Developing Fraction Sense

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Developing Fraction Sense
A 2008 NCTI Technology in the Works Research Project

Final Summary Report

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Developing Fraction Sense: Final Report  
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Summary

With grant funding provided by the National Center for Technology Innovation, Technology in the Works grant program, Spotlight on Learning, LLC, designed interactive software-based fraction concept activities for students in grades three through five. The activities were created in accordance with principles of universal design for learning. They provided manipulative models using explicit instruction and strategic feedback in an accessible digital environment that permitted alternative methods of input and provided audio support. The study was implemented in ten inclusive fifth grade classrooms using a quasi-experimental pretest-posttest group design. The research sought to investigate the effectiveness of the software when compared to traditional paper-and-pencil learning activities. The results reveal that the intervention holds promising potential for three of four AYP student groups who traditionally experience chronic academic failure: students of color, students of poverty, and students with disabilities. Pre-existing differences between the experimental and control groups made it impossible to statistically evaluate the academic learning outcomes of the eight-week intervention. The implications of this project for future research and practice are summarized.

Introduction

In terms of instructional approaches, lessons delivered to students with disabilities are often focused on procedures and memorizing rules rather than on developing conceptual foundations prior to skill building. “Computational practice is usually structured hierarchically, with an emphasis on mastery of procedural steps in an algorithm as students move from easy to complex problems. Students frequently learn these rote procedures without any conceptual understanding” (Woodward & Montague, 2002). Students who struggle with math need multiple opportunities to practice in formats that build conceptual understanding prior to using algorithms.

Although difficulties with math are not unique to students with disabilities, it is clear that their disabilities can impact their achievement. Cawley and Miller (1989) report that students with learning disabilities perform far below their grade-level peers and progress at half the speed, often not progressing beyond a fifth grade level. Therefore, many of these students are not mastering higher-level skills such as fraction equivalencies, operations with uncommon denominators and multiplication and division of fractions.

One intervention that has been successfully used to teach students with disabilities is the use of a concrete-representation-abstract instructional sequence in which mastery learning is emphasized. In this approach conceptual learning is thoroughly developed before the teaching of abstract algorithms begins. First, concepts are introduced and practiced using hands-on manipulatives. The concepts then are reinforced with representational drawings. Abstract algorithms are introduced and practiced only after concepts are mastered. Researchers such as Cecil Mercer and Susan Miller recommend that instruction follow a concrete-to-representational-to-abstract (CRA) sequence of instruction to ensure that students truly have a thorough understanding of the math concepts/skills they are learning. Research-based studies show that students who use concrete
materials develop more precise and more comprehensive mental representations, often show more motivation and on-task behavior, understand mathematical ideas, and better apply these ideas to life situations.

Difficulty with fractions among teachers is well documented. Studies of teacher knowledge of fractions have consistently found that elementary and secondary teachers have difficulty with both the procedural and conceptual understanding of fractions. These studies also report that teachers are “considerably less confident and less successful in the area of rational numbers than they are in the domain of whole numbers” (Ball, 2001, p. 434). In addition to an ability to work with fractions, considerable weaknesses have been found in teachers’ pedagogical content knowledge in that the explanations they provide to students when working with fractions is often inaccurate. Schuman (1986) defined pedagogical content knowledge as “knowledge of a subject for teaching” which is different from pure subject knowledge in that it includes an understanding of the best ways to present content to students with the most useful examples as well as an understanding of misconceptions and preconceptions that their learners may have.

Given that fractions are the most troublesome form of rational numbers for students to learn and for teachers to teach (Sowder, Philipp, Armstrong, & Shappelle, 1998), this project explored the use of software activities as a method to develop “fraction sense” in fifth grade students. “Number sense” describes the development of concepts such as the meaning of a number, ways of representing numbers, relationships among numbers, the relative magnitude of numbers, and skills in working with them. From this, the term “fraction sense” encompasses the development of these concepts with rational numbers. The need to develop this fraction sense more fully gave purpose to this project as it explored the use of computer activities that link conceptual models with procedural understanding through the use of virtual manipulatives with systematic corrective feedback in a universally designed environment.

