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# Experiential Education: Teaching Elementary Mathematics With a Deweyan Framework

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Experiential Education: Teaching Elementary Mathematics  
With a Deweyan Framework

by

Amy Keithley

An Honors Thesis Presented to the Honors Committee  
of Western Oregon University  
In Partial Fulfillment of the Requirements for  
Graduation from the Honors Program

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Dr. Steven Wojcikiewicz, Thesis Advisor

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Dr. Gavin Keulks, Honors Program Director

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## ABSTRACT

In the current educational climate in America, standardization is the driving force. Across the United States school districts are facing severe budget cuts which, when paired with legislature such as the No Child Left Behind Act, are creating a learning environment void of creativity and spontaneity. John Dewey, the father of progressive education, believed that learning should not be marked by rote memorization, but rather should aspire to actively engage students in experience and learning that erased boundaries between subject areas and integrated daily life practices. This thesis addresses the question of whether or not it is possible for a typical classroom teacher in the public elementary school setting to implement an experiential education framework into academic curriculum through the administration of a mathematics unit. Using the backdrop of art, music, and cooking, students will develop the necessary skills and knowledge to authentically use fractions.

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## DEVELOPMENT OF A THEORY

### Introduction

Education has the power to positively or adversely affect the lives of millions of students in the United States yearly. The design of schools, both in the public and private sectors, and their consequent curriculum are vital for ensuring future generations of well-rounded and educated individuals. John Dewey, known as the father of progressive education, has provided key insights into educating the “whole child,” including educational reform, experience-based education, and creating lasting ties between schools and communities in his many works (Dewey 1938, Dewey 1902, Dewey 1915, Tanner 1997). In this thesis, the role of a Deweyan framework in education is investigated. The concept of experiential education is thought by some to be the remedy for our current educational era of high-stakes testing, and this introductory section will explore education through the lens of John Dewey in an effort to examine the effects of a Deweyan framework in schools today. The latter sections will describe the methods, and consequent conclusions, of a mathematical unit on fractions taught in a fifth grade class over a span of several weeks.

This study began as a mere idea in the fall of 2011 and blossomed into its current state through research, planning and teaching. I discussed my ideas with my peers and faculty at Western, which helped shape the entire study design. Once I had narrowed down my topic, I knew that I had to do a copious amount of research. If I was going to create a unit based on key points of John Dewey’s philosophies, I had to fully understand what experiential education was. Not only that, I also had to research the curriculum for

fifth grade to ensure I hit all of the necessary components of the math standards. Once I had conducted the research, I set out to create a timeline and framework for my unit.

The unit that I created was based on a mathematic standard pertaining to fractions. Although fractions were the primary focus of my lessons, I created a unit divided into three subsections: (1) art, (2) music, and (3) cooking. Within each of these subsections, students learned the basic operations of fractions in authentic scenarios (i.e., doubling a recipe). My specific lessons utilized key foundational concepts from Dewey's educational pedagogy to create a cohesive unit that allowed students the rare opportunity to see real world application of content-specific knowledge.

### **Educational Reform**

The proposal of education reform came from a widespread progressivist movement across the United States in the late 1800's into the early 1900's. John Dewey, along with other reformers, saw the decline in community and democracy that the Industrial Revolution had produced, especially on children in rural areas. During this time, the structure of society was changing from a rural populated communal setting to urbanized industry (*The Industrial Revolution, 2003*). With many people working at factory jobs for long hours and minimum wages, there was less contact with families and a consequent "breakdown of family units" (*The Industrial Revolution, 2003*). This created a potential "need" for educational reform in which students learned essential life skills, such as democracy and community, through schools, causing a rift between traditional and progressive education.

Dewey saw traditional education through the lens of a progressivist—as an institution with a pervasive and ever-growing chasm between subject matter and the life

experiences of students (Dewey, 1938). Progressive education was the “antidote,” lending itself to the promotion of free activity, preparation for the future, vocational skills, and experiential learning (Dewey, 1938). The importance of educational reform lies in the fact that this battle can still be seen in the field of education between those favoring high-stakes testing and the others who promote learning in alternative manners. A Deweyan framework can provide an alternative method of teaching that still allows children to gain the necessary information and skills—but in a way that evokes emotion and connection of material to their lives (Tanner, 1997).

It is clear that the idea for Dewey’s school came from his own educational experiences, experiences that were riddled with boredom and monotony (Tanner, 1997). He observed that for many of his peers, household and familial duties were replacing school education (Tanner, 1997). Due to important economic and social change during the Industrial Revolution, this dying ‘small rural town sense of family and community’ played a huge role in Dewey’s future ideas about education.

### **Influences**

Although John Dewey is often seen in America as the singular father of progressive education, he was greatly influenced by several great thinkers of the time. The educational movements across Europe before his time inspired many of his foundational pedagogical and philosophical ideas regarding education.

In 1774, a man by the name of Johann Heinrich Pestalozzi created a school in Switzerland for children in need. His school allowed students the freedom to learn the foundational content knowledge while also teaching them how to survive in the world; boys learned to farm while girls learned to cook and sew (DePencier, 1996). To help



support the cost of their schooling, both genders also were taught how to spin and weave. Visitors came from near and far to observe his school, and the most impressive aspect they found was a pervasive happiness from the students due to its familial environment (DePencier, 1996). Growing up in a rural community himself, the idea of school being a tight-knit community was an important facet in Dewey's pedagogy. Unfortunately Pestalozzi's school was stopped due to financial strains, but he later created his second school, which lasted for over twenty years and slowly spread his educational ideas throughout Europe (DePencier, 1996).

In Germany, Pestalozzi's counterpart, Friedrich Froebel, was starting his own educational reform movement. Froebel merged the idea that children learn best with "learning through activity" with the importance of "play." His ideas were embodied in Kindergarten, or "children's garden" where children learned through the art of play (DePencier, 1996). This focus on children leaning through play was one of the foundational building blocks when Dewey created his Lab School. Today many misconstrue and bastardize the word play, creating a clear dichotomy between the ideas of work and play in school. Dewey offered a definition for play that encompassed an activity towards an educational end, explaining that the problem at the elementary level is:

...to get hold of the child's natural impulses and instincts, and to utilize them so that the child is carried on to a higher plane of perception and judgment, and equipped with more efficient habits, so that he has an enlarged and deepened consciousness and increased control of powers of action. Wherever this result is

not reached, play results in mere amusement and not in educative growth.

(Dewey, 1900, p. 48)

### **School and Society**

Dewey, along with Pestalozzi and Froebel, recognized the need for children to have ample opportunity to learn and develop naturally through a family life-centered model. This path of “natural learning” was heavily aided by the importance of social relationships (Dewey, 1915). While in current times social relationships have a much broader and more flexible definition, Dewey was alluding to social relationships between families and friends in a sense of local community. Dewey felt that the optimal social situation was the strong bonds seen in small rural towns where children gave back to their families, and neighbors would always be there to lend a helping hand when needed.

Education, using this backdrop, was an environment that fostered genuine social situations for students. The idea behind this practice was that the more often students engaged in real life social interactions with their peers and adults, the greater positive effect it would have on their synthesis of knowledge and moral growth (Dewey, 1915).

Since Dewey’s model of education was based off of familial and community life, there was a strong sense of camaraderie imbedded in education. He strongly believed that societies have a “common spirit” which binds them together and drives them towards moral and spiritual growth (Dewey, 1902). This type of growth cannot occur at the same pace or rigor when schools are asking for only assimilation and regurgitation of facts. For progressive education there is not a clear social motive for the acquisition of “mere learning” or how to garner success in future endeavors and relationships (Dewey, 1902).

Instead, it fills students with the importance of competitiveness based on pure academics, creating divisions instead of unity among peers.

Many critics believed that schools fostering at a more familial and cooperative activity level would increase the behavioral and discipline problems in schools. Dewey disagreed and reminded skeptics that "...there is the confusion, the bustle, that results from activity. But out of occupation, out of doing things that are to produce results, and out of doing these in a social and cooperative way, there is born a discipline of its own kind and type" (Dewey, 1902, p. 10). This type of discipline is one that springs forth from schoolwork and allow students to be part of an active team or community; work that helps to teach students the weight of their own responsibility. Instead of creating behavioral or disciplinary issues, the cooperative activities actually served as the greatest source for learning responsibility and growth of moral character through life experiences, and one way to emulate life is for schools to deliver constructive work to their students (Dewey, 1902).

This sense of growth in moral character and responsibility is mirrored today through the idea of required service-learning and volunteerism projects in schools. Many critics of this type of learning believe that students will not be able to grow and learn because they are being forced into a situation where they feel they are obligated to give their time, instead of enjoying the experience (Tanner, 1997). Those in favor of this type of learning disagree, and believe that if we do not afford students the opportunity to give back to their communities, they may not make the time to, and therefore would miss an integral step in learning about responsibility and their role in society (Tanner, 1997).

Imagination versus reality was also important to Dewey's pedagogical beliefs. Dewey took great offense to the idea of providing children mock or "artificial" materials for activities modeled after a home environment. Although many critics disagreed with the nature of his argument, Dewey was a proponent of allowing children, even at the kindergarten level, to do "simple dusting, cooking, and dish washing" as means of interactive play (similar to a game) through the use of real tasks (Tanner, 1997, p. 31). Students would someday need to learn the process, and importance, of household tasks, so what better preparation than learning with real objects and purpose in schools?

Although this is not necessarily practical in today's classrooms due to the overall lack of budget and materials available to teachers and students, the sentiment still holds true. Schools, when acting as "miniature societies," have the power to provide authentic tools and skills that will help shape future generations of students.

## **Curriculum**

The Progressive Movement set the precedent for reforming education. Once a group of individuals had decided to take action, they needed a place to start. For John Dewey, the answer came from the curriculum of schools. At the time, public schooling was extremely militaristic, a key trait defined by the rigid Industrial Revolution movement. Children were taught the basic "R"s still seen today: Arithmetic, Reading, and Writing. They were forced into rote memorization of subjects, and expected to sit silently at their desks listening to teacher-centered lectures (Dewey, 1902).

Dewey saw this type of education as a travesty. He saw that schools were not promoting the child and the curriculum; education was in fact a conflicting war of child versus the curriculum (Dewey, 1902). Children, especially during their younger years,

live in a seemingly fluid and unified world primarily of people, nature, and personal interests (Dewey, 1902). Unfortunately, schools do not teach in this manner. Schools, and their consequent curriculum, focus on isolation and segregation of facts (Dewey, 1902). Each subject is divided into separate bodies of knowledge, and further fractures inside occur among subtopics. In the real world, all subjects are inevitably intertwined; there are not separate realms dedicated to only one subject such as mathematics.

It is plausible then to realize that when students go from a world dominated by unity and connection to the schools systems, where subjects are divvied up and facts are “torn” from their original source and categorized according to mature logic, it creates internal disequilibrium (Dewey, 1902). In order to relieve the discomfort of disequilibrium, Dewey suggested that educators turn to an interdisciplinary curriculum taught with self-activity-based learning. When an interdisciplinary curriculum is taught, students are far more likely to be able to connect seemingly unrelated topics (Tanner, 1997).

However, the use of an interdisciplinary curriculum is not enough. Educators must also focus on the importance of adapting and adjusting our teaching to allow self-activity in an educational environment that inspires and promotes inquiry and self-discovery of truths. If this is done, the curriculum will return to a more organic composition; facts and knowledge taught in connection to prior student experiences transform from symbolic knowledge to actual experience (Dewey, 1902). Bringing real life back into schools can better help teachers to fully educate the whole child (Tanner, 1997).

In addition to the aforementioned building blocks, the creation of “experience” in education was the mortar for the Deweyan framework. Dewey’s definition of experience involves genuine education through personal life events. Not all experiences that one has can be considered quality; quality experience is the cohesion of a person finding an agreeability within the experience and themselves, and consequently influences an internal desire to further enjoyable personal experiences (Dewey, 1938). Quality experiences’ result of furthering experiences creates and perpetuates a learning continuum. Although this was clearly part of his more philosophical work, it is easier to think of experience as an activity that actively moves a student towards powerful learning. The complexity of experience comes in its inherent nature. In education that would be allowing students to experiment and search for answers to academic questions rather than handing them only the information and expecting mere rote memorization. In the process of seeking out new information, students are undergoing an internal wave of learning. However, it is important to note that Dewey was not against all forms of structure. Teachers played an important role in shaping experiences, so long as the structure did not directly impede student learning (Dewey, 1938). Optimally, schools employing a Deweyan framework should instill growth and progression that advances societal skills as well as provides a moving force towards maturity and morality.

Although not the only of his time to become interested in, and philosophize about, the concepts of experiential education, Dewey had the great fortune of opportunity on his side. His famous University of Chicago Laboratory School was created in the late 1800’s and took his pedagogical beliefs and theories and put them to the test with actual students.

