An Online Algebra 1 Course

by

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Signature Page

Date:

This curriculum development paper has been examined and approved.

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Director of Graduate Studies

Abstract

Online courses are increasing in number. Many colleges offer them and now many high schools are doing the same. Not every child in high school is ready for an online course. But many are, and our Wisconsin Evangelical Lutheran Synod (WELS) high schools need to continue to offer online courses as part of a well-rounded education to their communities.

This paper reviews the development of an online Algebra 1 course as an alternative to a traditional face-to-face (F2F) course. Research of others has shown that this project is plausible. An online algebra unit was developed and implemented with 9th and 10th grade students. Data were gathered and personal comments were collected. These data were used to help shape the rest of the course. The data also showed students seemed receptive to this type of learning and the use of technology to teach it.

Acknowledgements

I would like to thank all who supported me throughout this journey including Manitowoc Lutheran High School (MLHS). They have supported me financially and encouraged me throughout this process. A big thanks to Dr. Grunwald, my advisor, for his support during this project. I would like to thank my wife and family for their support. Finally, to God be the glory; and as the hymn verse states, "(we) lay (our) trophies at His feet."

Table of Contents

Chapter I: Introduction

The purpose of the project

Parents want what is best for their children. They are looking for opportunities for their children to excel. To meet this need, schools are offering additional courses and activities, while the amount of time allowed for learning remains the same. Teacher schedules are limiting students' course selections. Creating online courses is a way to help schools provide more course choices to students and meet students' scheduling needs. This project, to create an online Algebra course, was designed to give high school students an opportunity to take the course without being limited to certain hours of the day when the course is offered face-to-face (F2F). The course might also be useful for high school students who would like to gain lost credit. The course utilizes formative assessments to inform students of their status in the course and has summative assessments to offer evidence of mastery of the course.

Importance of the project

I have taught Algebra 1 since I was assigned to MLHS in 1999. I can remember when I told my students that one day Algebra 1 might not be taught in high school. I saw the trends in which an increased number of grade school students were successful at this level of math. Today many students can learn math at this level without having to sit in a 9^{th} grade classroom. Unfortunately, it is often the only option available to them. At the same time, high schools are trying to broaden their curricula. This makes it difficult for students to fit the courses they want into a standard school day, due to academic schedule conflicts. Providing an opportunity for these students to take an Algebra 1 course online

could be beneficial to these students because they can take an online course at any time of the day.

Project goal

This online format can potentially serve three different groups of students. First, it could serve high school students who wish to take Algebra 1 during the year but cannot fit a F2F section of Algebra 1 into their schedule. Secondly, it can better serve high school students who failed a traditional F2F Algebra 1 course, giving them another option for credit recovery. Perhaps working with an onsite tutor to help guide them through the course would be beneficial. Finally, while it is not the focus of the project at this time, an online course could serve grade school students who are ready to take Algebra 1. This would assist the grade school that finds it difficult to provide the course in a traditional format.

Chapter II: Literature Review

Introduction

Online courses are growing in number. More and more students now have access to courses that their schools do not offer. This trend has also been observed with the 2012 emergence of ALHS Online as an online course provider to facilitate the creation and offering of online courses in the WELS (J. Grunwald, personal communication, October 17, 2016). Picciano, Seaman, & Allen (2010) reported that 75% of high schools in the nation now offer some sort of online course to enhance their offerings or to help students recover credit.

What do we know?

When comparing online delivery to a traditional F2F course, is it even possible for students to gain the same education? Much research has been done on that subject. In their article, Cavanaugh & Jacquemin (2015) listed many of those studies. In one study, Larson and Sung (2009) stated that there was no significant difference in students who take F2F versus online versus blended learning. In another study, McLaren (2004) stated that students taking online business courses scored the same as those that took the same course F2F. A study by Atchley, Wingenbach, & Akers (2013) stated that students in an online math course performed better than a F2F course (0.35 GPA better). In addition, schools and students were not required to purchase textbooks. Finally, more specifically to high school math, Ashby, Sadera, & McNary (2001) said in their report that students taking an online math course were less likely to drop the course, and they performed the same as F2F students. These reports seem to show that online courses can be effective and produce the same results as F2F courses.

When it comes specifically to Algebra 1, two studies showed significant gains in student achievement while taking an online Algebra 1 course. The first study (Heppen et al., 2011), compared 8th grade students who took Algebra 1 online versus students who took a normal F2F math course. The study showed significant gains in Algebra 1 achievement by the group that took an Algebra 1 online course. In addition, the online students tended to take more challenging math courses in high school compared to the students who took the F2F course. The second study, O'Dwyer, Carey, & Kleinman (2007) showed that while online learning was not for every student and not every student enjoyed it, an online Algebra 1 course can be effective and produces similar results to a F2F course.

Another benefit from an online course may be for students who need to recover a credit. As previously mentioned, some schools provide online course options for credit recovery. In fact, some states even require schools that have high failure rates to create online options for recovery (Picciano, Seaman, & Allen 2010). In a study by Heppen et al. (2012), students took either a F2F course or an online course in summer to recover a credit. The study found both F2F and online courses had successes and failures. Higher scores were posted for those students who had enrolled in the F2F option. However, students in both courses received credit. Forty-five percent of the students in the F2F course passed, received their credits, and passed Geometry the next school year. Forty-two percent of the students in the online course passed, received credit, and passed Geometry the next school year. While the number of those who passed may be less than 50 percent, it did show that online recovery is an option for students that can help keep them on pace in high school. Another interesting finding was that no significant

difference was found when sophomores in both groups took the standardized PLAN (pre-ACT) tests scores.

There are many online resources available to supplement and manage the delivery of online courses. ALHS Online uses Moodle as the learning management system (LMS) to distribute courses to their students. In the O'Dwyer, Carey, & Kleiman (2007) report mentioned previously, the students used Blackboard. Another common resource that is already in use in many algebra F2F courses is the Khan Academy website (www.khanacademy.org). The website was created in 2006 to help students master basic concepts so they could free up time to learn more math concepts (Cargile & Harkness, 2015). While used by millions of people and serving as a great resource for students and teachers, Khan Academy wasn't designed to offer stand-alone math courses for high school credit (Cargile & Harkness, 2015). Another resource many schools already have is an onsite math teacher to assist with the online course. O'Dwyer, Carey, & Kleiman (2007) noted that students not only benefited from an expert online instructor, but also an onsite teacher who could help them stay focused and answer questions.

What has our WELS done?

ALHS Online began a pilot program in 2015 to offer an online Algebra 1 course to 7th and 8th graders. By 2016, the enrollment had increased to 25 students (J. Grunwald, personal communication, October 1, 2016). This finding suggests that online opportunities are attractive to WELS schools, and the need is there to offer these types of courses. Although this project could serve grade school students, it will focus on high school students who are looking for an alternative approach or recovery credit.

Summary

The resources are available for WELS schools to adopt more online courses. The research shows that offering an online Algebra 1 course for both potential algebra students or for those who need recovery credit is viable. Online educational opportunities have the ability to enhance a school's curriculum. Students can benefit from having access to online courses. By making the course independent of textbooks, schools can save money and increase available options.

Chapter III: Implementation

Introduction

Developing an online Algebra 1 course can serve three groups of students: high school students who are ready for Algebra 1, but have trouble fitting it into their schedules; high school students looking for credit recovery; and, possibly, grade school students ready for Algebra 1. Schools may benefit by freeing up teachers' classroom periods and allowing their students to take courses that can better accommodate their schedules.