Four research questions were to be answered by this study:

1. Will the use of accessible instructional software, designed using principles of universal design for learning and implemented with teacher professional development, allow all students in the experimental group to experience a significant increase in their conceptual and procedural knowledge of fractions, as measured by the change score from their pretest to posttest?

2. Will students in the experimental group demonstrate gains in their conceptual and procedural knowledge of factions at a level that outperforms their peers in the control group, as measured by the change score from their pretest to posttest?

3. Will students with disabilities in the experimental group demonstrate gains in their conceptual and procedural knowledge of fractions at a level that outperforms their peers in the control group, as measured by the change score from their pretest to posttest?

4. What impact will the intervention have on the maintenance of fraction knowledge and skills when measured four weeks following the study?
Methods

Subjects

Upon receiving approval from the Institutional Review Board, the research team met with the Assistant Superintendent of a school system in northwest Connecticut. The research team had conducted a variety of professional development activities for this district, but this was the first research study conducted by the team in this school system. The Assistant Superintendent and Principals were immediately interested in the project, as improving mathematics performance was a district priority based on recent No Child Left Behind Annual Yearly Progress (AYP) data. Additionally, the district had three Title 1 schools that could participate and interest in participation in the project was expressed by two of the three schools.

A total of 177 fifth grade students in 10 classrooms participated in the study. However, students with missing data were removed from the analysis. As a result, usable data was obtained from 106 students in the experimental condition and 39 students in the control condition, for a total of 145 students. The demographics of the participants are illustrated in Table 1. This sample represented 37% of all fifth grade students within the school district.

Table 1: Summary of key demographics.

<table>
<thead>
<tr>
<th>Group</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n</strong></td>
<td>106</td>
<td>39</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>55</td>
<td>22</td>
</tr>
<tr>
<td>Female</td>
<td>51</td>
<td>17</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>82</td>
<td>28</td>
</tr>
<tr>
<td>African American</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Hispanic</td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td>Asian</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>Poverty</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced Lunch</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Free Lunch</td>
<td>39</td>
<td>14</td>
</tr>
<tr>
<td><strong>Disability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADD/ADHD</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Emotional</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Medical</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>OHI</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Specific Learning</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Speech/Language</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>English Language Learners</strong></td>
<td>11</td>
<td>6</td>
</tr>
</tbody>
</table>
Initially, the study was designed to randomly assign seven fifth grade teachers and their math classes in two of the district-selected Title 1 schools to either the control or intervention groups. Prior to the beginning of the study, teaching assignments changed and only one teacher in each of the two selected buildings was to teach all sections of math, contrary to the original design. An additional Title 1 school with similar demographics needed to be selected as the control. All classrooms in the study included students with a range of abilities and disabilities including, but not limited to, English language learners, students with attention concerns and other learning problems.

Procedure

Given the situation of having to use intact classrooms, this study used a quasi-experimental pretest-posttest group design to investigate the use of the effect of the designed software intervention for teaching fractions when compared to traditional classroom instruction.

All fifth grade math classes in the district used the *Growing with Mathematics* (2004) curricular materials and pacing guide from Wright Group/McGraw-Hill. The program uses an activity-based and problem-solving approach to learning mathematics. It matches the current NCTM standards and contains lessons in all content and process standards. In addition to the use of manipulatives, heavy emphasis is placed on language development and use of real world problems. The program also provides differentiated instruction for students with special needs and for those for whom English is a second language.

Students in the control groups received math instruction “as usual” as it was planned and implemented by the teacher for 50 minutes per day. Students in the control group did not have access to the software during the eight-week period of the study.

Teachers in the experimental group participated in a one-day staff development workshop prior to the start of the school year that focused on the curricular components of the software and research supporting the scope, sequence and design of the activities, as well as the implementation protocol. Students in the experimental group received math instruction from their teacher as it was planned and implemented for 50 minutes per day. As part of these class activities, the students used the software in 20-minute lab sessions, three times per week (total of 60 minutes per week), during the eight-week period of the study.