## **Laboratory School**

When the University of Chicago's Laboratory School, later referred to as either the Lab School or Dewey School, opened its doors in January, 1896, it showed the culmination of hard work and dedication from many educators, administrators, and community members. The underlying purpose of Dewey's school was that of a scientific laboratory: "to exhibit, test, verify and criticize theoretical statements and principles and to add to the sum of facts and principles in its special line" (DePencier, 1996, p. 3). The timing of the creation of this school paralleled the country's progressive movement, so many were intrigued by the potential of the Lab School. The Lab School had a direct focus on creating project-based instruction, where problem-solving and activities were used to teach the whole child (Tanner, 1997). Children were afforded the rare opportunity to use facilities and equipment of their partner university, the University of Chicago.

In the beginning, Dewey was granted \$1,000 from the University of Chicago to create his laboratory-based school. He began with only 12 students, two teachers, and one instructor (DePencier, 1996). Although Dewey's school came from these humble beginnings, he created a school and style of teaching that has had a lasting impact because of its "students, teachers, parents, administrators, and scholars, all dedicated to creativity, innovation, and building a school of true stature" (Harms, 1996, p. 2).

The University of Chicago Laboratory School was not the first of its kind. Beginning in 1873 at the University of Iowa, and in due time spreading its reach to Harvard, Columbia, and Cornell, work was being done towards professorships in education by creating a more scholarly and scientific-based pedagogy. This paved the way for the President of the University of Chicago, William Harper, to create a scholarly

educational opportunity for himself and his university (Harms, 1996). It came as no surprise in 1894 that President Harper was interested when Dewey, the Head of the Departments of Philosophy, Psychology, and Pedagogy at the time, wrote him a letter stating,

It is my honest and firm conviction that the American University, which first sees rightly the existing situation in education and acts upon the possibilities involved, will be that very fact command the entire University situation. I also firmly and honestly believe that Chicago is the most ripe place in America for undertaking this work. (Harms, 1996, p. 3)

Sisters Katherine Camp Mayhew and Anna Camp Edwards were two active teachers and leaders in the University of Chicago Laboratory School. Together they wrote a book detailing their collective accounts about working in the Lab School and with its radical curriculum. They provided many first hand accounts of the types of experiments and activities the students were performing. With a strong scientific foundation, many of the activities students participated in involved a combination of real life experiences and experiments. While Mayhew and Edward's book provided a wealth of curricula, two lessons stood out as quintessential examples of Dewey's educational pedagogy and theories in action.

One fall, students were studying the harvest in collaboration with orchards, and were able to go on frequent visits outside of the school to nearby orchards. Afterwards, the students got to create and play in a grocery store setting—some students were cashiers selling the necessary ingredients to make jelly while others were delivery boys, mothers, cashiers, among other positions (Mayhew, 1936). Another time the students



were studying different types of plants, and in addition to working in gardens to grow the plants themselves, the students had to create a bisque. Instead of giving the students reliable recipes, they were encouraged to experiment with different ingredients and techniques until they found a recipe that would produce a true bisque (Mayhew, 1936).

Both of the aforementioned examples show the concrete meaning behind Dewey's idea of experiential education. At the Lab School, students were not simply given answers, but they had to follow the path of inquiry and experimentation. While most students at the time were expected to read and commit to memory the mere process of science, Deweyan students were allowed to learn from their mistakes and find beauty in their experiences to better understand how the world around them worked. Experiments were important in the school because they were "not for the purpose of making technical generalizations or even arriving at abstract truths. Children simply like to do things and watch what will happen" (Dewey, 1900).

The aim and function of this school was for Dewey's ideas on education to come to life and be tested on students. Dewey believed the education should focus on the student, and that the common use of rote memorization and drill in education "left the students seriously undeveloped" (Harms, 1996). His proposition was a style of teaching which allowed the students to learn through movement, aesthetic experiences, and real life activities in a community setting. Spontaneity and creativity were seen as assets instead of childish whims, and students were encouraged to learn by experiments and solving problems creatively. Additionally, he believed that there was "no fixed body of facts which, in itself, [was] externally set off and labeled" (Tanner, 1997) but instead all subjects were intertwined and should be taught in a unified manner.

This said, Dewey was constantly developing new ideas, theories, and curriculum for education while his laboratory school was in session. He spent a lot of time working with the teachers and parents while observing the students. As a result, by 1903 he had developed a specific set of beliefs that would help guide others in their future journey towards more progressive education:

- Students begin learning by experimentation and develop interests in traditional subjects to help them gather information.
- Students are part of a social group in which everyone learns to help each other.
- Students should be challenged to use their creativity to arrive at individual solutions to problems.
- The child, not the lesson, is the center of the teacher's attention; each student has individual strengths, which should be cultivated and grown. (Harms, 1996, p. 4)

### **21<sup>st</sup> Century Implications**

Although the above criteria were developed in the early 1900's, they are a lasting testament to the ideas that John Dewey had for forward progression in education. What the skeptics seem to forget is that the heart of the progressive education movement is to better the education system by focusing on a more challenging, relevant, and hands-on way of teaching and learning. What Dewey is saying with his above criteria is not to radically remove all of the facets of education that are currently in place; he is saying that with a shift towards a more student and community-based educational system we will better prepare our students to become active citizens.

The education system in the United States has over gone many changes since the late 1800's, and many critics and theorists are skeptical about the actual replication and

practicality of laboratory schools today (Coffey, n.d.). With the current state of education, it is understandable that a direct transition from the curriculum and activities of the University of Chicago Laboratory School is potentially unworkable due to a lack of facilities, low funding for education, and high class sizes.

One of the largest assets that Dewey's Lab School had was its actual facility. Once it had gained a solid reputation and had a dedicated following of around 80 students and their guardians, the Lab School was known for its spacious lab spaces and work places for the students to complete their experimentations and other various activities. They were able to set up scientific experiments, sew, cook, and even garden (Tanner, 1997). It is obvious that most elementary school buildings today do not have the laboratory spaces, rolling gardens, or even the equipment that Dewey had access to through his close connection with the University of Chicago, particularly in this time of low funding levels..

Although these facilities may not be available to educators, adaptations may be made in regular public schools to maintain the spirit and idea of experiential education. This thesis studies the question of feasibility of an experiential education in fifth grade mathematics. It will be comprised of a small math unit on fractions with a heavy emphasis on creating learning experience through integrated activities. While this research is not exactly the same process and activities that students participated in at the Lab School, it holds the same sentiment of personal inquiry and experience.

After utilizing the vast quantities of research available on my topic, I began to understand the intricacies related to my thesis framework. John Dewey, along with his colleagues, wove the fabric of progressivist education, paving the way for future

educators. From the literature, I realized that I needed to create a cohesive unit inclusive of the following elements: (1) community, (2) authenticity, (3) creativity, and (4) cross-interdisciplinary content knowledge.

## METHODS

The overarching goal of my mathematics unit was to create a unit that allowed students to progress through learning fractions in three subsections: (1) art, (2) music, and (3) cooking. The decision for the subject of the “mini-units” was made entirely on their relevance to student interest, as well as real life application. Art began the unit with its concrete connections, music followed as a less-tangible reinforcement of skills, and cooking finished the unit due to its applicability to the more complex fractional processes (i.e., multiplication and division).

The research for this study was conducted in an elementary school in a city in the Pacific Northwest. This community has a multitude of resources available for teachers to utilize in their schools and classrooms, helping both students and their families alike who are in need. Being in the second largest district in the state with over 40,000 students from Kindergarten to 12<sup>th</sup> grade, it is easy to see the important role organizations and resources from the community have in the education system.

Due to enrollment numbers, the boundaries of the school covered both rural and urban sections of the city, which directly affected the participants in this project. As of 2010, this community had roughly 155,000 people who were considered living in poverty. Many of the participants in my study live in these areas of low socioeconomic statuses (SES), and the school site was recently accepted for Title I funds. Title I is a program which allocates “financial assistance through the state educational agencies (SEAs) to local educational agencies (LEAs) and public schools with high numbers or percentages of poor children” (*Improving Basic Programs*, n.d.). With the addition of

Title I funds, students have the availability of staff to help with targeted assistance (i.e., students who are considered high risk or failing) in addition to healthy breakfasts and lunches through the Free and Reduced Lunch Program.

The state I worked in is also one of 45 states and four territories to sign on to using Common Core Standards (*Common Core State Standards Initiative*, 2010). Schools around these states are making the switch from more localized standards, or what students are expected to know and do at each grade level, to standards and practices on a national level (*Common Core State Standards Initiative*, 2010). These standards are a culmination from teachers, parents, and community leaders and the “first step in providing our young people with high-quality education” (*Common Core State Standards Initiative*, 2010). Since I taught in a district transitioning from district standards to Common Core State Standards, the unit needed to align to the hybrid standards currently used there.

### **Participants**

The participants for this study included 27 students in my fifth grade class (see Table 1.1.). I was incredibly fortunate to be able to use the classroom where I was a student teacher as the platform to test my educational theories. Since I had been working with the students for four months prior to administering my research, the students were familiar with me and we had pre-existing relationships. These students, almost half and half boys and girls, came from a variety of backgrounds from affluent families to poverty and second language learners to native English speakers. In my classroom 60% of my students were English Language Learners, or ELLs, which added yet another layer of important to my study. Due to experiential education’s focus on real life application,

academic knowledge that may be difficult to grasp due to language can be more readily available. In addition, I had the help of my mentor teacher and an Instructional Assistant (IA) when necessary.

**Table 1.1 Student Characteristics**

	Female			Male			Total
Ethnicity	Hispanic	Caucasian	Other	Hispanic	Caucasian	Other	
Class	8	2	3	10	2	2	27

### Measures

The measures used for this study included three assessments (pre-, post-, and one month post), a Subject Ranking Survey, a Feelings About Math Survey, and student interviews. Both surveys were adapted for the purposes of my study from a PhD dissertation (Girod, 2001). Each measure served a specific purpose. The assessments provided data on the students' comprehension of conceptual information, including important mathematical terminology, operational problems with fractions, and mixed numbers and improper fractions.

For the Subject Ranking Survey (see Appendix B), students ranked eight different academic subjects from one, being their favorite, to eight, being their least favorite to study. By giving the students this survey, I was able to see where the subject of math ranked for the participants both before and after the unit. The Feelings About Math Survey (see Appendix A) had students answer 20 questions by agreeing or disagreeing

with statements about learning math in school that fell into four categories: (1) interest, (2) affect, (3) identity, and (4) efficacy. This survey helped me gain valuable insight into students' experiences in math.

Lastly, the student interviews were comprised of six questions that elicited specific information and allowed me the rare chance to see the impact of my unit through the lens of a student (see Appendix C). Since all of the participants in the interviews were fifth graders and therefore not legally competent to give consent, I created, distributed, and collected both consent and assent forms (see Appendices D-F). Since the classroom had a high percentage of ELLs, I had the parental consent form translated into Spanish to ensure comprehension of the information by the students' guardians.

Once the guardians and the students signed the given consent forms, each student was given the interview questions. Although the interviews were being conducted in English, I allowed the students to choose to have the interview questions ahead of time in either English or Spanish to help reduce anxiety surrounding the interview process. The questions were simple and short (see Appendix C) but allowed students to reflect on: (1) interest, (2) out-of-school transfer of information, (3) identity, and (4) efficacy. Students' interest reflected their current ideas of math, which have been formed and solidified by their prior experiences, while the out-of-school transfer of information showed the authenticity and real life applicability of content knowledge. Both categories of identity and self-efficacy are intricately intertwined. When a student identified as not being "good" at math, they often had a corresponding negative self-efficacy in the realm of mathematics. To protect the identities of the participants in this study, pseudonyms are used for all student examples.



## **Lesson Planning**

Once I had my framework solidified and measures created, I began to write my lessons. My lessons had to be a culmination of the curriculum, standards, and integration of experiential education. In order to maintain as much routine and order as possible, I incorporated many aspects of our daily math routine into my unit. This included traditional lessons as well as the workshop model. Had I been the full time teacher or had more time, I would have flushed out my lessons with a more holistically Deweyan centered approach. I also had to keep in mind the students, which was a direct benefit of having prior experiences with the students. On a whole, the students needed a focused introduction to a concept and when given freedom tended to abuse the privileges. With this in mind, I wrote lessons that allowed for creativity without excess amount of individual inquiry-only time, and had extra adult supervision for all major projects.

The first few days of the unit were focused entirely on laying down the foundation of fractional knowledge for the students. From the analysis of the pre-assessment I noted overwhelming gaps in prior knowledge that needed to be addressed before segueing into the more complex material. Through my research on the Laboratory School (Dewey 1938, Dewey 1902, Dewey 1915, Tanner 1997, DePencier 1996, Harms 1996, Mayhew 1936), I realized that even a school based entirely on experiential education still incorporated traditional lessons. I used this time to review basic fraction terminology with my students and note taking on the processes of adding and subtracting fractions, beginning with like denominators and progressing to unlike denominators.