Over the last several years, I have enjoyed preparing individual algebra lessons online for days when I would be missing school. However, it was never necessary to prepare several days in a row. I was excited to finally put together an entire Algebra 1 online unit and online course. After hours of work, it was enjoyable for me to teach the online unit of the Algebra 1 course. This chapter describes the process involved in creating that unit and the course.

Procedures

In creating this course, I completed seventy-one lessons that covered a normal semester of Algebra 1 topics (Appendix A). All the lessons were posted online using Microsoft OneNote and accessed by the students using Office 365 accounts provided at MLHS. Each lesson had a video, an assignment, key concepts, and directions on what to do (Appendix B). Various forms of assessments were given. When students were finished with an assessment, they needed to either take a picture, scan the paper, or use the OneNote app on their cellphone to post it into an assessment tab in OneNote (Appendix C). Once posted on the assessment tab, I graded them and made comments to

help point out their mistakes. Students could see the results, the suggestions, and fix mistakes they had made.

To help determine the effectiveness of teaching Algebra 1 in an online format, I taught one comparative unit to two separate sections of students. The two sections were formed based on the two class periods in which the students had been enrolled. Both sections covered the same content. One was taught in a traditional F2F format while the other used the online format to learn the content. The online section was moved to another classroom in the school where students could only communicate with me via Skype, email, or a collaboration page I had created (Appendix D). An onsite tutor was in the room with them to guide the students and help with technology issues that came up. Each day the students logged into the 365 network and accessed the lesson for that day in OneNote and worked through the tasks and assignments. Not every student was on the same lesson, and they had the freedom to move at their own pace with due dates appropriately spaced to coincide with major assessments. Students were reminded of the due dates in the video and on the OneNote lessons.

Two main items were used to help evaluate the effectiveness of the online unit. One evaluation included the scores recorded for the assessments during the unit. Three main assessments were given. The other evaluation was a student survey administered to the online section only. This was given at the end of the unit. Both were used to help identify weaknesses in the unit and to capture the students' thoughts regarding the online process.

Artifacts

As mentioned previously, lessons were located on a class notebook through Microsoft OneNote. Algebra topics were taught and lessons were broken into units and learning targets. Day to day assignments were constructed and completed by students to demonstrate mastery of targets. Assessments consisted of both problem-solving questions and written responses. Both were used to determine if they understood the learning targets of the unit (Appendix E). Summative assessments were administered three times and scored for students to show student mastery (Appendix F). All assessments were aligned with Common Core Standards (Appendix G).

After teaching the comparative online unit, assessment results from both the F2F and online sections were tallied. Personal comments of the online section were recorded using an online survey (Appendix H). Both F2F and online assessments were compared to determine the effectiveness of teaching the unit in an online format.

Results

The comparative online unit took about two and half weeks to complete. Students in the online section had mixed feelings about the unit but were excited to work through it. One student commented, “I enjoyed the ability to watch the video over and over until I got it.” Another student commented, “I liked that I could work at my pace.” However, one student didn’t like that freedom, “I didn’t like that everyone was on different sections.” Based on these comments, it would seem online algebra isn’t the preferred method of learning for everyone, but is a viable option for students.

I tallied the comparative online unit grades of the students in both sections. The results I obtained matched those in other research mentioned in Chapter 2. Both the

online section (13 students) and the F2F section (18 students) had similar grades before starting the comparative unit taught in both formats (Figure 1). This suggests that both sections contained students of similar abilities. After going through the online unit, despite both sections having lower scores, both sections ended with similar grades. Almost half (46%) of the online students did the same or better than they did in previous units, while the rest (54%) earned lower grades during the online unit. The same can be said about the F2F section where almost half (44%) had the same grade or better in the comparative unit and the rest (56%) had lower grades than before. This supports the idea that an online Algebra 1 course is a viable option for high school students since students in the online section were at least as successful in learning the content of the comparative unit as those in the F2F section.

Sections	Total in section	Ave. Grades prior to sample unit	Ave. Grades of sample unit	Students who had the same or better grades during sample unit	Students who had worse grades during sample unit
Online Section	13	B	C	6	7
F2F Section	18	B-	C+	8	10

Figure 1. Comparative course and unit grades between online and F2F sections before and after sample unit.

After completing the comparative online unit, I finished the rest of the units for the semester. Based on the suggestions of the students and the observations I gained from teaching, the content, lessons, and assessments were good. However, I needed to create clearer due dates and be clearer with my day to day instructions. I also needed to allow more time for students to work at their own pace. Moreover, I should have created

more activities with technology ahead of the units so students would have been better prepared for the online format. Some examples of activities are lessons on how to use OneNote, smartphones, and how to apply the OneNote app. In addition, students would benefit from time management instruction.

Chapter IV: Reflective Essay

Introduction

The primary purpose of the project was to create an online Algebra 1 course for high school students. This course would be developed for the benefit of high school students who are required to take Algebra 1, but may have trouble fitting a F2F course into their schedules. A secondary purpose for the development of this course was to give students an opportunity to receive a recovery credit in algebra. This would be for high school students who had previously failed a F2F algebra course. Lastly, with some modifications, this course could be developed to serve grade schools that cannot offer Algebra 1 to their students in a traditional format. The number of online courses being offered online is increasing. Students are gaining knowledge from these experiences. This chapter will describe some limitations and a few insights I gained during this process.

Conclusions

There were a few limitations for this project. First, since this was not a scientific study, the two Algebra sections were not randomly selected and assigned, which could have skewed the results. A second limitation was that with little or no introduction, the online students were put into an online course and may have struggled to adjust to the course setup and what was expected. A third limitation had to do with the technology the online section was using. Each day they needed to log in and sync all the data which took time away from the lessons. This was required because the school computers they used were also used by other students throughout the day, and student privacy needed to be protected. If students would have used their own machines, more time could have

been spent on the lessons. The last limitation was the limited length of time of the online unit. This may have altered the overall results.

I learned that online students needed more time to finish the unit. I underestimated the time it took for the online section to catch on to the technology. We often perceive teenagers as being experts with technology, but that is not always true when it comes to using technologies with which they have minimal experience. The students struggled with some activities. One flustered student, for example, came to my office and handed me sheets of paper instead of submitting assignments online.

I also learned there is still a place for F2F courses. As previously mentioned, not all students are able to do well in an online environment. After asking the students if they would consider taking an online math course again, most said no or not unless they were required to do so. Many students missed the social interaction with the teacher and each other. Overall, most did enjoy the course and agreed it was setup well and easy to follow.

Finally, I found it interesting to note that most students coming into the comparative online unit with lower scores continued to struggle. I mention this because the current online course format may not be the best way to help students to recover a credit, as previously thought. Perhaps with some modifications to this course and an onsite tutor guiding them, this course might still work, or a different course may need to be created to help those students.

Recommendations

Overall, I enjoyed creating and teaching the online unit. I was glad to see my results matched the results found in other research. I knew that every student might not enjoy online learning, but I was pleased with the number that not only enjoyed it, but

improved their grade during the one comparative online unit. Upon reflection, I would make these changes before teaching the entire course online:

- Add more time for lessons to be completed before moving on.
- Allow more days before the online units begin for students to become familiar with OneNote and other programs we will use.
- Make sure students can use the same computers or their own computers each day.
- Make sure students have access to a scanner or feel comfortable using their smartphone to take pictures of the assessments to help post them to OneNote.
- Have the students touch base with me at least once during each unit via skype or email.
- Create a timeline that clearly states due dates for assignments assessments.
- Encourage students to have a stylus and touch screen to create notes and answer daily work digitally.