The software used in this project, *Fraction Sense*, is a series of carefully sequenced activities created with IntelliTools Classroom Suite 4 (ICS 4). ICS 4 is a software program that contains activity templates that are easily customized to support curricular objectives and/or meet individual student needs. In addition to the instructional templates, the program contains creativity tools that can be used as a basis for creating new interactions. A scripting language allows for more sophisticated interactions.

The activities provide students with a variety of conceptual models of fraction concepts and operations through the use of virtual manipulatives. Content is presented in an explicit format using modeling, guided practice and assessment. Students receive strategic instructional feedback as they progress through both skill-based and problem-solving activities. All activities
are universally designed in that students who require the use of adapted keyboards or switches can access the digital manipulatives.

The Fraction Sense activities are organized into three units, each of which is broken into sub skills. As noted in the literature, smaller steps and a great deal of guidance are included in an appropriate format for all students who struggle with fractions (Bley & Thorton, 2001). Unit I focuses on developing the concept of a unit, meaning identification of a whole, fractional amounts and how to represent fractional amounts. Unit II focuses on equivalencies and comparisons in which students learn to identify the larger/smaller fraction, improper fractional amounts, mixed numbers and representing improper and mixed numbers. Unit III focuses on creating equivalent fractions and on operations with common denominators. Each of the activities has error correction that is immediate, clear and systematic.

For the purpose of this study, customized units were created consisting of a total of 75 activities. These activities were created either from templates that come with ICS 4 or were uniquely designed using the authoring environment available within the program. The ICS 4 program was selected as a vehicle for creating the Fraction Sense units since it contains 1) fraction templates, 2) a scripting language that allows for new interactions and, most importantly, 3) collects data. It was an efficient and effective method for testing the instructional design.

An explicit method of instruction, especially the application of strategic feedback as used in the ICS 4 templates, is critical for students to gain an understanding of fractions. It also is important for students to manipulate materials to gain a strong conceptual understanding of fraction concepts, relationships and operations. Therefore, in an effort to provide students with environments in which they can manipulate objects to solve problems, three additional activity types were created: concept of a unit (sets), concept of a unit (part/whole using fraction circles), and problem solving activities. In all of these interactions, students manipulate objects to determine the answers. Three additional activity types were created to present content not well represented in the ICS program: comparing fractions, improper fractions, and mixed numbers. See Appendix A for a scope and sequence chart of the instructional activities and selected screen prints of the software.

**Procedures.** The study was conducted in five phases.

**Teacher Staff Development.** The intervention teachers participated in a one-day staff development workshop prior to the start of the school year, conducted by the senior researchers, which focused on the curricular components of the software, research supporting the scope, sequence and design of the activities as well as implementation protocol. The mnemonic SOS (Support student learning, Optimize time and Structure the learning environment), which outlines teacher behaviors, was introduced to teachers as part of the staff development. Second, to support student learning, teachers were provided with techniques for establishing routines, managing behaviors and communicating expectations. Teachers were expected to optimize the student time on task to ensure that each student received twenty minutes of time with the software, three days per week. Teachers learned to minimize “extra teacher talk,” methods for introducing lessons in the computer lab, how to maintain engagement and the importance of summarizing upon
completion of the twenty-minute session. Components of structuring the learning environment included questioning techniques, methods for monitoring performance and providing appropriate feedback.

**Baseline Assessment.** Data concerning each student's present level of performance was gathered through standardized test scores on the Connecticut Mastery Test given to students in the spring of fourth grade. In addition, a paper and pencil Pretest consisting of fifty items was given to all students. The assessment was developed by the researchers based on fraction examples found on the grades 3 and 4 of the Connecticut Mastery Test as well as items found in the fourth and fifth grade curriculum materials used by the district.

**Experimental Treatment.** An introductory group-based session on the Fraction Sense software was conducted in the schools’ computer lab approximately one week after the pretest. The researchers modeled the SOS implementation protocol for the intervention teachers and modeled the components of the software for the students and teachers. Frequent observations and coaching sessions were conducted during the study to ensure the teachers’ implementation of the protocol. An email group was created for the teachers to facilitate communication between the researchers and the intervention teachers. The intervention phase lasted eight weeks from September 15 to November 12, 2008.