Between and throughout the mini-units, I incorporated a variety of more traditional lessons for the students to gain content knowledge to apply to authentic learning activities. Without the ability to add fractions, the students would not have been

able to complete the major projects in the first two mini-units. They also could not have progressed to multiplying and dividing fractions, which was vital to learning how to double and halve a recipe. Additionally, the students worked on their fluidity with converting mixed numbers to improper fractions and vice versa which was a useful skill during the cooking unit.

### **Design & Procedure**

The framework of my unit posed more challenges than I had originally realized. Since I was a full time student in addition to teaching three days a week, I had to be creative in my planning. I was already teaching all-day Mondays, Tuesdays, and Thursdays, but in an effort to create a more fluid and cohesive unit for my students, I began teaching in the mornings on Wednesdays before my university classes.

This said, once I had overall framework and lessons planned, I needed to gather the necessary supplies. Finances played a large role in the actual implementation of my unit; knowing the background of my students, I knew I could not ask for supplies from home. Although I was not fully cognizant of it before jumping in, my unit required a expenditure. To anyone considering this path, I would suggest making a strict budget before the planning stage begins. In addition to providing art supplies for each of the projects, I also needed the necessary materials for the cooking projects for a class of 27 students—ingredients, measuring tools, mixing bowls, etc. In the end, I was able to collect everything I needed for my lessons beforehand.

The last step before administering the unit was creating an action plan. My action plan lay out the steps which I followed in order to create a successful unit and glean the essential data for my research. The following is the action plan I used:

1. Conduct the Subject Survey and Feelings About Math Survey
2. Administer the student interviews
3. Implement the Pre-Assessment
4. Complete the Math Unit
5. Implement the Post-Assessment
6. Re-conduct the Subject Survey and Feelings About Math Survey
7. Re-administer the student interviews
8. Implement the One-Month Post-Assessment

### **Curriculum & Activities**

Throughout the unit I tried to incorporate an array of teaching strategies to reinforce my underlying goal of authentic and powerful learning. By allowing students to complete their own art, music, and cooking, while being taught by local guest speakers, these goals were exemplified. The guest speakers not only provided the students an opportunity to learn about the topics from a new face and perspective, they also helped to ingrain the wide-range of potential future careers available to them.

I frequently used chants, with corresponding Total Physical Response (TPR) gestures, to accompany any traditional lessons. All too often there is a lack of music used in the classroom. In my personal experiences, students are greatly aided through the use of music to remember facts and processes. I found that through repetition of short chants, students could easily verbally explain the exact steps needed to perform specific operations.

Finally, I made an effort to include technology integration in my lessons. Prior to teaching, I had never used SMART Board technologies, so I made it a goal to utilize it as

frequently as appropriate. In my own personal teaching style, I found that the availability of interactions made possible through a SMART Board presentation verses an alternative technology (i.e., PowerPoint or Prezi) kept my students engaged and interested in the lessons.

### **Art Unit**

Within the Art Unit, students were required to gain knowledge about art in addition to creating artwork. Students looked at the mathematical concept of the relationship of parts to a whole while creating Fraction Name Art. By taking their last name and breaking it down into the number of consonants and vowels, students were able to create fractional values. For example, if the last name was Smith, a student would break it down into four consonants (part) out of the entire name (whole) and one vowel (part) out of the entire name (whole). From this, the student would prescribe the value of  $\frac{4}{5}$ , or four parts out of the whole to consonants and  $\frac{1}{5}$  to vowels (see Appendix J).

Next, students studied the profession of an artist and a variety of artwork from around the world through a SMART Board presentation. This piece was crucial to helping students understand that artwork, much like mathematics, is ubiquitous. Art is more than just drawing or painting; it encompasses architecture, authors, photography, flower arranging and much more. Once students had the opportunity to explore what art and an artist could be, the next connection was to tie art to mathematics. The class studied pictures of art typically connected to math (i.e., M.C. Escher's tessellations), examples of artwork from around the globe, and discussed a form of abstract expressionism that was created using fractions of colors. Students also delved into architecture, with discussions focused on the Golden Rectangle, measurement, and

engineering. Using architecture was a concrete example for the students to see the explicit connection between mathematical concepts and the creation of art. Students were then given fraction pieces of various colors (all  $\frac{1}{4}$  pieces) to create their own artwork (see Appendix J). Once the artwork itself was completed, students had to again describe the fractional value of each color in the relationship between parts and a whole.

Finally, students created Fractional Bird Art (see Appendix J). The first step was painting a watercolor background, then using a variety of fractional pieces—including wholes, halves, fourths, and eights—to produce birds. While this appealed to the creative side, students also had to find the total fractional value of their bird, noting that if one of the fractional pieces was missing, the bird would be incomplete. To do so, the students had to employ the skill set of adding fractions with unlike denominators. By learning and applying this skill in the previous lesson, with the addition of chants and accompanying gestures, the students were able to complete the written process for adding each of the pieces.

### **Music Unit**

Music is a complex and less tangible example of mathematics outside of the traditional curriculum. Many of the students were involved in band, choir, and orchestra, and therefore had more experience with music, whereas the remaining students had only rudimentary prior knowledge on the subject. With this in mind, I began the unit by exploring musical sounds from around the world. The students listened to different songs and using only their schema and the direct clues within the music, had to predict which country the song came from. With a setup similar to that of a game show, students also

had the opportunity for “bonus points” if they could name the genre of music or musical instruments being used. At the end, the answers were revealed to the students.

With the aforementioned activity as a mental warm up, the students then transitioned into a SMART Board presentation on music as it relates to mathematics. The students participated in an interactive song and dance about rhythm and beats, and then learned about time signature. Although I wanted to go farther into the time signature piece, I understood that developmentally and with the students who had no prior knowledge, an in depth discussion was not appropriate. Next, students looked at the fractional value of music notes (i.e., whole note is  $\frac{1}{1}$ , half note is  $\frac{1}{2}$ , quarter note is  $\frac{1}{4}$ , etc.). The students quickly realized the direct connection between the music notes name and its assigned fractional value.

Since the students were completely on board, they moved forward to examining questions about music notes in relationship to each other by answer questions such as (1) How many quarter notes equal a half note? A whole note? and (2) How many eighth notes equal a whole note? A half note?. This activity allowed for students to look at fractional relationships, and posed as the segue into ‘writing’ music. Each student wrote a piece of music with the different notes and their partner had to determine the total fractional value of the “song.” This unit was brought to a close with the introduction of a local musician. She gave a presentation to the students about writing music, showed music she had written, and played several songs. At the end, students were given time to ask her questions about music, the importance of math in writing/performing music, and possible future career opportunities in music.

## **Cooking Unit**

Cooking was by far the most highly anticipated mini-unit for fractions. In an effort to switch the students' thinking from music into cooking, as well as leveling the playing field of cooking experience, I invited a local chef to be a guest speaker in our classroom. Not only was she able to share her expertise of cooking and samples of recipes from her recently published cookbook, she taught the students about cooking hygiene, preparation techniques, and how to correctly use measuring tools.

Since students had gained the essential algorithmic skills to multiply and divide fractions with tradition lessons before this unit commenced, they were able to slip seamlessly into working with different recipes. The students prepared three items: (1) smoothies, (2) pancakes, and (3) cookies. With the smoothies, the students had to double a reasonably simple recipe I often use before being allowed to work in their differentiated math groups to actually prepare them. Next, students had to halve a recipe for pancakes before creating the batter, cooking them, and finally consuming them. Both of these exercises motivated the students to come to class prepared and equipped them for the final test of their fractional and cooking skills: the cooking competition.

Cooperating with their peers, groups of students had to halve a chocolate chip cookie recipe and whip together the ingredients based on their "new" recipe to make the best cookie dough possible. Students were informed ahead of time that their dough would be baked and judged in the Ultimate Cooking Competition. With the help of our kitchen staff, my mentor teacher and I were able to get the cookies baked and enlisted the help of our IA and counselor to star as guest judges in our cooking competition. The students worked diligently on their batters and were riveted to our mock cooking competition "show."

I also incorporated two literacy lessons during this unit to complement the focus on cooking. While learning about cooking for our chef guest speaker, as a class we had briefly touched on the career of a connoisseur. Using the framework of a lesson I had been involved with in a university class, I crafted a block of time afternoon where my students would be allowed to become a true connoisseur.

A week after our taste testing lesson, I surprised my class with a cultural food experience. Using a SMART Board presentation as the visual realia backdrop for gaining cultural awareness, students traveled the globe to try different kinds of cuisine. Beginning with tame foods and working towards more exotic ones, students had their eyes opened to the sights, smells, and tastes of countries they had never been to or heard of before. While they nibbled through their provisions, they had to jot down the country where the food was from and a description of the food itself. After they had a chance to try all of the new foods, team leaders drew slips of paper with the food names on them and prepared persuasive debates in groups using their notes to convince the class that their food was the best in the world. The importance of these literacy-based lessons was to further students' knowledge of the real life occupations in the field of food/cooking. If students became excited about jobs in this field, with the corresponding importance of math in the cooking unit, it might create the intrinsic motivation for students to work harder in mathematics.

### **Study Limitations**

Overall, there were three important facets that created unanticipated noise during the implementation of my unit: (1) general lack of prior knowledge, (2) additional district-mandated items, and (3) school-wide interruptions. When creating this unit, I



research the trajectory of fractions through the Common Core State Standards (CCSS). CCSS showed that the concept of fractions (i.e., relationship of parts to a whole) was introduced in third grade and expanded upon in fourth grade to the addition and subtraction of like fractions. After analyzing the pre-assessment, I had the shocking realization that my students were grossly lacking the necessary prior knowledge to complete my planned unit.

During the unit there was also a surge of assessments from the district including Common Formative Assessments (CFA) and District Interim Assessments (DIA) in both math and reading. These pushed back my unit dates and created a break in the cohesive unit I had created. Lastly, school-wide events, which are announced at the beginning of the each week such as fire drills and assemblies, also created unexpected push-backs in the scheduling process.

## FINDINGS

### Pre-Assessment

The pre-assessment (see Appendix G) followed a typical mathematical test formula. The questions were directly related to the given standard, in addition to looking at the real life applicability of the material. I designed the assessment instrument to target three different areas: (1) vocabulary, (2) real life applicability of the material, and (3) mathematical computations. I created the first page to look non-threatening with three questions on vocabulary, one for labeling fractions, and a simple question on authentic learning. I left all of the mathematical computation problems together on the back page so students would get to it once their brains were “warmed up.” I put each equation in a separate box to ensure that students would use the space to write their answers and show their work in an organized manner.

In addition, I also incorporated a mix of addition, subtraction, multiplication, and division with like/unlike denominators and mixed numbers. Originally I planned for my assessments to cover only the four basic operations with fractions, however my mentor requested that I include mixed numbers to help students with the switch to Common Core next year. Additionally, during our PLC meetings, the other teachers in our grade level decided not to move into dividing and multiplying fractions since it was not technically required yet. Instead of changing my entire unit, I made the curricular decision to keep my unit in its same format.

When I created the points for the pre-assessment, I looked at each question individually then added the total point values. On the front page, there was a variation of

point values because of the nature of the question format. I set question #1 worth two points (one for each vocabulary word), question #2 worth 5 points (one for each match), question #3 worth two points (one for each blank), and question 4 worth one point. I did not want question #4 to be worth several points because it is relevant and important but not directly tied with a student's comprehension of fraction mathematical skills. On the back page, each question was worth 2 points. Students could receive partial credit if they answered the question but did not simplify the answer. I did this because I did not want to severely penalize a student who did the work without simplifying, however they could not receive full points without simplifying since it was clearly stated in the directions.

The test was administered from 10:00-10:45 AM, which is the normal time for mathematics in my classroom. I did this to allow a sense of normalcy during the exam. I allotted 45 minutes for the assessment because in the past 30 minutes was not a long enough period of time for the students to take assessments, but an hour was too long. I allowed students to take the full 45 minutes if they needed it, and those who finished early were encouraged to double check their answers and then read silently. I read through the assessment directions to the whole class, and reminded the students that I could read the directions to them if needed.

Overall, the results for the pre-assessment were low, once again alluding to the aforementioned lack in background knowledge of my students (see Table 3.1). The test mean was a mere 45% with a median of 47% and modes of 47% and 53% (see Figures 1.1-1.3 below). I believe that the low scores were informative regarding students' prior knowledge and skills. The class did well on front page of questions pertaining to the terminology, written counterparts, and applicability, but severely struggled with the back

page. Most students had the basic knowledge of what the parts of a fraction were, so during the unit I did not focus strongly on it.