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Appendix A: Scope and Sequence

Unit A

Title	Learning Targets
a: Expressions, Equations and Inequalities, and Functions	a1: Investigate basic terms a2: Identify order of operations a3: Create Expressions a4: Convert unit rates a5: Create inequalities a6: Solve Word problems a7: Define domain and range a8: Define terms of measurement and Precision

Unit B

Title	Learning Targets
b. Solve Linear Equations	b1: Simplify Square Roots b2: Solve linear equations b3: Write proportions and ratios b4: Rewrite equations and formulas

Unit C

Title	Learning Targets
c. Graphing Linear Equations and Functions	c1: Plot points and identity parts of graph c2: Graph equations using 3 forms c3: Find Slope and Rate of change c3: Model Direct Variation c4: Use Function notation to solve and graph

Unit D

Title	Learning Targets
d. Writing Linear Equations	d1: Write equations into Slope-Intercept form, point Slope form, and Standard Form d2: Create equations of Parallel and Perpendicular Lines d3: Predict using Linear Models

Unit E

Title	Learning Targets
e. Inequalities	e1. Solve inequalities e2. Solve compound Inequalities e3. Simplify ABS inequalities e4. Graph inequalities using 1 and 2 variables

Unit F

Title	Learning Targets
f. Systems of Equations and Inequalities	f1. Solve systems by algebraic and graphing f2. Solve special situation systems f3. Solve Linear Inequalities by graphing

Unit G

Title	Learning Targets
g. Exponents	g1. Apply exponential rules to simplify expressions g2. Create and graph exponential growth equations g3. Create and graph exponential decay equations

Unit H

Title	Learning Targets
h. Polynomials	h1. Adding and Subtracting Polynomials h2. Multiply Polynomials together (FOIL, Distribute) h3. Simplify polynomials by Factoring (Grouping, GCF, Simile face factoring) h4. Apply the Zero product property to find solutions

Unit I

Title	Learning Targets
i. Quadratics	i1. Students can graph Quadratic Functions i2. Students know 3 forms of Quadratics and can identify key part of each i3. Students know how to solve Quadratics several ways i4. Students can solve systems of Quadratics by graphing i5. Students know the 3 basic forms of equations and can model each one

Unit J

Title	Learning Targets
j. Data and Statistics	j1. Students understand how to collect data and to classify it j2. Students know 5 different measures of numbers j3. Students can create various visuals to display data

Unit K

Title	Learning Targets
k. Radical equations and functions	k1. Students know how to reduce radical expressions k2. Students understand how to simplify radical equations k3. Students can graph Square root functions

Appendix B: Sample Online Lesson

F Section 3 by Elimination

Key points to remember:
- Get opposite numbers
- 4 steps to solve
- Ordered pair answers

Things to do:
- Watch video (password is unit f)
- Work on assignment (enter problems in paper notes)
- Write down questions you have
- Write key points into notes
- Finish homework tab question f1 and f2 (this is graded!!!)
- Review Quiz f1 for questions, once all have submitted work and answers will be given to you. You may retake this if you want, contact me

Name: _____ **Alg I**

Unit F Section 3

Solve the system:

1. $4x + 4y = -12$
   $3x - 4y = -23$

2. $x + 4y = -23$
   $-3x + y = 4$

3. Use elimination to solve the linear system.
   $4x + 3y = -2$
   $3x + 2y = -3$

4. Solve the linear system by any method.
   $3x - 2y = 3$
   $6x + 2y = 3$

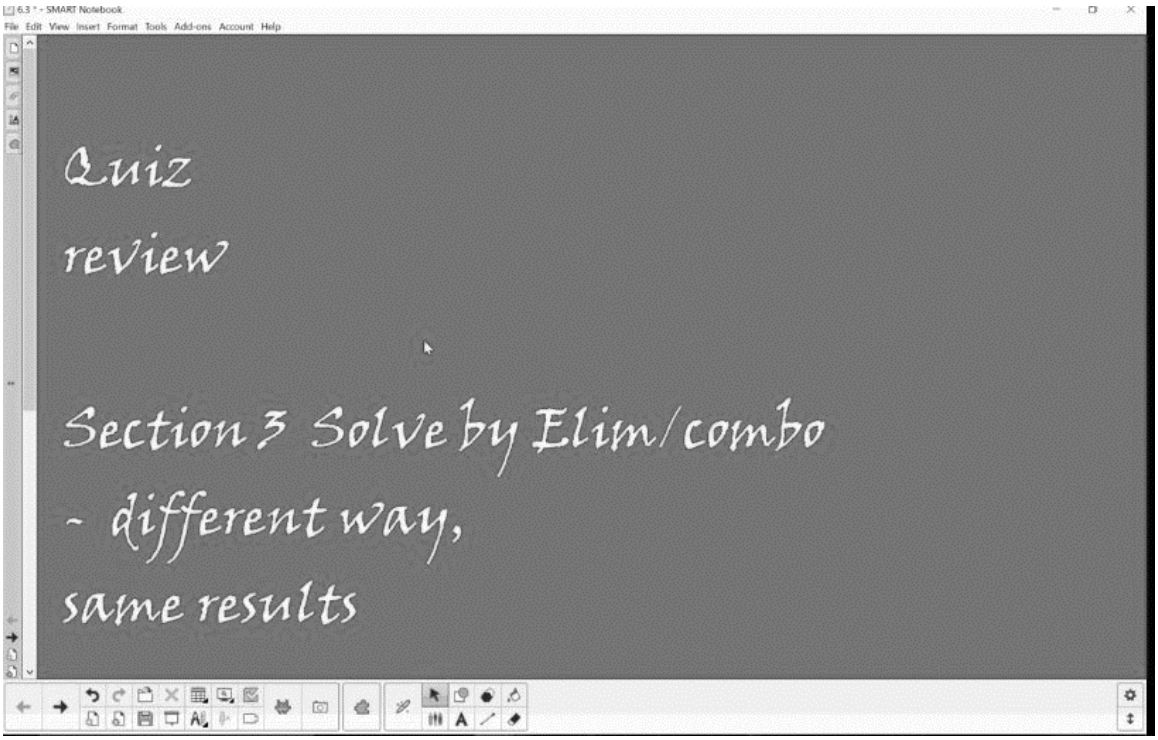
5. A total of $10,000 is invested in two funds paying 5% and 7% annual interest. The combined annual interest is $644. How much of the $10,000 is invested in each fund?