**Posttest Assessment and Teacher Interviews.** Group post-testing was carried out in all participating classrooms during a single 45-minute session. The posttest was an identical administration of the 50-item pretest given at the beginning of the project. During this same period, video interviews with the intervention teachers and a principal were conducted.

**Maintenance Assessment.** A second posttest was administered during the third week in February. This test was identical to the pretest and posttest previously administered.

**Results**

Given the quasi-experimental design, prior to analyzing the outcome data it was necessary to ensure that the two groups were equivalent in terms of their academic characteristics at the outset of the study. As illustrated in Table 2, the experimental group was almost three times larger than the control group due to the last minute change in math teacher assignments in the original two buildings and the necessity of adding a third building for the control. In addition, the academic achievement of the experimental group exceeded that of the control group in terms of performance on the fourth grade Connecticut math and reading test, and the pre-test of fraction knowledge. This finding indicates that the two groups were not equivalent at the outset of the study and compromises the comparisons that can be made between the two groups.

<table>
<thead>
<tr>
<th>Group</th>
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<tbody>
<tr>
<td>n</td>
<td>106</td>
<td>39</td>
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**Table 2:** Mean Performance of the Two Groups on Baseline Assessments.
The first research question sought to understand the impact of the intervention on enhancing students' conceptual and procedural knowledge of fractions as a result of using specially designed software. To answer this question, a change score was computed by subtracting the pretest score from the posttest score for all students in the experimental treatment. The results indicate that 19% (n=20) of the students had a small drop (-1 to -3 points) in their posttest scores. Six percent (n=6) students had no change between their pretest and posttest scores. The majority of students (75%, n=80) had a positive change in their posttest scores. Gains ranged from 1 to 18 points with a mean increase of 3.44 in gain from the pretest to the posttest.

To understand the nature of the students who benefited the most from the intervention, the top 20% of students were identified to establish a cut score. This created a subgroup of 21 students who gained nine or more points on the posttest. Interestingly, within this group, six students had specific learning disabilities (SLD) and one student had ADHD, which demonstrates that 33% of the students with the highest gain scores were students with mild disabilities. This group experienced significant benefit: 58% (n=7/12) of the students with disabilities in the experimental group had gain scores in the top 20% of all students. In fact, three of the top five scores belonged to students with SLD or ADHD, showing gains of 15-18 points from the pretest to the posttest. The intervention also was effective for students of poverty, in that 44% students with reduced/free lunch scored within the top 20% of all students gaining nine or more points on the posttest. This group experienced important benefit from the intervention (n=9/47, 19% of this population had gain scores in the top 20% of all students). The intervention had a very positive effect for African American students (n=2/3); 66% of this population had gain scores in the top 20% of all students. Eleven percent of the Hispanic students also scored in the top 20% of gain scores. Only one ELL student (n=1/11, 10%) showed gains that ranked in the top 20% of all students. Within the top 20% of the students, the intervention was equally effective for males and females.

The second research question focused on comparing the academic performance of the students in the two groups. The means of the pretest, posttest, and a retention test (posttest2 given twelve weeks following the study) are illustrated in Table 3. Because of the earlier finding that the two groups were not equivalent at the outset, no firm conclusions can be drawn concerning the effect of the intervention since pre-existing differences confound the ability to analyze the data.

Table 3: Mean Performance of the Two Groups on Three Measures of Fraction Knowledge and Concepts.

<table>
<thead>
<tr>
<th>Group</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>106</td>
<td>39</td>
</tr>
<tr>
<td>Pretest</td>
<td>37.39</td>
<td>32.59</td>
</tr>
<tr>
<td>Posttest</td>
<td>41.27</td>
<td>39.33</td>
</tr>
<tr>
<td>Posttest 2</td>
<td>43.76</td>
<td>42.08</td>
</tr>
</tbody>
</table>
The third research question sought to understand the benefit of the intervention on students with disabilities by hypothesizing that students with disabilities who participated in the experimental group would demonstrate greater gains in their conceptual and procedural knowledge of fractions than their peers in the control group. To answer this question, the academic performance data for all students with disabilities were extracted from the data set for analysis. As shown in Table 4, preexisting differences in the academic performance between the two groups reveal that the experimental group was higher performing at the outset of the study. As a result, no conclusions can be drawn from this evidence concerning the effectiveness of one approach over the other. However, it is worth noting the change scores for each group: Experimental (mean gain = 6.59, range from -2 to 18) and Control (mean gain = 4.50, range from -3 to 16).