Figure 1.1: Pre-, Post-, and One Month Post-Assessment mean data

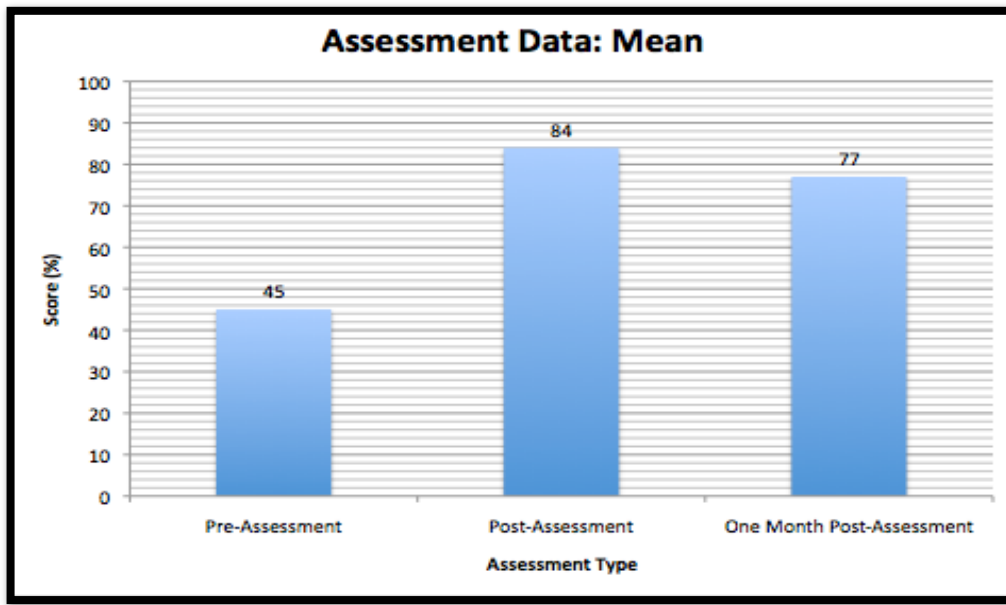


Figure 1.2: Pre-, Post-, and One Month Post-Assessment median data

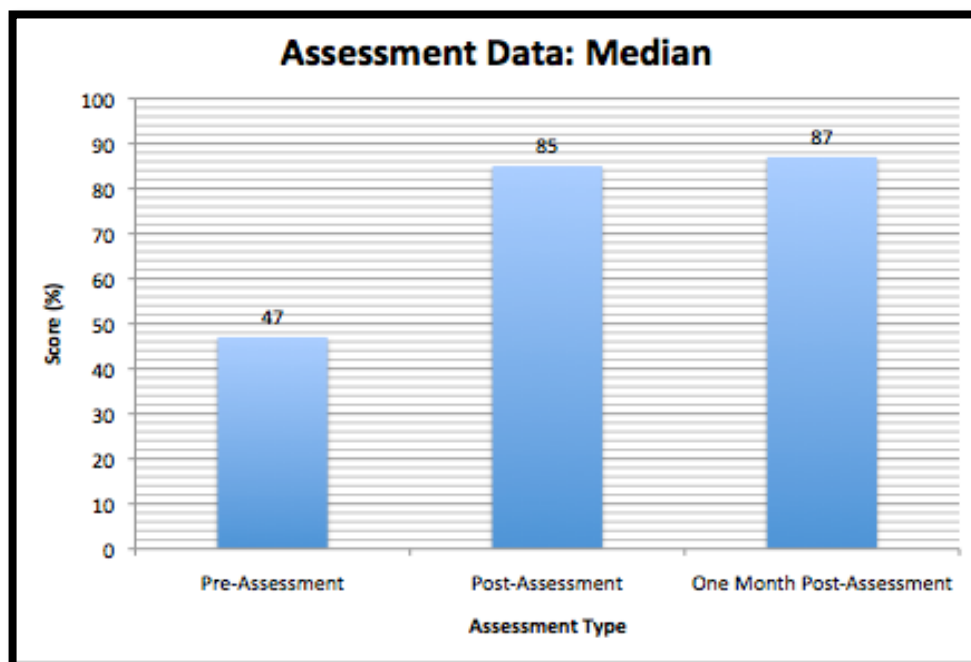
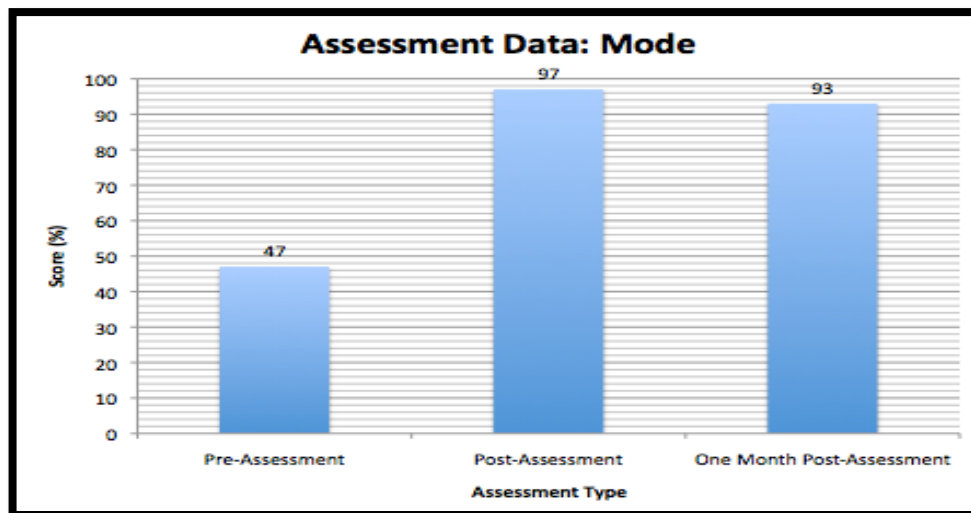


Figure 1.3: Pre-, Post-, and One Month Post-Assessment mode data



Based on all of the data and information I gleaned from my pre-assessment, I adjusted the pacing of my unit. Since I originally planned my unit believing that my students would have the necessary prior knowledge, I spent more time focused in the beginning of the unit on explicitly teaching and modeling the basic computational math processes for fractions. Again, my students had little to no knowledge on multiplying and dividing fractions, so those concepts were taught at the end of the unit once the students had a foundational skill set.

### **Post-Assessment**

The post-assessment (see Appendix H) was changed in a few minor ways from the pre-assessment. My unit ended up having a stronger focus on mixed numbers and improper fractions than I had originally planned, so I replaced my awkwardly worded question #3 with a multiple choice question regarding vocabulary we had focused on during the unit. I also made question #4 listing four items instead of three since the

students had more direct experiences relating to the answer. On that same track, I removed a part from question #2 (making it worth only four points) and used the extra point towards question #4. The only main difference on the back page of questions was that the numbers were changed; however the processes were still the same. The administration of the assessment followed the same steps as the pre-assessment.

The gains from the pre-assessment to the post-assessment were phenomenal (see Table 3.1 and Table 3.2). The test average was 84% with a median of 85% and a mode of 97% (see Figures 1.1-1.3 above). Out of all 27 students in my classroom, zero students had a percent decrease in their pre-assessment to their post-assessment. Only one student did not take the post-assessment due to being pulled-out every day for LRC services and chronic absences. Since he took the pre-assessment but not the post-assessment, I removed his score when computing the data as to not have a zero negatively impacting the averages and percentage learning gains. I was surprised and overjoyed to see that 27% of my students had an increase between 40-49% from their pre-assessment to their post. I broke down the percentage assessment gains into the following table:

Table 3.1: Pre-Assessment and Post-Assessment Gains

<b>Percent Increase</b>	0-9%	10-19%	20-29%	30-39%	40-49%	50-59%	60-69%	Exempt
# of students	2	3	2	4	7	4	4	1

### **One Month Post-Assessment**

The one month post-assessment was exactly the same as the post-assessment and administered at the same time, for the same length, and in the exact manner as the prior assessments. The results of this assessment were not surprising (see Table 3.2). Many of

the students had a slight decrease in scores, however four students had gains. The test average was 77% with a median of 87% and mode of 93% (see Figures 1.1-1.3). Table 3.2, along with Figures 1.4 and 1.5 (below) are a compilation of all students' data for the three assessments. It is important to note that students #4 and #11 moved schools between assessments.

The use of a one month post-assessment was to analyze the long-term effectiveness in learning retention from teaching with a Deweyan style. During the four weeks between the unit's final lesson and the one month post-assessment, the students moved into another unit on decimals. Over that period of time, there was a potential for a loss of content knowledge. The more traditional educational teaching style of using rote memorization works "at times for short term memory...but the knowledge can only be effectively retained if it is meaningful" (Thompson, 2004). If the students had used this style of learning via pure memorization just for the test, there would have been a significant drop in the one month post-assessment since the students were not using the specific information gained during the fractions unit. Figures 1.4-1.5 and Table 3.2 show that although some students had a decrease in their test scores, a majority of students had either only a minimal decrease (i.e., 0-10%), a net gain of 0%, or an increase in their scores. These results showed me the positive correlation in retention of knowledge over a longer period of time.