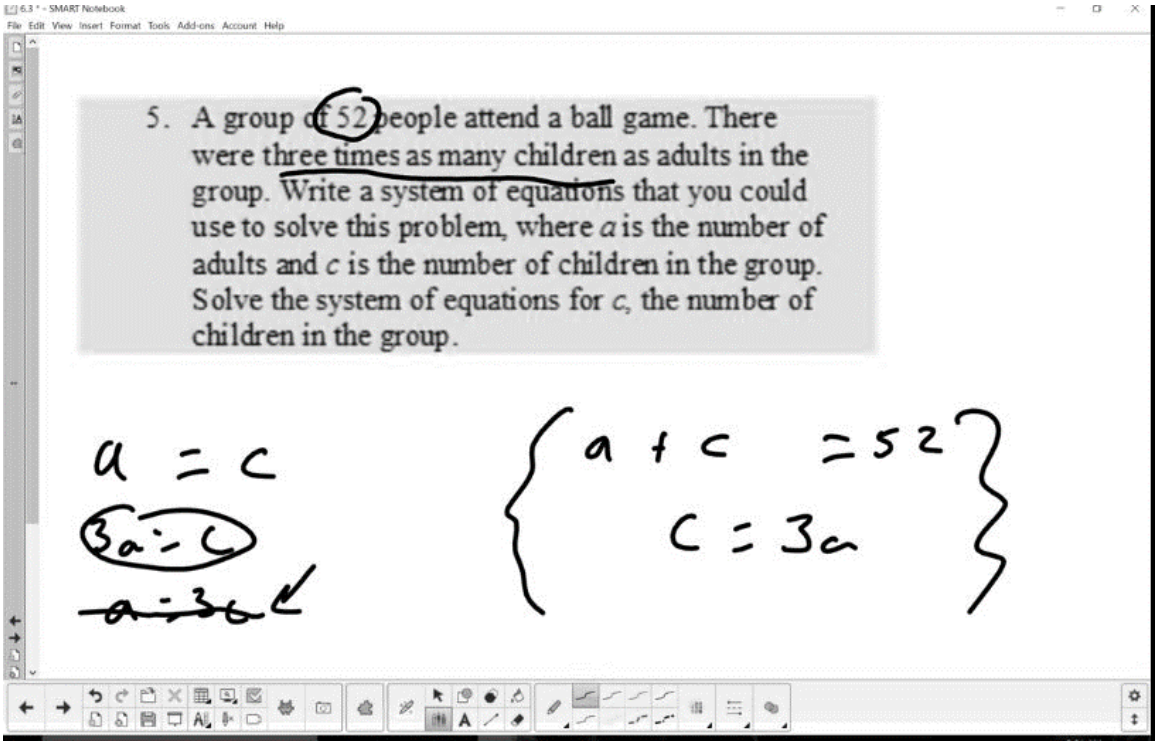
6. The table below shows the costs of two different combinations of hot dogs and sodas at a ballgame. What is the cost h of one hot dog and the cost s of one soda?

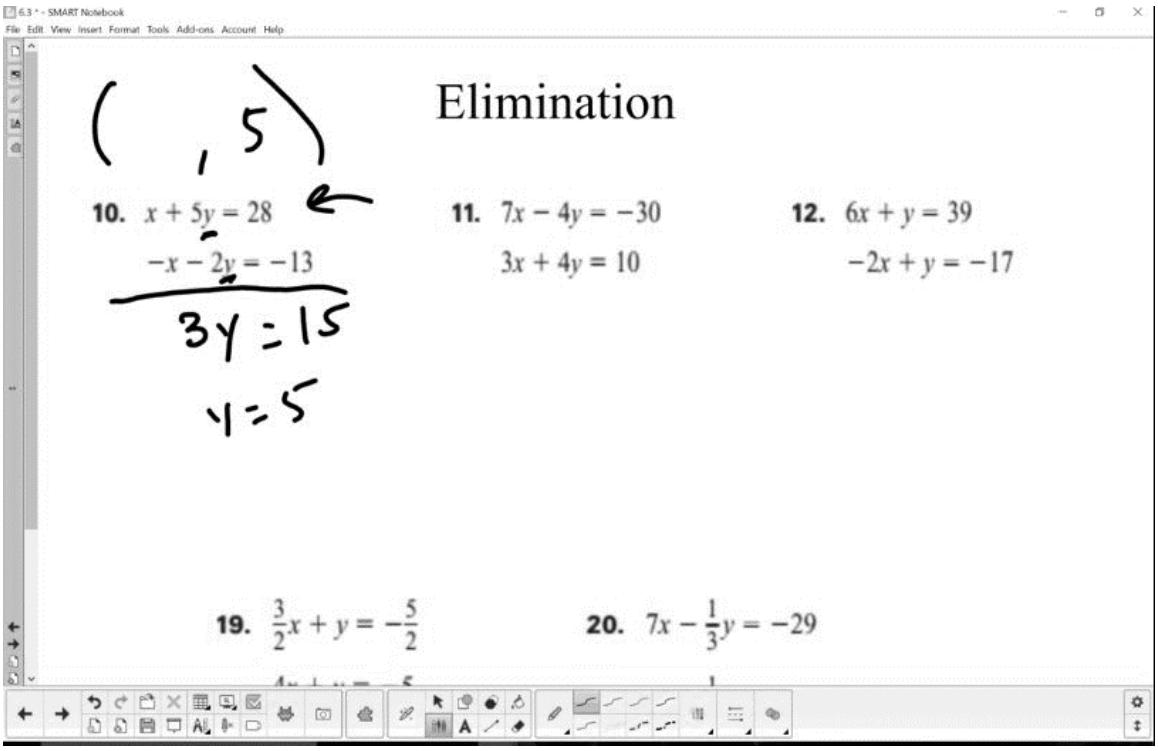
Number of hot dogs	Number of sodas	Total Cost
4	4	$20
4	6	$24

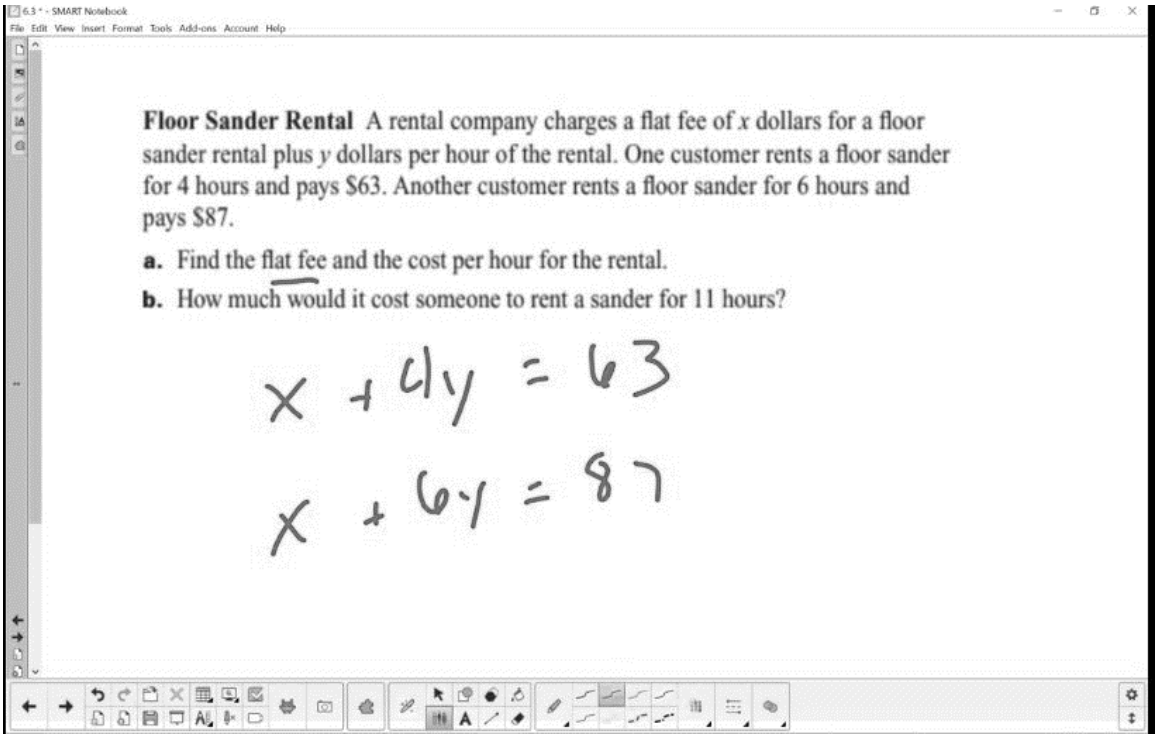
Good link if you are still struggling with Substitution

Screen shots from a video in the above sample lesson plan.