Table 4: Mean Performance of Students with Disabilities on Key Variables.

<table>
<thead>
<tr>
<th>Students with Disabilities in Each Group</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>Math Standard Score</td>
<td>225.76</td>
<td>212.50</td>
</tr>
<tr>
<td>Reading Standard Score</td>
<td>198.35</td>
<td>197.88</td>
</tr>
<tr>
<td>Pretest</td>
<td>29.41</td>
<td>28.88</td>
</tr>
<tr>
<td>Posttest</td>
<td>36.00</td>
<td>33.38</td>
</tr>
<tr>
<td>Posttest 2</td>
<td>39.47</td>
<td>37.75</td>
</tr>
</tbody>
</table>

The final research question sought to examine the impact of the intervention on the retention of students' fraction knowledge and skills when measured twelve weeks following the study. As noted in Table 3, both groups demonstrated slight levels of continued growth after the study concluded. However, because of the problem of non-equivalent groups, no conclusions can be drawn from this evidence.

Discussion

The purpose of this study was to determine if the use of computer software along with specific instructional protocols could improve the development of “fraction sense” for a group of fifth grade students receiving instruction in inclusive math settings.

Because of the last minute change in math teacher assignments, the control group sample was severely compromised in size. As a result, a significant imbalance between the experimental and control groups resulted in statistically significant differences in the baseline assessments. Therefore, few definitive conclusions can be drawn from the data. Nonetheless, there are a number of lessons that have been learned as a result of this investigation.

First, the goal of enhancing the academic achievement of all students through the application of universal design for learning principles is perhaps overly optimistic. In this study, specially created materials were able to positively influence the conceptual and procedural knowledge of fractions of 75% of the fifth grade students that used the software. As a result, more insight is
needed in order to design learning environments and materials that help every student make academic progress.

Second, the study provided a number of powerful insights into the differential benefit of accessible and engaging digital instruction materials. Most gratifying were data that indicated that three of four AYP subgroup populations showed meaningful change in their gain scores in that some of these struggling students were among the top 20% of students with improved gain scores as a result of using the specially designed software. As a result, more research is needed about the effects of Fraction Sense for students with disabilities, students of color, and students of poverty. The limited impact of the intervention for English Language Learners remains a question.

Finally, this research illustrates the complexity associated with conducting research in public schools. While the researchers had previously worked in the school district, were known to top administrators, and had permission to conduct the study, there were many variables associated with the school schedule and network environment that could not be controlled.

In addition to the change in teaching assignments, network design affected access at one of the schools that in turn affected access by three of the classes to each of their lab sessions during the eight weeks. The same school had a software license problem that denied access to the activities for three lab sessions. This occurred approximately four weeks into the intervention. Students in this school expressed concern to the researcher that their lab time was no longer available and then relief when access was re-established.

Lab computers were sometimes not available to all the students in a lab session due to their inoperability. Although the district designated this project as a top priority and had the foresight to install several extra computers in each of the labs to more than meet the class sizes, there were times when the number of operable computers did not serve the class size because computer technicians could not always keep up with the demands in a timely manner.

The work described in this study is important because it indicates that the use of software that provides manipulative models and strategic feedback may be another instructional tool for teachers to effectively teach fraction concepts to students with varying levels of ability. This study adds to the research literature because it is the first investigation that addresses the accessibility issues of students with disabilities in the content area of fractions.