Figure 1.4: Comparative Assessment Data for Students #1-#14

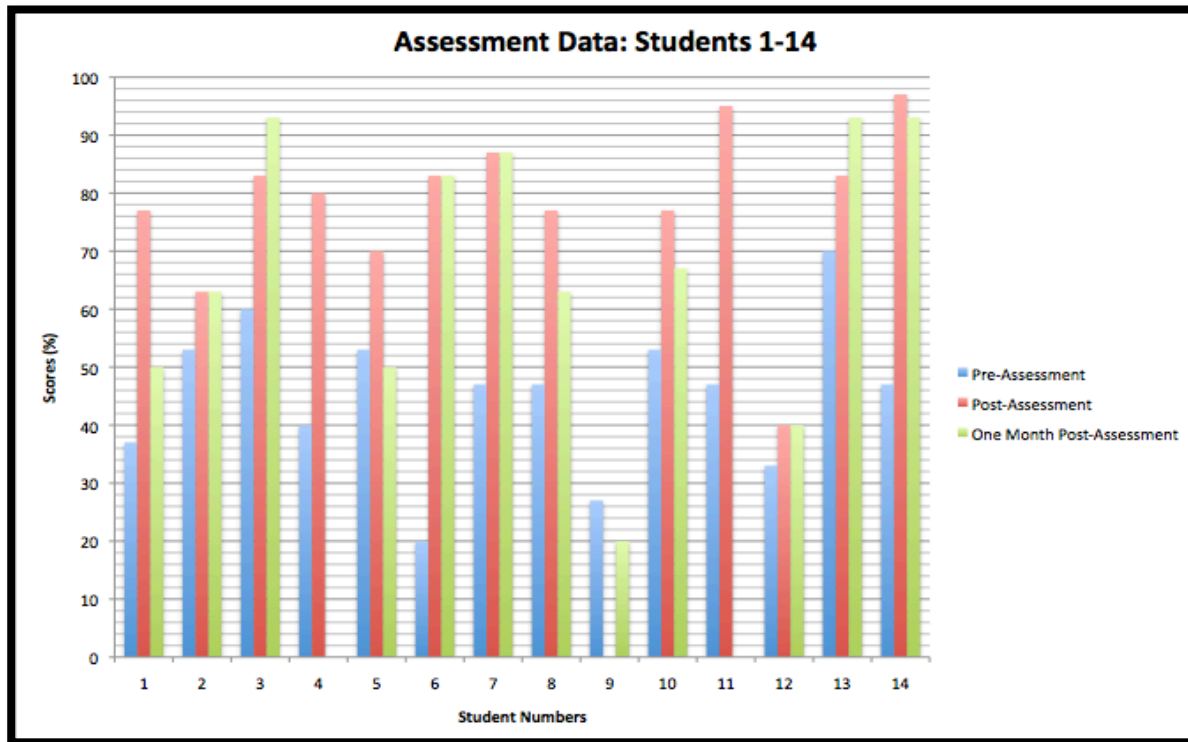


Figure 1.5: Comparative Assessment Data for Students #15-#27

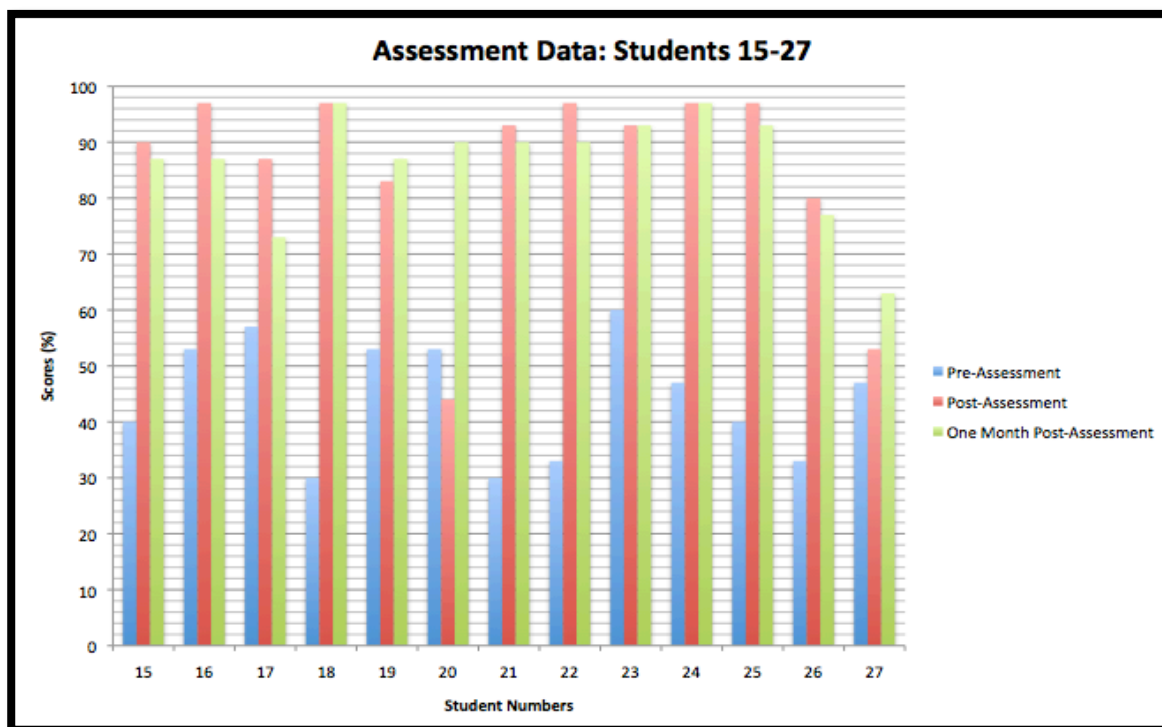




Table 3.2: Assessment data based on pre-assessment scores from highest to lowest

Coded #	Pre-Assessment Score	Pre-Assessment %	Post-Assessment Score	Post-Assessment %	% Change from pre to post	One Month Post-Assessment Score	One Month Post %	% Change from post to one month
13	21/30	70	25/30	83	13	28/30	93	10
23	18/30	60	28/30	93	33	28/30	93	0
3	18/30	60	25/30	83	23	28/30	93	10
17	17/30	57	26/30	87	30	22/30	73	-14
20	16/30	53	29/30	97	44	27/30	90	-7
19	16/30	53	25/30	83	30	26/30	87	4
16	16/30	53	29/30	97	44	26/30	87	-10
10	16/30	53	23/30	77	24	20/30	67	-10
5	16/30	53	21/30	70	17	15/30	50	-20
2	16/30	53	19/30	63	10	19/30	63	0
27	14/30	47	16/30	53	6	19/30	63	10
24	14/30	47	29/30	97	50	29/30	97	0
14	14/30	47	29/30	97	50	28/30	93	-4
11	14/30	47	28/30	93	46	-	-	-
8	14/30	47	23/30	77	30	19/30	63	-14
7	14/30	47	26/30	87	40	26/30	87	0
25	12/30	40	29/30	97	57	28/30	93	-4
15	12/30	40	27/30	90	50	26/30	87	-3
4	12/30	40	24/30	80	40	-	-	-
1	11/30	37	23/30	77	40	15/30	50	-27
26	10/30	33	24/30	80	47	23/30	77	-3
22	10/30	33	29/30	97	64	27/30	90	-7
12	10/30	33	12/30	40	7	12/30	40	0
21	9/30	30	28/30	93	63	27/30	90	-3
18	9/30	30	29/30	97	67	29/30	97	0
9	8/30	27	-	-	-	6/30	20	-
6	6/30	20	25/30	83	63	25/30	83	0

### Student Interviews

In an effort to see the effect of my unit on the students' feelings and understanding of math, I conducted recorded interviews with six of my students. The selection of students was broken down into the following categories:

- 2 high achieving students (1 male, 1 female)
- 2 average achieving students (1 male, 1 female)
- 2 low achieving students (1 male, 1 female)

I chose the aforementioned categories to examine the effect of my unit on achievement levels as well as gender, to represent a more balanced view of student experiences. The students were chosen by looking at their academic levels in math in addition to feedback from my mentor on certain students to select within each achievement level bracket.

### **Representative case studies: High achievement level**

The first student who I interviewed was a young woman named Carmen. Although she is an English Language Learner (ELL), language is not an obstacle for her and she excels in all of her subject areas. Since most things come easy to her, she quickly becomes discouraged and frustrated when a concept is hard for her. Before the unit Carmen discussed the connection between math and cooking with her mom, especially since her mother “knows all of the recipes by heart.” She noted her preference for doing math worksheets alone in silence and how there are always new things to learn that she never knew before. While her affect and efficacy in relationship to math are increased through teaching her younger sister math, she commented, “I don't like how sometimes I don't get things. They're too hard and I don't understand. I just stare at it [...] once I forgot what we were doing and I couldn't get it and I didn't get a single question right.” The most interesting comment she made regarding her experiences learning math in school was, “They're all the same. The teacher always talks about [math] and we listen.” I was both shocked by, and appreciative of, her raw honesty—as both a student and teacher I saw the truth behind her words. Her observation reinforced the heart behind my study's purpose.

After the unit, her answers varied slightly. She again mentioned cooking and worksheets, but her attitude towards math had changed. When I asked if she thought of

herself as someone who was good at math she smiled and told me, “Yes, because [...] I can get a lot of answers really quickly.” This answer was slightly shadowed by her affirmation that she still became frustrated if she could not solve a problem quickly. She also finally had a story for a positive experience in math; she talked about using math in measurement to make the pancakes. Sadly, she noted that she did not think about fractions differently or outside of school.

Adam was the second high achieving student whom I interviewed. While Adam has shown high intelligent through his academic work in school and succeeds in most subjects with ease, he often struggles with his lack of motivation. Before the unit, Adam mentioned a plethora of ways math connected to everyday life from cooking and shopping to games like pool and monopoly. It was not surprising to find he felt he learned best through games such as SumDog® where he could “play games and learn at the same time” instead of worksheets that were “just too much work.” Finally, when he was asked if he thought of himself as a person who is good at math he stated that he was not a math person, but more of a tech person.

After the unit, Adam narrowed his examples for math in daily life to cooking, money, and his possible future careers as an archeologist to “mark where you’re going to dig in” or a drummer because you “have to learn [...] beats and what time they’re going to come up in.” Again he confirmed his dislike of worksheets, in addition to tests and quizzes, and interest in learning through “fun activities” like cooking, guest speakers, and chants. The only real change in his answers came when he admitted that he thought of himself as a math-type person because “people always tell me I can grow up and by anything I want as long as I have math and that I’m really good at it.” Like Carmen,

Adam did not feel his view had been changed or that he thought of math/fractions outside of school.

Adam and Carmen both exhibited high achievement levels with the accompanying hindrance of motivation and frustration, respectively. It was exciting to hear them both align themselves mentally towards the track of higher self-efficacy in math and their identity as a math person. On the flip side, it was extremely disappointing to hear that neither of them felt changed or compelled to think about math in their daily lives outside of school. I was hoping that at least one of them, if not both, would have taken the lessons into deeper-level thinking and experienced some form of change.

#### **Representative case studies: Average achievement level**

Mary was the first average achievement level student that I interviewed. She is a bright young woman who works incredibly hard in school and aspires to be a future teacher. Before the unit, she adamantly expressed the need for math by stating, “When you’re older you have projects. You’ll have to use math to get a good education.” She described in detail her experiences using math in correlation to donating money to her church, and noted that she enjoyed doing projects in math. In addition to high interest in math, she loved to learn it with “pretty much anything” and “in a textbook, because it teaches you how to review things, like if you don’t know or you forgot to know it in your mind.” When asked if she was good at math, she articulated a high self-efficacy due to support from her family and friends, relating her only negative experience of math with when she was attempting to re-teach her younger sibling a counting strategy.

In the post-unit interview, Mary again tied her educational experiences in math to her future occupational aspirations and family. Her example of daily math outside of school switched to discussing cooking with her family, where you have to “use a [...] measuring cup and measure out each ingredient.” This example was paralleled with her response to what she liked about math. She explained she learned fractions best with the “cooking activities” because each student got to “scoop out each ingredient and measure it.” This said, she followed her answer by stating she learned best through worksheets. Her identity as a math person, along with a strong sense of personal achievement, was seen. Unlike many of her peers, she thought about fractions “like every day I cook I think about fractions. I look at the measuring cups when I cook to see what I’m going to do.”

Zach is a stereotypical American boy who loves watching and playing football. Although he does well in most subject areas, he flourishes in writing where his zest and passion for words is clear. Before beginning the fractions unit, Zach identified math as being important in everyday life, particularly in specific to the “different sections of the garden” and the different yards and rankings in football. Despite his obvious enthusiasm with writing, he admitted that the best thing about math was there were “lots of ways to learn math. And one thing I don’t like about math is when it ends!” Not surprisingly, he best learned math through the process of writing the steps out, and identified himself as a person who is good at math. His favorite math lesson had to do with learning fraction basics in fourth grade through the use of Hershey’s chocolate bars and maintained that he had never had a negative experience with math in school.

After the unit had been taught, many of Zach's answers remained nearly identical. He restated that he learned math best using algorithms and was a person who is good at math because he "always pay[s] attention when math is in session." A difference arose when he discussed his favorite math lesson. Instead of retelling the story of his fourth grade experiences, he happily described the cooking unit we had just finished. When asked why it was his favorite, he announced proudly, "Because it was both fun *and* educational!" While his comment was definitely a highlight, it was disappointing to hear that he did not think about fractions outside of school. As I would find out later, I realized that the seeming lack of thinking of fractions outside of school might have been a function of the way I asked the interview question rather than an actual deficiency in student learning.

Mary and Zach each had positive experiences with the unit. Each student continued to uphold the belief that they were not only interested in, but excelled at, math. In addition, both updated their positive experience with math in school to include elements of my unit. While the continuation of positive influence of math was uplifting, I was disappointed that there was not as much growth towards thinking outside the box when it came to the importance that math plays in everyday life.

### **Representative case studies: Low achievement level**

Lilia was the representative for females in low achievement in mathematics. Although she typically scores lower than her peers in several subject areas, this is often due to a language barrier since she is an ELL. She is a hard worker with an incredibly sweet albeit shy personality. Before the unit, many of Lilia's answers were short and

lacking in depth; this may be in part to both her introverted tendencies and language level. Her examples of math in daily life included cooking and shopping, and on a regular basis she said that she and her mom cook both chocolate cakes and tamales. Lilia discussed her fondness for solving area in two-dimension shapes because “it’s easy for me to [...] do the math” while she disliked “fractions because I don’t understand them that good.” It was disheartening to hear her tell me that she was not a math-type person “because I’m not that good at it.”

After the unit, it was apparent that Lilia had personal growth in relationship to math. She again described cooking with her mom, but also elaborated on how money and shopping show math. In a complete change of events, Lilia told me the one thing she liked about math was “decimals and fractions [...] because they’re fun” while there was “nothing” she disliked about it. Even more inspiring was her self-identification as someone who was good at math. She told me that she was good at math “because I love math and my mom gave me math problems and I got every one [...] of them correct!” Lastly, she was also one of the only students to mention that she now thought about math when she was at home baking cakes.

Alex is a student whose attitude towards math unfortunately mirrors that of myself at his age. Often he expresses his disinterest in learning math in front of the entire class, which visibly reflects his negative self-efficacy in math. Like his peers, before the unit he noted the correlation between cooking and math and liked it because “it will help us [...] in our life.” I was surprised that he only noted not liking fractions as his dislikes in math; I believe he was not being fully honest in his reflection. When asked if he felt he was good at math, he responded with a heartbreaking, “I think I’m not smart at math.”

After the unit, I was pleased with his progression in most aspects. We had a good discussion about how math is important to his future plans of being a pilot so he knows the speed of the plane and how many miles he has flown. Alex also mentioned his favorite experience learning math in school was “doing fun stuff...like when we did the smoothies!” Fractions were replaced on his dislike list with “nothing,” but despite working with him one-on-one on positive attitudes and promoting strong self-efficacy, Alex unfortunately maintained that he was not good at math because he was “not smart.”

Lilia and Alex both impressed me with their individual gains in the period between interviews. Both seemed to grow more confident in their opinions and responses, and provided me with more details than in their pre-unit interviews. It was a bittersweet feeling to watch Lilia move into a more comfortable and positive relationship with math while Alex held fast to his beliefs in an inability to perform well in math. With this knowledge, I will continue to pursue the goal as an educator of promoting positive self-efficacy for all students.

