learning.

References

- Adaptive learning research & results: prodigy. (n.d.). Retrieved from <https://www.prodigygame.com/Research/>.
- Freeman, B., & Crawford, L. (2008). Creating a middle school mathematics curriculum for English-language learners. *Remedial and Special Education, 29*(1), 9-19. doi: 10.1177/0741932507309717
- Ioannou, P., Rodiou, E., & Iliou, T. (2017). Pictures with narration versus pictures with on-screen text during teaching mathematics. *Research in Pedagogy, 7*(1), 57–68. doi: 10.17810/2015.48
- Chew, Keng Sheng. (2016). Tailoring teaching instructions according to student’s different learning styles: Are we hitting the right button? *Education in Medicine Journal, 8*(3), 103–107. <http://dx.doi.org/10.5959/eimj.v8i3.455>
- Downes, S. (2010). New technology supporting informal learning. *Journal of Emerging Technologies in Web Intelligence, 2*(1), 27-33.
- Ketterlin-Geller, L., Chard, D. J., & Fien, H. (2008). Making connections in mathematics: Conceptual mathematics intervention for low-performing students: RASE RASE TL & LD. *Remedial and Special Education, 29*(1), 33-45. <https://doi.org/10.1177/0741932507309711>
- Kiger, D., Herro, D., & Prunty, D. (2012). Examining the influence of a mobile learning intervention on third grade math achievement. *Journal of Research on Technology in Education, 45*(1), 61-82. doi: 10.1080/15391523.2012.10782597
- Ma, L., & Kessel, C. (2003). *Knowing mathematics*. Boston, MA: Houghton Mifflin

Mayer, R. E. (2005). *The Cambridge handbook of multimedia learning*. New York: University of Cambridge.

National Assessment of Educational Progress. (2017). Mathematics assessment. Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics.

O'Malley, P., Jenkins, S., Wesley, B., Donehower, C., Rabuck, D., & Lewis, M. (2013).

Effectiveness of Using iPads to Build Math Fluency. Council for Exceptional Children Annual Meeting, San Antonio, Texas, Apr 3-6, 2013. Retrieved from <https://eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=ED541158>

Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, 2(1), 3-10.

Zhang, M., Trussell, R. P., Gallegos, B., & Asam, R. R. (2015). Using math apps for improving student learning: An exploratory study in an inclusive fourth grade classroom. *TechTrends*, 59(2), 32-39. doi:10.1007/s11528-015-0837-y

1 in 4 Students is an English Language Learner: Are We Leaving Them Behind? (2018, May 1). Retrieved February 6, 2020, from <https://counseling.steinhardt.nyu.edu/blog/english-language-learners/>

Appendix A
Math Attitudes Survey

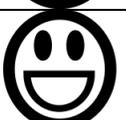
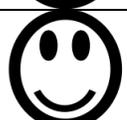
Question					
1) I like doing math.					
2) I am good at math.					
3) I believe that math is important.					
4) I can use math outside of school.					
5) I look forward to using Prodigy in school.					
6) I look forward to using Prodigy out of school.					
7) I believe that Prodigy helps me understand math.					
8) I have someone at home to help me with math.					
9) I have done well in math in the past.					
10) I look forward to learning in math.					

Image: [Smileys black and white] received from https://openclipart.org/image/800px/svg_to_png/172731/lineart-smileys.png

Appendix B

Teacher Observational Data Collection

Week ___ Notes

Day	Activities	Notes
M		
T		
W		
Th		
F		