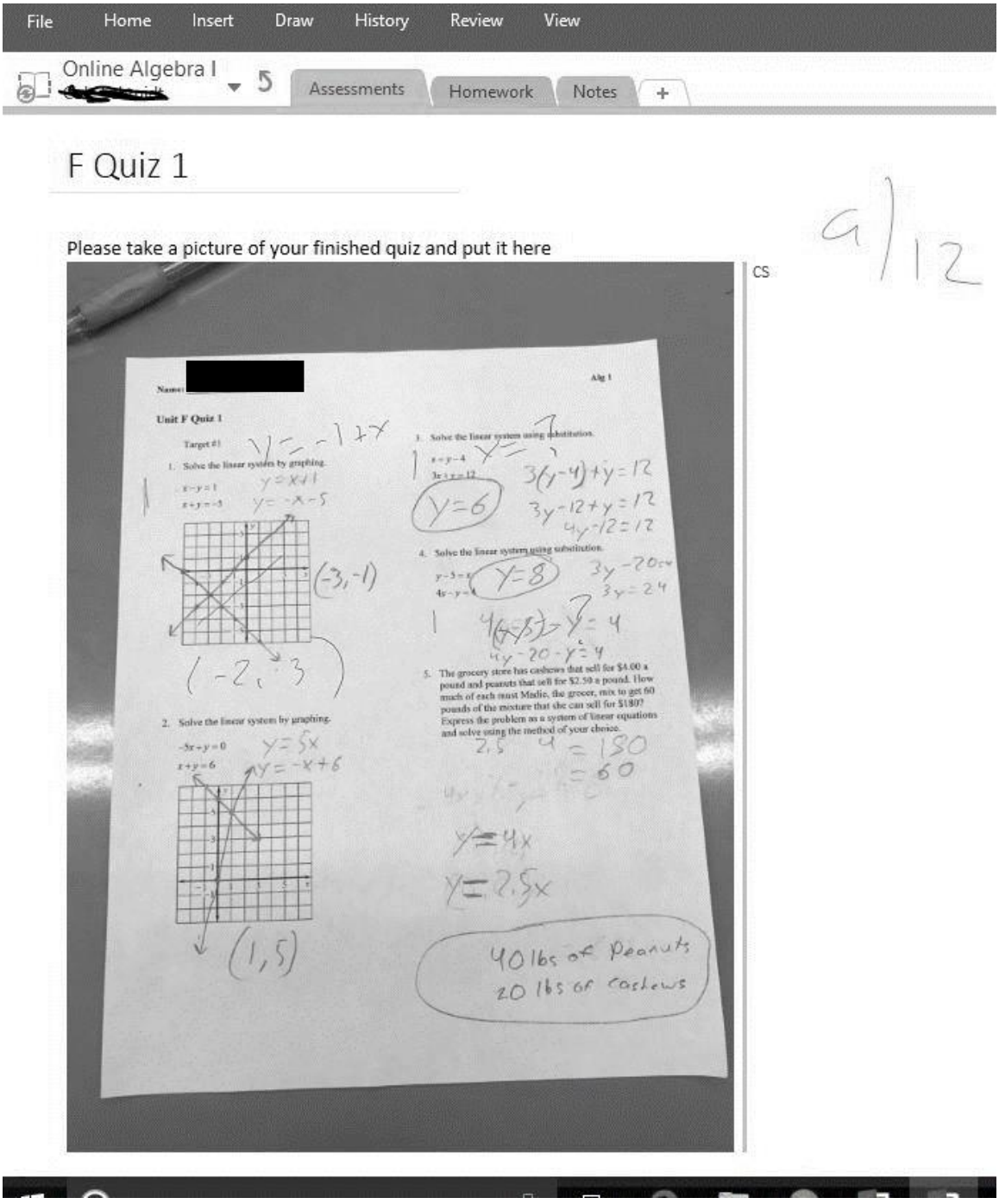




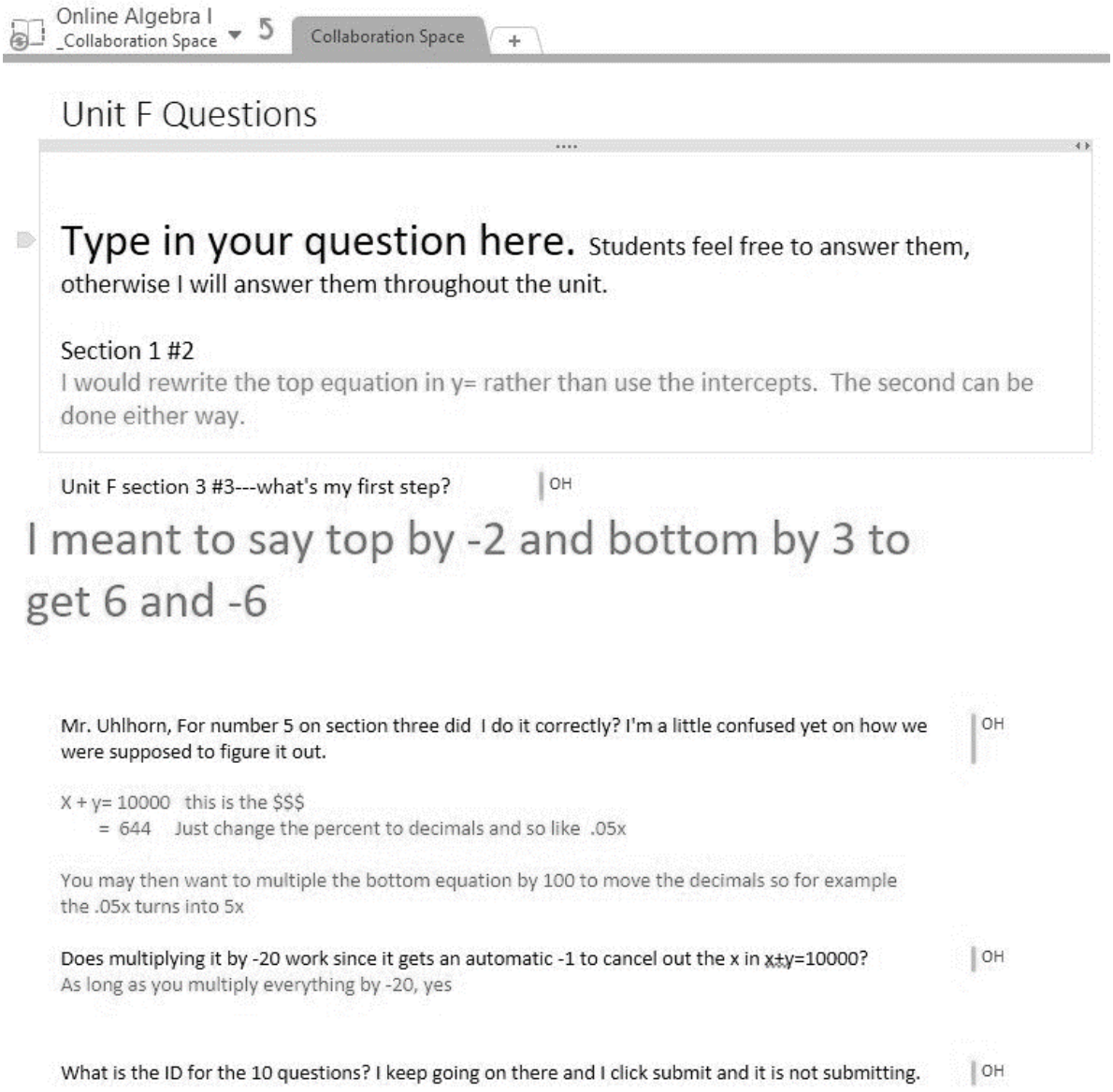

6.3 * - SMART Notebook
File Edit View Insert Format Tools Add-ons Account Help
(, 5)
Elimination
10. $x + 5y = 28$
$-x - 2y = -13$
$3y = 15$
$y = 5$
11. $7x - 4y = -30$
$3x + 4y = 10$
12. $6x + y = 39$
$-2x + y = -17$
19. $\frac{3}{2}x + y = -\frac{5}{2}$
20. $7x - \frac{1}{3}y = -29$