### **Subject Survey**

Each student in the classroom was given a Subject Survey (see Appendix B) to complete individually both before and after my unit. With the choices ranging from specials (i.e., P.E., music, and art) to core academic content areas (i.e., reading, writing, math, science, and social studies) students were able to rank their favorite subjects from one to eight, with one being their favorite and eight being their least favorite. The idea behind this survey was to give me an idea of where the overall class’s opinion of math lay in the scheme of all subjects. Although my unit was brief, I was curious to see if



teaching with an experiential education framework would change students' overall opinions.

After analyzing the data for both pre- and post- unit, I found that the overall opinion of math had not changed. The average for math pre-unit on the scale of one to eight was a 4.5, while the average for math post-unit was 4.7. Out of the 27 students total, 22 maintained an answer that was within +/- 2 of their original ranking of math; four students had an increase of three or more from their original answers while only one student had a decrease of three or more.

Once I had analyzed the data as a whole, I began to wonder what the averages would look like for math only using the core academic subjects seeing as many of the students had ranked the specials in their top three positions. I went back through every Subject Survey and reassigned the core academic subjects values corresponding to a one to five point scale. The average for the pre-unit on the new scale was a 2.6, while the post-unit was a 2.7—again showing only a small difference between the two.

Although it was slightly disappointing to see such close results pre- and post-unit, I recognized two key factors in regards to my research. The first was that my unit was hyper-focused on only fractions, as well as being conducted on an extremely succinct timeline. Fractions as a subject matter could directly affect students' opinion of math, as well as having learned with an experiential framework only once briefly. The second was that my students are between the ages of 10 and 11, and most of them have a decently solidified opinion already about mathematics. If I were to do this research again, it would be interesting to focus on the progression of subject ranking over the

course of the entire school year, or comparing the results over a several year period with the same group of students.

### Feelings About Math Survey

All students were also given a Feelings About Math Survey (see Appendix A) to complete individually both before and after the unit. As mentioned previously, the Feelings About Math Survey covered four regions: (1) interest, (2) affect, (3) identity, and (4) efficacy. Out of the twenty questions, each region had five questions that correlated specifically to it. I chose to make each section with five questions because with only four there was a possibility the end results could come out 50-50. For their responses, students had the option of selecting DISAGREE (*strongly* disagreed), Disagree, Neutral, Agree, or AGREE (*strongly* agreed). After the survey was completed, I created a spreadsheet of each student's answers broken down for each question in all four regions. With that spreadsheet of raw data, I was able to compile Tables 3.1 and 3.2 to show the comparison of the number of student answers for each question.

Table 3.1: Measuring interest and efficacy in mathematics

INTEREST			EFFICACY		
Question #1	Pre-Unit	Post-Unit	Question #2	Pre-Unit	Post-Unit
DISAGREE	2	1	DISAGREE	8	3
Disagree	1	4	Disagree	13	15
Neutral	4	2	Neutral	1	4
Agree	11	11	Agree	3	4
AGREE	9	9	AGREE	2	1
Question #5	Pre-Unit	Post-Unit	Question #6	Pre-Unit	Post-Unit
DISAGREE	4	2	DISAGREE	7	5
Disagree	1	3	Disagree	9	9
Neutral	3	3	Neutral	4	3
Agree	5	7	Agree	4	8
AGREE	14	12	AGREE	3	2
Question #9	Pre-Unit	Post-Unit	Question #10	Pre-Unit	Post-Unit
DISAGREE	10	7	DISAGREE	1	0
Disagree	12	15	Disagree	1	1
Neutral	1	2	Neutral	7	5

Agree	4	3	Agree	8	13
AGREE	0	0	AGREE	10	8
<b>Question #13</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>	<b>Question #14</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>
DISAGREE	10	2	DISAGREE	0	2
Disagree	10	3	Disagree	2	2
Neutral	0	3	Neutral	5	3
Agree	2	7	Agree	9	13
AGREE	5	12	AGREE	11	7
<b>Question #17</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>	<b>Question #18</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>
DISAGREE	12	8	DISAGREE	1	0
Disagree	8	12	Disagree	3	0
Neutral	2	3	Neutral	1	4
Agree	3	2	Agree	7	11
AGREE	2	2	AGREE	15	12

Table 3.2: Measuring identity and affect in mathematics

IDENTITY			AFFECT		
<b>Question #3</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>	<b>Question #4</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>
DISAGREE	5	2	DISAGREE	10	9
Disagree	7	7	Disagree	8	11
Neutral	5	7	Neutral	4	3
Agree	5	7	Agree	2	3
AGREE	5	4	AGREE	3	1
<b>Question #7</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>	<b>Question #8</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>
DISAGREE	8	3	DISAGREE	11	9
Disagree	5	10	Disagree	10	11
Neutral	6	6	Neutral	3	3
Agree	3	2	Agree	1	3
AGREE	5	6	AGREE	2	1
<b>Question #11</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>	<b>Question #12</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>
DISAGREE	11	9	DISAGREE	4	1
Disagree	8	13	Disagree	1	1
Neutral	3	2	Neutral	3	2
Agree	2	1	Agree	8	7
AGREE	3	2	AGREE	11	16
<b>Question #15</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>	<b>Question #16</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>
DISAGREE	11	10	DISAGREE	2	0
Disagree	10	9	Disagree	2	3
Neutral	2	4	Neutral	5	5
Agree	3	4	Agree	8	11
AGREE	1	0	AGREE	10	8
<b>Question #19</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>	<b>Question #20</b>	<b>Pre-Unit</b>	<b>Post-Unit</b>
DISAGREE	8	7	DISAGREE	5	1
Disagree	6	8	Disagree	2	4
Neutral	5	4	Neutral	4	4
Agree	5	4	Agree	4	7
AGREE	3	4	AGREE	12	11

**Interest**

The results for the category of student interest in math were overwhelmingly positive, both before and after the unit was taught. By examining the results for questions #1, #5, #9, #13, and #17, I found that students enjoyed learning math, wanted to learn more about it, and did not think that it was boring. Most of the results from the pre-unit and post-unit were fairly similar without major changes towards a positive or negative viewpoint. It was exciting as a teacher to see the class as a whole exhibit a largely positive interest in the subject of math. However, the results of this survey made me question if students felt high interest in math why it was ranked lower than other academic subjects on the Subject Ranking Survey. At this stage in my research, I do not have the answer to this question.

**Efficacy**

Self-efficacy plays a monumental role in the development of learners at any age (Zimmerman, 2000). Without a strong self-efficacy in a subject area, even highly intelligent and capable pupils will struggle to create and maintain academic growth. Fortunately, the class exhibited a high efficacy on the whole. While they strongly noted that they are capable of learning math ideas, believed they would do well with math tasks this year, and will know a great deal about math by the end of the year, the results were extremely close for whether or not they had a difficult time understanding math ideas. When asked if math has been hard this year (question #2), a majority of students responded by disagreeing, however the scores were almost split 50-50 for difficulty learning math ideas this year (question #6); pre-unit 16 disagreed while 12 agreed and post-unit 14 disagreed while 10 agreed. This called into question if the verbiage of the question posed was succinct and clear enough or confusing for the students.

## **Identity**

The questions regarding students' identification with math as an individual were of interest. Almost 50% of the participants recorded wanting a future career that did *not* involve using a lot of math. In addition to those results, when asked if they think, or others have told them, that they are a "math-type" person, 44% of participants disagreed pre-unit while post-unit that number decreased to 33%, while the number of participants marking "neutral" increased by 7%. The flipping from more participants disagreeing to agreeing with this question made me contemplate if such a small movement of numbers actually denoted a true change in the results. Lastly, the students showed a slight increase in identifying math as a subject they associated with, while there was also a slight decrease in experiencing a feeling of dislike with the word math.

## **Affect**

The given affect questions related to the students' feelings, moods, and attitudes surrounding math. Personal affect is highly tied to the theory of self-fulfilling prophecies. If students think a subject is meaningless, harbor negative attitudes about it, or think they cannot do the work given they will never succeed. Although there were a few participants who continued to feel pessimistic, as a whole class the results were positive. Participants noted that they liked, had good feelings towards, and were comfortable with math. The most exciting result for me as an educator was by the post-unit data, 23 students noted that they agreed learning math was fun compared to the two who felt neutral and two who disagreed. I worked incredibly hard to show that learning math could be both enjoyable and educational and to remind my students their worth as individuals and learners.

## CONCLUSION

### Study conclusions

This research worked to address the central question of whether or not it is possible for a typical classroom teacher in the public elementary school setting to implement an experiential education framework into academic curriculum. Although this was a focus in my investigations, I also looked at my findings to see possible learning gains and changes in students' identity, affect, efficacy, and interest.

When I reflected on my overall findings, I saw that there was not an immense change in students' interest, affect, identity, or efficacy. I feel that a huge part of this was not because the unit was ineffective or the students did not enjoy the lesson, but the amount of time. If the given styles of teaching were addressed and used in a particular subject area for an entire year, I feel that the aforementioned categories would show a tremendous increase. This said, the student's quality of work was higher than in other units I had taught, and there was a positive trend in percentage increase between the pre- and post-assessments. This unit, with or without modifications, could be used in other classroom in the future to further data in this field.

The interviews created the backdrop of the human psyche throughout the course of my thesis work. In general, although there was not a significant increase in most categories, there was a positive trend in efficacy. One of the most paramount examples of this was when my students changed their opinions of being "dumb" when it came to math to being confident in their abilities. The implications for all students, regardless of their achievement level, was that using a Deweyan style framework can provide an opportunity to the lower their affective filters and gain self-efficacy. In addition, the

results from the post-assessment to the one month post-assessment showed a high retention rate of information learned from the students. With a majority of students falling within +/- 10% of their post-assessment scores after a one month hiatus, it reflected to me the positive effect of meaning and purpose in the students' learning.

My thesis also raised many questions when it comes to incorporating experiential education into core academia. Would using an entirely Deweyan-focused teaching style yield higher learning gains than standard curriculums? How does it affect students' state standardized test scores? How is the effectiveness altered when used in a classroom where a majority of students prefer traditional worksheet and textbook style learning? Is it applicable to all grades, as well as across all subject areas? These questions are currently unanswered in my work. In other words, I do not believe the full spectrum and effect of the Deweyan framework was investigated during this study, however this project was meant to examine the mere plausibility of experiential education in the subject of mathematics.

After integrating experiential education-based activities into several lessons, I found that it would be possible but require substantial time, effort, and funds from the educators. Although there is an abundant supply of resources on the theoretical components of experiential education, I have yet to stumble upon a comprehensive curriculum built with it as the foundational component.

### **Weaknesses & Implications for future research**

In the future, I would be interested in expanding upon this line of research, however there are several aspects I would modify. If I had the opportunity, I would increase to a larger sample size and do several units back-to-back for a longer period of

time. It is impossible to say any data is entirely conclusive with such a small pool of participants, however it does provide interesting information for future research. Additionally, many aspects within the participants (i.e., effect of gender, ethnicity, etc) may play an important role in the effectiveness of a unit. With the use of several connected units, students would have the chance to become familiar and comfortable with the more open-ended and inquiry-based lessons. It would also allow the students a longer opportunity to reflect on their learning styles and ideas surrounding a subject area. Only one series of lessons cannot accomplish immense change in the fact of all other experiences with learning math.

Finally, I would change the design of the unit. Although I would maintain the different measures, I would split the participants into a control class and treatment class. By having both groups, I could co-teach specific content material with another educator to see the direct effect of experiential education on learning gains. All students would learn content from the same objectives, however the treatment class would be involved in authentic learning and more hands on experiential activities. I would like to experiment with either random assignments to classes, or use a classroom of my own. Both branches of this experiment would work to further educational research in different areas. I believe that this modification, with the aforementioned additional attributes, would create a more well-rounded study in the future.

John Dewey was a phenomenal educator and a pioneer in the field of education. His pedagogical focus on creating a community environment that fostered creativity and authenticity was mirrored in my thesis work. As an educator, I saw the positive results firsthand of the effectiveness of this foundation of learning. Unfortunately, with the



current emphasis on standardized testing and rote memorization of content knowledge, this style of experiential education is very difficult to replicate on a large scale. However, through my research, I have seen and come to believe that Dewey's educational philosophies benefit all students and should be the future of education.