Anecdotal data from the study suggest several advantages for using these software activities. The students were attentive to the computer activities during the lab sessions even after its initial introduction. Earphones allowed students to be focused without distractions. One teacher indicated that an identified ADHD student was progressing at the same rate as her peers for the first time in recent years. Student attentiveness and engagement allowed teachers to address individual student concerns and questions.
Conclusions

Software activities along with implementation protocols, such as the ones designed for this project, have the potential to positively impact student performance. Anecdotal information from teachers and the researchers and, in one instance, a principal, indicated a high level of engagement by the students while in the lab using the software. The engagement in fraction learning activities provided students in seven typical classrooms with a wide range of abilities an opportunity to develop an understanding of fraction concepts and operations. Given the findings that suggest a powerful impact on three of the four AYP groups, future research is warranted.

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Appendix A

Software Scope and Sequence with Selected Screen Prints
UNIT I: Concepts and Relationships
Part-whole Concepts (identifying and naming fractions) using different models)
This unit focuses on development in 3 skill areas: 1. Develop fluency with basic multiplication and division facts 2. Develop strong mental images of fractions and 3. Make the connection to the relationship of division to fractions. Fraction activities focus on developing the concept of a unit.

UNIT I Sequence

1_1 Assessment: Multiplication: 1, 2, 3, 4 and 5’s including the commutative property.

- IF fails goes to activity
  - Multiplication Practice: 1, 2, 3, 4, 5’s

1_2 Assessment: Division: 1, 2, 3, 4, 5’s

- IF fails goes to activity
  - Division Practice: 1, 2, 3, 4, 5’s

1_3 Show Fractions Set 1: halves, thirds, fourths (fifths)
Opens in practice the first time so they can learn the interaction

Number displayed and student supplies model by using –1, –5, +5, & +1 buttons.

1_4 Writing Fractions Set 1: halves, thirds, fourths (fifths)
Opens in practice the first time so they can do a show me
Model is displayed student supplies the fraction.

1_5 Manipulating Sets Students are presented with a collection of objects to sort and then determine fractional amounts.

1_6 Assessment: Multiplication 6, 7, 8’s low

- IF fails goes to activity
  - Multiplication Practice: 6, 7, 8’s

1_7 Assessment: Division 6, 7, 8’s low

- IF fails goes to activity
  - Division Practice: 6, 7, 8’s
1_8 Show Fractions Set 2: Sixths, sevenths, eighths
Opens in challenge so students have an option to try to pass without practice.

1_9 Writing Fractions Set 2: Sixths, sevenths, eighths
Opens in challenge so students have an option to try to pass without practice.

1_10 Concept of a Unit Activity 1
In this activity students manipulate fractional amounts into a whole and then determine and enter the represented fractional amount. Strategic feedback is provided.

1_11 Assessment: Multiplication 9, 10’s
- IF fails goes to activity
  - Division Practice 9, 10’s

1_12 Assessment: Division 9, 10’s
- IF fails goes to activity
  - Division Practice 9, 10’s

1_13 Show Fractions Set 3: Ninths, tenths, elevenths, & twelfths
Opens in challenge allowing students to skip practice

1_14 Writing Fractions Set 3: Ninths, tenths, elevenths, & twelfths
Opens in challenge allowing students to skip practice

1_15 Fraction Problems Set 1
This set is a series of word problems that allow manipulation of objects to determine answers. Has strategic feedback.

UNIT II: Comparison and Equivalence
This unit focuses in strengthening the understanding of the impact of the numerator and denominator on the size of the fraction and fractional amount. Specifically, students identify the larger of two fractions, work with improper fractions, mixed numbers and determine equivalencies.

UNIT II Sequence

2_1 Assessment: Multiplication 6, 7, 8 Higher Fact Set
*In future move later in the sequence
- IF fails goes to activity
  - Multiplication Practice: 6, 7, 8 higher fact set
2_2 Assessment: Division 6, 7, 8 Higher Fact Set
*In future move later in the sequence
  • IF fails goes to activity
    - Division Practice: 6, 7, 8, higher fact set

2_3 Assessment: Which is Larger with Like Denominators
  • IF fails goes to activity
    - Comparing Fractions Set 1 (like denominator)

2_4 Assessment: Which is Larger with Like Numerators
  • IF fails goes to activity
    - Comparing Fractions Set 1

2_5 Manipulating Sets

2_6 Assessment: Multiplication Review
  • IF fails goes to activity
    - Multiplication practice 11, 12’s

2_5 Assessment: Improper Fractions
  • IF fails goes to activity
    - Write Improper Fractions Set 1

2_6 Assessment: Mixed Numbers
  • IF fails goes to activity
    - Write Mixed Numbers Set 1

2_7 Equivalent Fractions– Denominator Provided
Student is required to complete practice. Student provides 3 numerators to create equivalent fractions.