6.3 * - SMART Notebook
File Edit View Insert Format Tools Add-ons Account Help
Floor Sander Rental A rental company charges a flat fee of x dollars for a floor sander rental plus y dollars per hour of the rental. One customer rents a floor sander for 4 hours and pays $63. Another customer rents a floor sander for 6 hours and pays $87.
a. Find the flat fee and the cost per hour for the rental.
b. How much would it cost someone to rent a sander for 11 hours?
$x + 4y = 63$
$x + 6y = 87$

Appendix C: Assessment Post



Appendix D: Collaboration Page



Appendix E: Sample Daily Assignments

Unit F Section 3

Solve the system:

1. $4x + 4y = -12$
   $3x - 4y = -23$

2. $x + 4y = -23$
   $-3x + y = 4$

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5. A total of $10,000 is invested in two funds paying 5% and 7% annual interest. The combined annual interest is $644. How much of the $10,000 is invested in each fund.6.

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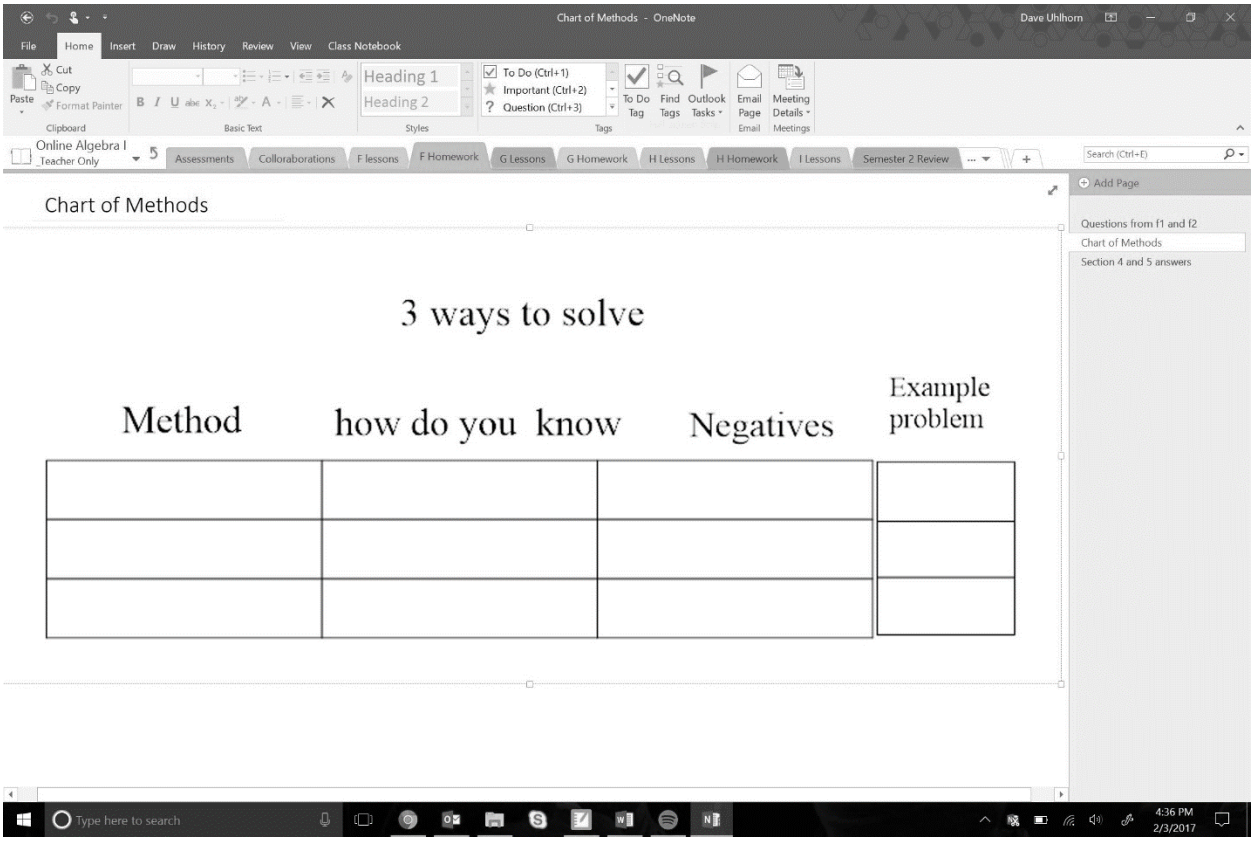
Number of hot dogs	Number of sodas	Total Cost
4	4	$20
4	6	$24

An example of a non-problem solving type of daily work.



Appendix F: Sample summative assessment

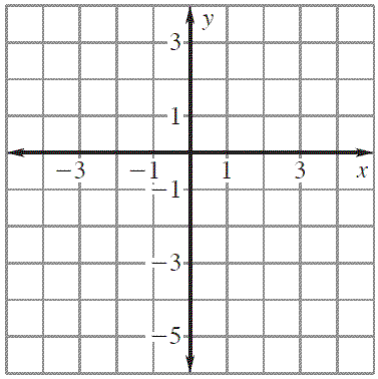
Unit F Quiz 1

Target #1

1. Solve the linear system by graphing.

$x - y = 1$

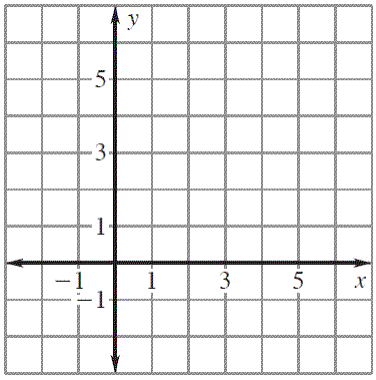
$x + y = -5$



2. Solve the linear system by graphing.

$-5x + y = 0$

$x + y = 6$



3. Solve the linear system using substitution.

$x = y - 4$

$3x + y = 12$

4. Solve the linear system using substitution.

$y - 5 = x$

$4x - y = 4$

5. The grocery store has cashews that sell for $4.00 a pound and peanuts that sell for $2.50 a pound. How much of each must Madie, the grocer, mix to get 60 pounds of the mixture that she can sell for $180? Express the problem as a system of linear equations and solve using the method of your choice.

Appendix G: Common Core Standards for Mathematics

Adapted for this course from complete list available at https://dpi.wi.gov/sites/default/files/imce/standards/pdf/common-core-math-standards.pdf, pages 62-83.

A.APR.1	Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.
A.APR.3	Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.
A.APR.4	Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x 2 + y2)2 = (x2 - y2)2 + (2xy)2 can be used to generate Pythagorean triples.
A.CED.1	Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
A.CED.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A.CED.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
A.CED.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.
A.REI.1	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A.REI.3	Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A.REI.4	Solve quadratic equations in one variable.
A.REI.4b	Solve quadratic equations by inspection (e.g., for x 2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.
A.REI.5	Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A.REI.6	Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
A.REI.7	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = -3x and the circle x 2 + y2 = 3.