## APPENDICES

### Appendix A: Feelings About Math Survey

Name \_\_\_\_\_ Date \_\_\_\_\_

*Please answer each question as best as you can. Circle the answer that **best** describes the way you feel about math. Use the following scale for all of the questions:*

Circle	DISAGREE	if you <u>strongly</u> disagree with the statement
Circle	Disagree	if you disagree with the statement
Circle	neutral	if you do not have feelings one way or another
Circle	Agree	if you agree with the statement
Circle	AGREE	if you <u>strongly</u> agree with the statement

1. Math is a topic that I enjoy learning.

**DISAGREE                  Disagree                  neutral                  Agree                  AGREE**

2. Mastering math ideas taught this year has been hard for me.

**DISAGREE                  Disagree                  neutral                  Agree                  AGREE**

3. I think, or others tell me, that I am a math-type person.

**DISAGREE                  Disagree                  neutral                  Agree                  AGREE**

4. I **do not** like math and it bothers me to have to study it.

**DISAGREE                  Disagree                  neutral                  Agree                  AGREE**

5. I would like to learn more about math.

**DISAGREE                  Disagree                  neutral                  Agree                  AGREE**

6. I have a hard time understanding the math ideas taught this year.

**DISAGREE                  Disagree                  neutral                  Agree                  AGREE**

7. I would like to have a job someday that involves using lots of math.

**DISAGREE                  Disagree                  neutral                  Agree                  AGREE**

8. Math makes me uncomfortable, irritable, and impatient.

**DISAGREE                  Disagree                  neutral                  Agree                  AGREE**

9. During math lessons, I am usually **not** interested.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

10. I think I am capable of learning math ideas.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

11. Math just **is not** for me.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

12. Learning about math is fun.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

13. I think that math is boring.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

14. I believe that I will do very well on the math tasks this year.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

15. When I hear the word math, I have a feeling of dislike.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

16. I have a good feeling towards math.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

17. Math is a topic that I **do not** enjoy studying.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

18. I think I will know a great deal about math by the end of this year.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

19. I **do not** think of myself as a math-type person.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

20. I feel comfortable with math and like it very much.

**DISAGREE**                      **Disagree**                      **neutral**                      **Agree**                      **AGREE**

## Appendix B: Subject Ranking Survey

### Subject Survey

Please rank the following subjects from 1-8, with one (1) being your most favorite subject and eight (8) being your least favorite subject:

_____	Reading
_____	Writing
_____	Math
_____	Science
_____	Social Studies
_____	Art
_____	P.E.
_____	Music

### Subject Survey

Please rank the following subjects from 1-8, with one (1) being your most favorite subject and eight (8) being your least favorite subject:

_____	Reading
_____	Writing
_____	Math
_____	Science
_____	Social Studies
_____	Art
_____	P.E.
_____	Music

### Subject Survey

Please rank the following subjects from 1-8, with one (1) being your most favorite subject and eight (8) being your least favorite subject:

_____	Reading
_____	Writing
_____	Math
_____	Science
_____	Social Studies
_____	Art
_____	P.E.
_____	Music

### Subject Survey

Please rank the following subjects from 1-8, with one (1) being your most favorite subject and eight (8) being your least favorite subject:

_____	Reading
_____	Writing
_____	Math
_____	Science
_____	Social Studies
_____	Art
_____	P.E.
_____	Music

### Appendix C: Interview Questions

1. Do you think it is important to learn math? Why or why not?
2. What is one thing you do on a regular basis outside of school that requires the use of math?
3. What is one thing you really **like** about math? What is one thing you really **dislike** about math?
4. What do you think is the best way that you learn math?
5. Do you think of yourself as a person who is “good” at math? Why or why not?
6. What is one **positive** experience you have had with learning math in school?  
What is one **negative** experience you have had with learning math in school?
7. Did learning about fractions lead you to pursue more about it on your own? Did you try to find examples of it, wonder about it, or tell others about it?\*

#### Interview Questions in Spanish:

1. ¿Crees que es importante aprender matemáticas? Porque si o porque no?
2. ¿Cuál es una actividad que tu realices fuera de la escuela que requiera el uso de las matemáticas?
3. ¿Cuál es una cosa que realmente te gusta de las matemáticas? Cual es una cosa que realmente te disgusta de las matemáticas?
4. ¿Cuál es la mejor manera en que aprendes matemáticas?
5. ¿Piensas que tú eres una persona que es “buena” en matemáticas? Porque si o porque no?
6. ¿Cuál es una experiencia positive que hayas tenido al aprender matemáticas en la escuela?  
¿Cuál es una experiencia negativa que tu hayas tenido al aprender matemáticas en la escuela?
7. ¿EL haber aprendido fracciones, te impulso a aprender más por tu propia cuenta?  
¿Trataste de encontrar ejemplos de fracciones? ¿Te maravillaste con ellas? ¿Les contaste a otros a cerca de las fracciones?\*

\*Question number 7 was asked on the exit interviews only.

## Appendices D-F: Consent Forms

### Consent Form for Student Participation in Research Interviews

I am conducting a study of experiential education in order to observe and document how hands-on learning affects students' enjoyment and knowledge retention. Mrs. X's class will be the site of the study, and I hope that you will agree to participate, and that your parents/guardians will also consent to your participation.

This study aims to examine how experiential education, a concept utilized by John Dewey in the late 1890's, can impact students in the 21<sup>st</sup> century. This study is intended to be the foundation for further exploration of the important effects that teaching within an experiential education framework can have on students. It will help to look critically at formal curricula in the education system today, and strive to work towards formulating potential curricular changes based on the data collected. As I carry out this study, I am interested in interviewing some of the students about their experiences in math education.

These interviews will be carried out from January through March 2013, and will take place during the school day in the pull-out areas in the halls. These interviews will be conducted between 9:05 and 9:30 AM so they will not interfere with your student's content-area learning, specials (P.E., music, library), recess, or lunch. Additionally these interviews will be conducted with the knowledge of the teacher and school administrators.

Interviews will be tape-recorded, and the interviews will be transcribed and stored on a secured laptop computer. Any hard copies of interviews will be stored in a secure location. No one outside of the Western Oregon University researchers involved in this project will have access to the information in these interviews.

As a student, your participation in these interviews is voluntary. You, and your parents/guardians, will decide if you will do these interviews. If you and your parents/guardians say yes now, and change your minds later, you are under no obligation to continue the interviews. Participation in these interviews will not affect your grade. If you do not participate, that will not affect your grade either. If you do participate, you will not be identified in any research report. Your confidentiality will be protected to the maximum extent allowable by law.

If you would like further information about this research you may contact me, Amy Keithley, at [akeithley08@wou.edu](mailto:akeithley08@wou.edu). If you have any questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact, anonymously if you wish, Dr. Ella Taylor, Western Oregon University Instructional Review Board: (503) 838-9200, email: [irb@wou.edu](mailto:irb@wou.edu), or regular mail: Todd Hall #242, Monmouth Oregon, 97361.

I agree to participate in the interview piece of this research project. I may stop participating in these interviews at any time.

_____	_____	_____
Print name of student here	Signature of student participant	Date

I agree that my student may participate in the interview piece of this research project. I am free to discontinue his/her participation in these interviews at any time.

_____	_____	_____
Print name of parent/guardian here	Signature of parent/guardian	Date

_____	_____	_____
Print name of researcher here	Signature of researcher	Date

### Forma de Consentimiento para la Participación Estudiantil en Entrevistas de Investigación

Estoy realizando un estudio de la experiencia educacional para observar y documentar como el aprendizaje por práctica afecta el complacimento y retención de conocimiento de los estudiantes. La clase de la Sra. X será el sitio del estudio, y yo espero que concuerde en participar, y que sus padres/guardianes también consientan a su participación.

Este estudio propone examinar la educación por experiencia, un concepto utilizado por John Dewey al final de los años 1890's, puede impresionar a estudiantes en el siglo XXI. Este estudio es pensado ser la base para la exploración adicional de los efectos importantes que tiene la enseñanza dentro de la educación por experiencia en estudiantes. Ayudará a mirar críticamente un currículo formal en el sistema educacional de hoy, y hará un esfuerzo de potencialmente formar cambios curriculares basados en los datos colectados. Conforme lleve a cabo este estudio, me interesa entrevistar a algunos estudiantes acerca de sus experiencias en la educación de matemáticas.

Estas entrevistas serán llevadas a cabo desde enero hasta marzo del 2013, y sucederán durante el día escolar en las áreas extensibles de los pasillos. Estas entrevistas serán realizadas entre 9:05 y 9:30 A.M. para no interferir con los estudios regulares de los estudiantes, incluyendo educación física, música, la biblioteca, el recreo, o el almuerzo. Adicionalmente estas entrevistas serán realizadas con el consentimiento del maestro y administradores escolares.

Las entrevistas serán grabadas, y las entrevistas serán transcritas y serán almacenadas en una computadora personal portátil asegurada. Cualquier copia de las entrevistas será almacenada en una ubicación segura. Nadie fuera de la Universidad de Western Oregon involucrados en este proyecto tendrá acceso a la información de estas entrevistas.

Como estudiante, su participación en estas entrevistas es voluntaria. Usted, y sus padres/guardianes, decidirán si participará en estas entrevistas. Si usted y sus padres/guardianes aceptan ahora, y cambian de opinión más tarde, no tiene ninguna obligación de continuar las entrevistas. La participación en estas entrevistas no afectará su calificación. Si participa, usted no será identificado en cualquier informe de investigación. Su confidencialidad será protegida a la extensión máxima admisible por la ley.

Si quiere información adicional sobre esta investigación usted me puede contactar, Amy Keithley, en akeithley08@wou.edu. Si tiene cualquier pregunta o preocupaciones con respecto a sus derechos como un participante de estudio, o no es satisfecho en cualquier momento con cualquier aspecto de este estudio, puede contactar, anónimamente si desea, a la Dra. Ella Taylor, la Universidad de Western Oregon Tabla Instruccional de Revisión: (503) 838-9200, correo electrónico: irb@wou.edu, o correo regular: El Vestíbulo de Todd #242, Monmouth Oregon, 97361.

Concuerdo en tomar parte en la pieza de entrevista de este proyecto de investigación. Puedo detener mi participación en estas entrevistas a cualquier tiempo.

Imprima nombre de estudiante	La firma de estudiante	Fecha
------------------------------	------------------------	-------

Concuerdo que mi estudiante puede tomar parte en la pieza de entrevista de este proyecto de investigación. Puedo discontinuar su participación en estas entrevistas a cualquier tiempo.

Imprima nombre de padre o guardián	La firma de padre o guardián	Fecha
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Imprima nombre de investigadora	La firma de investigadora	Fecha
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## *Learning about Math!*

What is the project?

- To help Ms. Keithley make learning math fun and to have students talk about why they *do* or *do not* like math, how they use math outside of school, and how they learn best.

What do I have to do?

- Do a recorded interview, or talk about, math to Ms. Keithley two (2) different times—once in January and once in February!

What will happen to my interviews?

- They will be stored in a safe place, and Ms. Keithley will transcribe, or write out, the interview answers. Your answers may be used in the project, but under a different name so it keeps you safe!

Will I get anything if I participate?

- Nope!

What if I change my mind?

- It is okay to change your mind at any time! If you change your mind I will erase/delete everything to do with your interview.

Ready?

You can start the interview if:

- (1) You understand what the survey is
- (2) **YOU** decide you want to participate
- (3) You know that you don't have to
- (4) You know that we are here to help if you have any questions!

*I agree to be interviewed. I may stop participating in these interviews at any time.*

\_\_\_\_\_

Print name of student here

\_\_\_\_\_

Signature of student here

\_\_\_\_\_

Date

\_\_\_\_\_

Print name of researcher here

\_\_\_\_\_

Signature of researcher here

\_\_\_\_\_

Date



## Appendices G-H: Tests of conceptual understanding

### Fractions Pre-Assessment

Name **KEY**

Date \_\_\_\_\_

(1) Choose the correct vocabulary from the words provided, and write it in the appropriate box.

<u>1</u>	←		Denominator	Minuend
3	←		Decimator	Numerator

1 is the numerator; 3 is the denominator

(2) Match the written fraction to the appropriate fraction in numbers.



Three fifths



1/2

One half

4/9

Two thirds

3/5

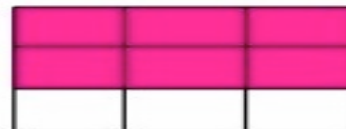
Four ninths

7/8

Seven eighths

2/3

(3) Label the shaded portion of the fraction in numbers and words.

Words: **six ninths**Numbers: **6/9**

(4) List **three** ways that we use fractions in every day life: **Answers may vary**

- 
- 
-

(5) Solve the following problems. Please write your answer clearly and in the simplest form.

$\frac{3}{7} + \frac{1}{7} = \frac{4}{7}$	$\frac{3}{8} + \frac{2}{5} = \frac{31}{40}$
$\frac{4}{9} + \frac{7}{9} = \frac{11}{9} = 1\frac{2}{9}$	$\frac{6}{11} - \frac{2}{11} = \frac{4}{11}$
$\frac{5}{12} - \frac{1}{6} = \frac{1}{3}$	$4\frac{1}{3} - 2\frac{1}{3} = 2$
$\frac{2}{5} \times \frac{3}{5} = \frac{6}{25}$	$\frac{4}{7} \times \frac{1}{3} = \frac{4}{21}$
$\frac{1}{3} \div \frac{2}{3} = \frac{1}{2}$	$\frac{1}{3} \div \frac{5}{7} = \frac{7}{15}$

## Fractions Post-Assessment

Name **KEY**

Date \_\_\_\_\_

(1) Choose the correct vocabulary from the words provided, and write it in the appropriate box.