2_8 Equivalent Fractions– Numerators Given

2_9 Equivalent Fractions– Simplest Terms

2_10 Equivalent Fractions– Create and Sequence
Students create 3 fractions that are equivalent to the one provided. (Students are required to complete Practice)

2_11 Concept of a Unit
UNIT III: Operations with fractions-Addition and Subtraction
This unit focuses on addition and subtraction of fractions with common denominators. This includes adding improper fractions and mixed numbers.

UNIT III Sequence

3_1 Adding Fractions with Common Denominators- Set 1
Students are given an addition problem in which they click on the denominator to divide the fraction bars; they then click on the numerators to solve the problem. (Halves, thirds, fourths; practice is required prior to Challenge) Proper fractions only

3_2 Adding Fractions with Common Denominators- Set 2
(Fifths, through eighths; practice required prior to Challenge) Proper fractions only

3_3 Adding Fractions with Common Denominators- Set 3
(Ninths through twelfths; opens in Challenge) Proper fractions only

3_4 Subtracting Fractions with Common Denominators- Set 1
(Halves, thirds, fourths; practice required prior to Challenge) Proper fractions only

3_5 Subtracting Fractions with Common Denominators- Set 2
(Fifths, through eighths; practice required prior to challenge) Proper fractions only

3_6 Subtracting Fractions with Common Denominators- Set 3
(Ninths through twelfths; opens in challenge) Proper fractions only

3_7 Write Improper Fractions- Set 2

3_8 Addition of Fractions with Common Denominators with Improper Answers- Set 1
Students are given an addition problem in which they click on the denominator to divide the fraction bars, and then click on the numerators to solve the problem. All answers are improper fractions. Students work with halves thirds and fourths.

3_9 Equivalent Fractions-Create and Sequence
Students create 3 fractions that are equivalent to the one provided. Opens in Challenge; allow student to test out.

3_10 Addition of Fractions with Common Denominators with Improper Answers- Set 2
Students work with fifths, sixths and sevenths.

3_11 Equivalent Fractions-simplest terms
Opens in Challenge; allow student to test out.

3_12 Addition of Fractions with Common Denominators with Improper Answers- Set 3
Students work with eighths, ninths, and tenths.

3_13 Subtraction of Fractions with Common Denominators with Improper Answer- Set 1
Students work with halves, thirds and fourths.

3_14 Subtraction of Improper Fractions with Common Denominators with Improper Answer- Set 2
Students work with fifths, sixths and sevenths.

3_15 Subtraction of Fractions with Common Denominators with Improper Answer- Set 3
Students work with eighths, ninths and tenths.

3_16 Write Mixed Numbers
Students are presented with graphics of a mixed number; they enter the whole number, the denominator and the numerator. Visual and auditory strategic feedback is provided to assist in understanding improper fractions.

3_17 Addition of Mixed Numbers with Common Denominators- Set 1
Students work with halves, thirds and fourths.

3_18 Addition of Mixed Numbers with Common Denominators- Set 2
Students work with fifths, sixths and sevenths.

3_19 Addition of Mixed Numbers with Common Denominators- Set 3
Students work with eighths, ninths and tenths.

3_2 Write Improper Fractions and the Mixed Number- Set 1
Students are presented with a graphic, write the improper fraction and then the mixed number. Various levels of strategic feedback are provided.

3_21 Subtraction of Fractions with Proper Fraction Answer- Set 1
Students work with halves, thirds and fourths.

3_22 Subtraction of Fractions with Proper Fraction Answer- Set 2
Students work with fifths, sixths and sevenths.

3_23 Subtraction of Fractions with Proper Fraction Answer- Set 3
Students work with eighths, ninths and tenths.