A.REI.10	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
A.REI.12	Graph the solutions to a linear inequality in two variables as a halfplane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.
A.SSE.1	Interpret expressions that represent a quantity in terms of its context.
A.SSE.3a	Factor a quadratic expression to reveal the zeros of the function it defines.
A.SSE.3c	Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15 t can be rewritten as (1.151/12)12t ? 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.
F.BF.2	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
F.BF.3	Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
F.BF.5	Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
F.IF.1	Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).
F.IF.2	Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
F.IF.3	Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ? 1.
F.IF.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.
F.IF.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.
F.IF.6	Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

F.IF.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
F.IF.7a	Graph linear and quadratic functions and show intercepts, maxima, and minima.
F.IF.7b	Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
F.IF.7e	Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
F.IF.8a	Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
F.LE.1	Distinguish between situations that can be modeled with linear functions and with exponential functions.
F.LE.2	Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
G.GPE.5	Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).
N.Q.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
N.Q.2	Define appropriate quantities for the purpose of descriptive modeling.
N.Q.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
N.RN.1	Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 5 1/3 to be the cube root of 5 because we want (51/3)3 = 5(1/3)3 to hold, so (51/3)3 must equal 5.
N.RN.2	Rewrite expressions involving radicals and rational exponents using the properties of exponents.
S.IC.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
S.IC.3	Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
S.ID.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
S.ID.2	Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
S.ID.3	Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
S.ID.5	Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal,

	and conditional relative frequencies). Recognize possible associations and trends in the data.
S.ID.6	Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
S.ID.6a	Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
S.ID.6c	Fit a linear function for a scatter plot that suggests a linear association.
S.ID.7	Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

Appendix H: Student survey and responses

Online Algebra 1 Survey (done online via a form)
Thanks for participating in the online unit. I would like to get an idea of how you felt the unit went and the communication that took place. Read each statement and then select the word that best describes your attitude or feeling towards that statement.

1. I was able to access all the aspects of the class (websites, OneNote, skype, …)
   Strongly Disagree Disagree Neutral Agree Strongly Agree

2. The video was clear in the content and was easy to follow.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

3. It was clear to me what the day to day assignment was.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

4. It was an easy process to "submit" the quizzes and tests on OneNote
   Strongly Disagree Disagree Neutral Agree Strongly Agree

5. It was nice to work together and see others work.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

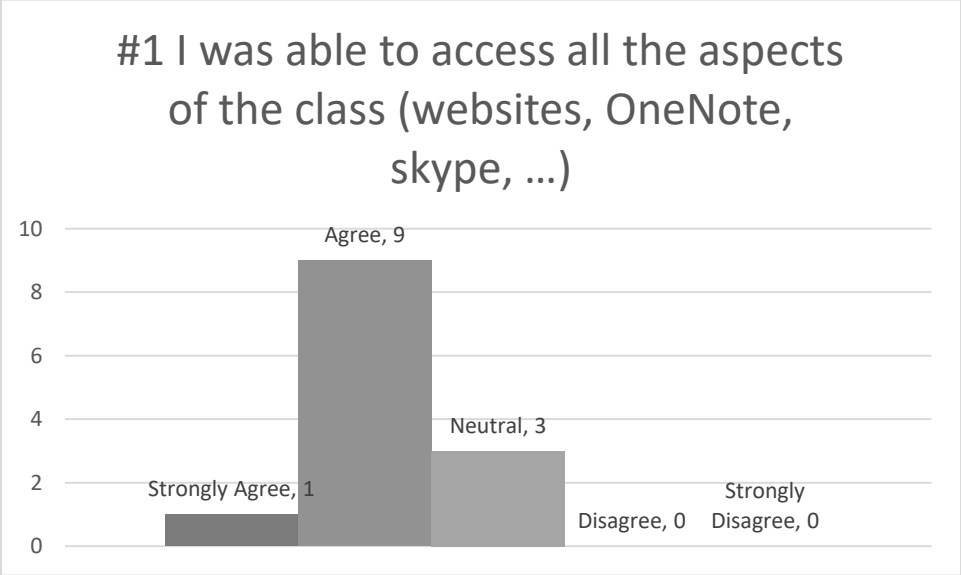
6. The teacher was able to answer any of my questions that came up.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

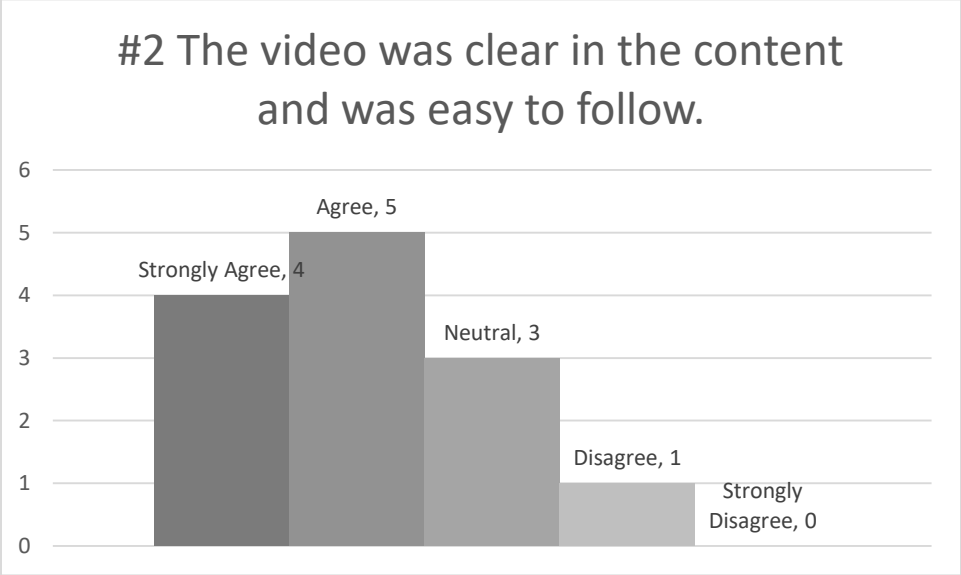
7. What are the things you like about the online class?

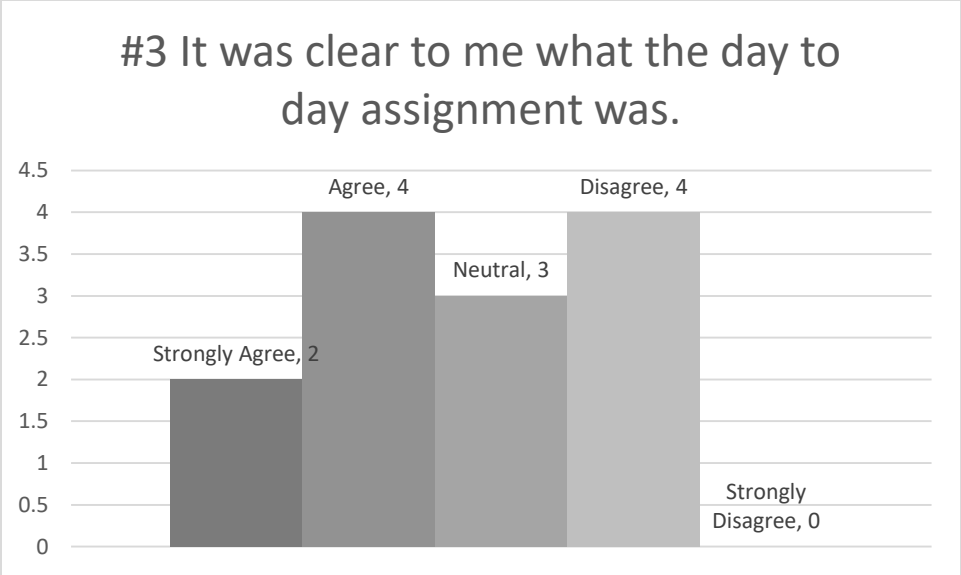
8. What would you change about the online class?

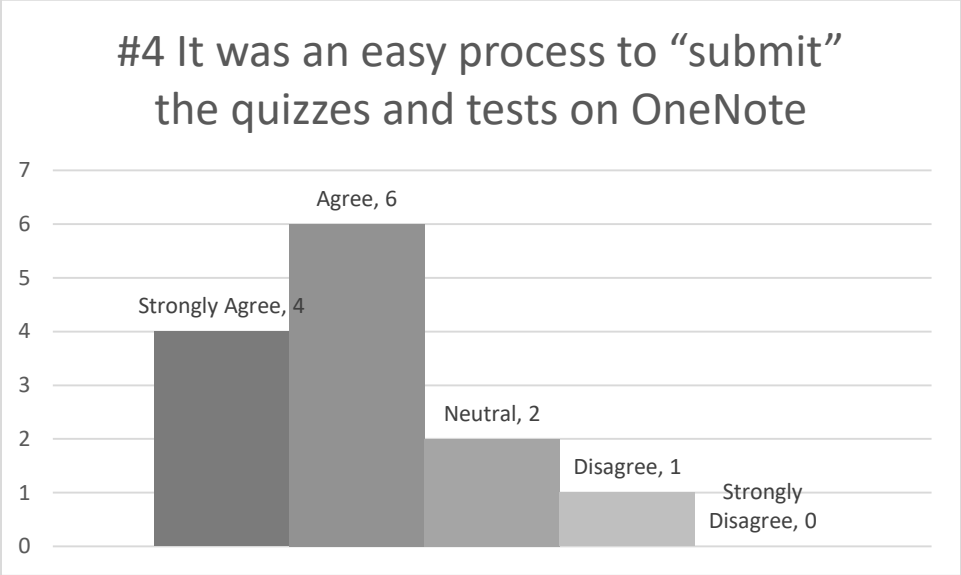
9. Would you feel comfortable taking a full course math class online?

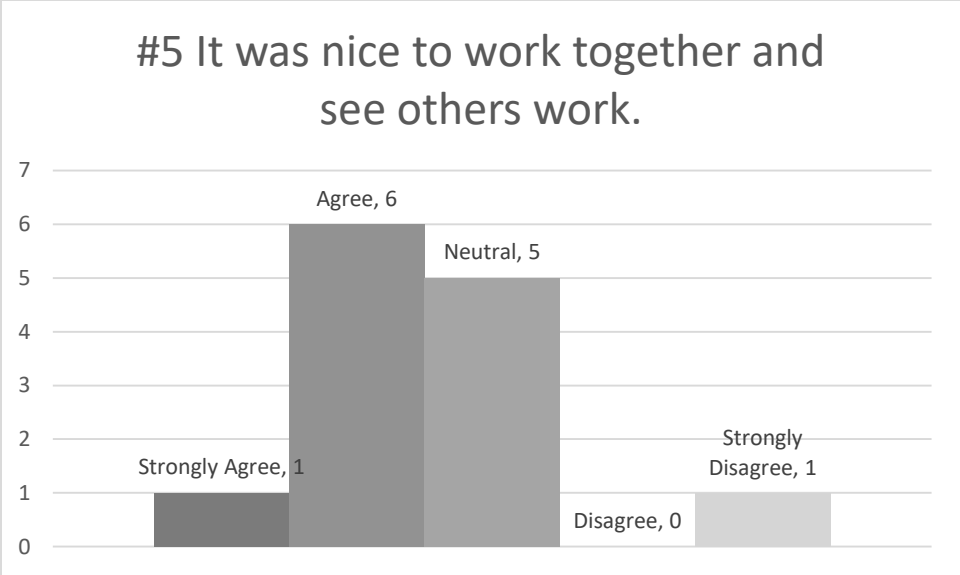
Responses

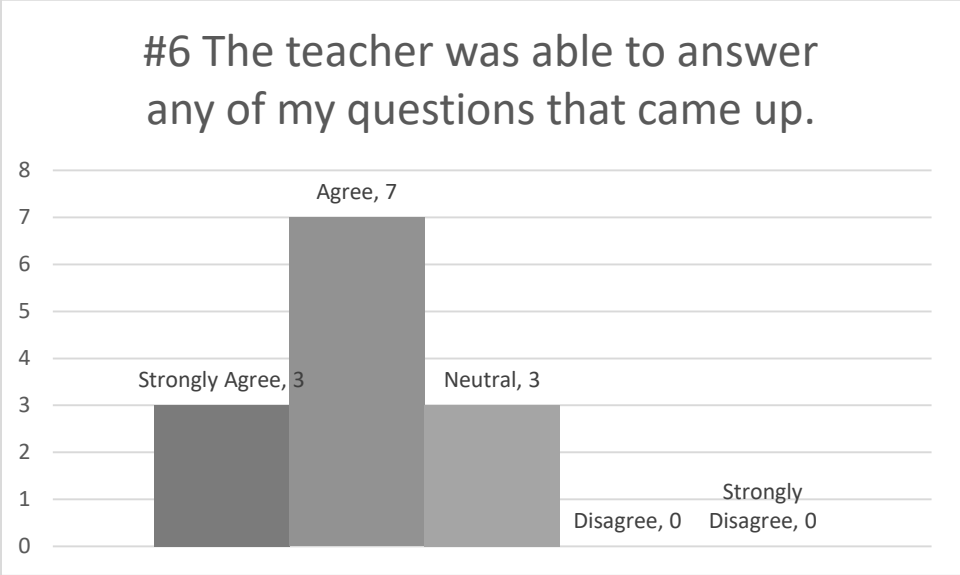

#1 I was able to access all the aspects of the class (websites, OneNote, skype, …)
10
8
6
4
2
0
Agree, 9
Neutral, 3
Strongly Agree, 1
Disagree, 0
Strongly Disagree, 0


#2 The video was clear in the content and was easy to follow.
6
5
4
3
2
1
0
Agree, 5
Strongly Agree, 4
Neutral, 3
Disagree, 1
Strongly Disagree, 0


#3 It was clear to me what the day to day assignment was.
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Strongly Agree, 2
Agree, 4
Neutral, 3
Disagree, 4
Strongly Disagree, 0


#4 It was an easy process to “submit” the quizzes and tests on OneNote
7
6
5
4
3
2
1
0
Strongly Agree, 4
Agree, 6
Neutral, 2
Disagree, 1
Strongly Disagree, 0





#7 What are the things you like about the online class?

- Constant access of any lesson and assignment
- How easy it was to understand everything, and (for me) I didn't have to take as much notes because everything was in the right spot so if I had a question, all I had to do was refer back to the video or the assignment.
- You didn’t have to take books home or papers.
- I liked how it as online if you missed class the next day you can easily do on the online and do the worksheet and watch the videos
- The easy access that was available at all times.
- I like that you had lots of space for writing your work out.

- being able to work at your own pace
- He answered all of my questions.
- Your videos were better explained and I could understand everything.
- Being able to watch videos
- I could watch the video over and over

#8 What would you change about the online class?

- Set specific times/due dates for items, or even just dates showing when each lesson is/was released so I can plan for tests and quizzes
- Maybe give us EXACT dates to explain when the assignment is due, or when a test or quiz comes up so I can plan accordingly.
- go [through] more problems and explain it more
- The teacher was there [teaching and] just the homework was online.
- Graphing lines should be easier.
- I did not like that everyone was on different assignments, because when we took quizzes some people may not have watched the video to that section.
- I couldn't get to some things.
- Knowing what exactly my assignments were.
- Nothing

#9 Would you feel comfortable taking a full course math class online?

- I could, but I [would] rather not :)
- Yes, very much so!
- No
- no
- I would not like to take a full course online math class because math is always easier to comprehend and replicate if seen in person.
- Yes, but when graphing comes up use paper and such.
- yes
- No
- Maybe
- No.
- no
- No