<u>2</u>	←		Denominator	Minuend
7	←		Decimator	Numerator

2 is the numerator; 7 is the denominator

(2) Match the written fractions to the appropriate fraction in numbers.

One sixth                      2/3

Four fifths                    1/2

One half                        4/5

Two thirds                      1/6

(3) Please circle the correct answer.

What type of fraction is  $\frac{13}{7}$ ?

a. Mixed number

**b. Improper fraction**

c. Proper fraction

(4) List **four** ways we use fractions in our every day life:

- **Answers may vary**
- 
- 
-

(5) Solve the following problems. Please write your answer clearly and in the simplest form.

$\frac{1}{6} + \frac{4}{6} = \frac{5}{6}$	$\frac{2}{5} + \frac{1}{3} = \frac{11}{15}$
$1\frac{1}{3} + 1\frac{1}{2} = \frac{17}{6} = 2\frac{5}{6}$	$\frac{7}{10} - \frac{4}{10} = \frac{3}{10}$
$\frac{3}{8} - \frac{1}{3} = \frac{1}{24}$	$2\frac{1}{3} - 1\frac{1}{4} = \frac{13}{12} = 1\frac{1}{12}$
$\frac{3}{7} \times \frac{6}{7} = \frac{18}{49}$	$\frac{3}{10} \times \frac{3}{4} = \frac{9}{40}$
$\frac{1}{3} \div \frac{2}{3} = \frac{1}{2}$	$\frac{1}{3} \div \frac{5}{7} = \frac{7}{15}$

## Appendix I: Lesson Plans

### Lesson Plan 1 out of 11

#### GOALS

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.

#### OBJECTIVES

- **Content Objective:**
  - After creating an anchor chart, students will be able to (SWBAT) identify the relationship between parts of a whole by labeling their Fraction Name Art with 100% accuracy.
- **Learning Strategy:**
  - Mathematical/Logical: Students will be using the mathematical/logical spheres of their brains to work through the given problems on the pre-assessment.
  - Visual: Students will be using visual cues from the class-created anchor chart.
  - Musical: Students will be singing chants to help them remember parts of fractions.
  - Total Physical Response (TPR): Students will be doing guided actions while performing the chants.

#### MATERIALS

- Pre-Assessment (see Pre-Assessment section)
- Student-friendly standards
- Anchor Chart (“*Official Parts of a Fraction*,” see Appendix A)
- My Name in Fractions (see Appendix B)
- My Favorite Animal in Fractions (see Appendix C)
- Colored pencils, markers, or crayons

#### PROCEDURE

##### Anticipatory Set

The lesson will begin with the implementation of the pre-assessment piece. The students will be given 45 minutes to complete the pre-assessment, with the option to read silently if they finish before the allotted time period. Using the pre-assessment will allow students to get into the mindset of fractions before the first mini-lesson.

After the allotted testing time, the students will gather around the rug and have the work sample explained to them. Students will gain a better understanding as to how the fractions unit will be broken down to help gain excitement/moral, as well as have their affective filter lowered.

### **Teaching (and modeling)**

The students will return to their desks. The teacher will point to/write out the relevant content standard in student-friendly language to help students better understand the purpose of what they are learning (“I can add (+) and subtract (-) fractions with like and unlike denominators”). It is especially helpful if students are part of this process.

Next, the students will look at an anchor chart about the official parts of a fraction (see Appendix A). Only the fraction will be written, and the teacher will lead a question and answer session to fill out the official vocabulary associated with fractions.

### **Guided Practice/Group Application**

Students will stand up and be led in a chant to help them remember the names of the different parts of the fractions:

Numerator over denominator  
 Parts of a whole  
 These are the fractions  
 That I know!

*Gestures: Numerator (reach high in the sky) over (flat line with both hands) denominator (reach low to the ground), Parts (hands miming parts) of a whole (“draw” a full circle with both hands), These are the fractions (dancing in any fashion) that I know (point to head).*

Students will then return to their desks to create Fraction Art. The teacher will begin by doing a modeled/group example of “My Name in Fractions” (see Appendix B) with their name. Their name needs to be written in the middle of the page in large dark letters. Next, the class will count the total number of letters to fill in the blank first line under their name (i.e., the denominator). From there, students will have a brief review of the differences between consonants and vowels. It is important to note that the teacher will have to clarify what to do with the letter “Y” as it can be seen as a vowel and a consonant. Then the students will figure out how many of the letters are consonants and how many are vowels, writing the numbers as fractions (i.e., number of consonants over total number of letters and number of vowels over total number of letters).

EX: “KEITHLEY” My name has 8 letters.  $\frac{4}{8}$  are consonants and  $\frac{4}{8}$  are vowels!

### **Independent Practice/Application**

Working individually, students will complete their own “My name in Fractions” art piece. This activity is important to help students understand the relationship between parts to a whole.

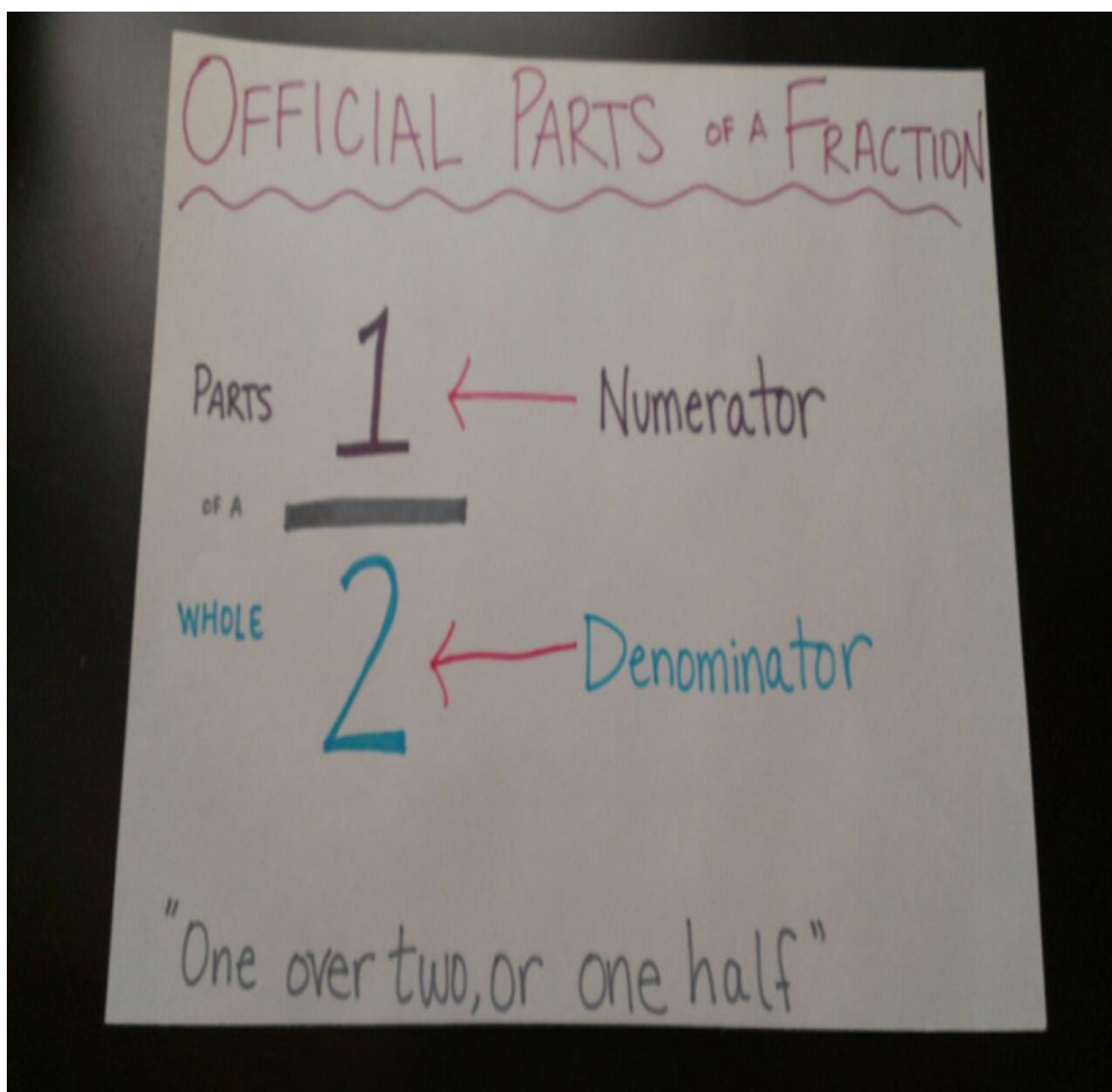
### **Closure/Expansion**

If students are diligently working and complete the task before the time is up, they may be given the “My Favorite Animal in Fractions” (see Appendix B) sheet to work on. Students will be given the opportunity to share their artwork with the class, explaining how they figured out their fractions (i.e., how did they know what the denominator was, which letters were vowels, etc).

### **DIFFERENTIATION**

Since a majority of this lesson is taken up by the pre-assessment, the differentiation is mainly seen with the additional worksheet (“*My Favorite Animal in Fractions*”) for those students who complete the assignment before it is time to move to the next subject.

## Appendix A





## Appendix B

# My Name in Fractions...

My name has \_\_\_\_\_ letters!

\_\_\_\_\_ are consonants and \_\_\_\_\_ are  
vowels!

## Appendix C

# My Favorite Animal in Fractions...

My name has \_\_\_\_\_ letters!

\_\_\_\_\_ are consonants and \_\_\_\_\_ are  
vowels!

## Lesson Plan 2 out of 11

### **GOALS**

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.

### **OBJECTIVES**

- **Content Objective:**
  - After whole class instruction, SBWAT demonstrate addition and subtraction of fractions with like and unlike denominators with 75% accuracy on the given exit ticket.
- **Learning Strategy:**
  - Logical-Mathematical: Students will be using logic to help solve mathematical processes in fractions.
  - Musical/Chants: Students will be singing/chanting the given chants.
  - Total Physical Response: Students will be doing gestures to accompany the mathematical chants.

### **MATERIALS**

- *Marvelous Math: A book of poems* by Lee Bennett Hopkins
- Computer, access to internet
- Math notebooks and pencils (one per student)
- White board, marker, and eraser
- Document camera and projector
- Chart paper and colorful markers
- Exit ticket (see Appendix A)

### **PROCEDURE**

#### **Anticipatory Set**

The teacher will begin by reading the poem “Marvelous Math” from the poem collection *Marvelous Math: A book of poems* to get students thinking about the real world application of math.

#### **Teaching (and modeling)**

Students will get out their math notebooks and open to their note taking section. The teacher will lead note taking on how to add and subtract fractions with *like* denominators (see below):

### Adding & Subtracting LIKE fractions

\*Must have the same denominators

1. Add or subtract the numerators
2. Denominators stay the same!

“Top plus the top and the bottom stays the same” and “Top minus top and the bottom stays the same”

Examples:  $\frac{1}{4} + \frac{2}{4} = \frac{3}{4}$        $\frac{7}{10} - \frac{4}{10} = \frac{3}{10}$

As the students are finishing copying the notes, the teacher will copy the same information onto chart paper to make an anchor chart to hang in the room.

Students will then learn chants from the teacher to help them remember how to add or subtract fractions with *like* denominators:

When you add fractions with like denominators,  
Top plus the top and the bottom stays the same.

*Gestures: When you add (hands in a plus sign) fractions with like (both fists up together) denominators, top (right hand palm away from the body) plus the (hands in a plus sign) top (left hand palm away from the body) and the bottom stays the same (hands creating a flat line)*

When you subtract fractions with like denominators,  
Top minus top and the bottom stays the same.

*Gestures: When you subtract (right hand in a minus sign) fractions with like (both fists up together) denominators, top (right hand palm away from the body) minus (right hand in a minus sign) top (left hand palm away from the body) and the bottom stays the same (hands creating a flat line)*

From there, the teacher will lead note taking on how to add and subtract fractions with *unlike* denominators using the Least Common Denominator (LCD) with the process and example problems (see below):

## Adding & Subtracting UNLIKE fractions

\*Only use when the denominators are NOT the same!

1. Find the least common multiple (LCM) of both fractions' denominators
2. Multiply the numerator and denominator of both fractions by the number to create equal fractions (both with LCM as denominator)
3. Add/Subtract the now LIKE fractions!

$$\frac{1}{4} + \frac{2}{3} = ?? \quad 4 = 4, 8, 12, 16, 20, 24, 28 \quad 3 = 3, 6, 9, 12, 15, 18$$

$$4 \times ? = 12 \rightarrow 4 \times 3 = 12 \rightarrow \frac{1}{4} \times \frac{3}{3} = \frac{3}{12} \quad 3 \times ? = 20 \rightarrow 3 \times 4 = 20 \rightarrow \frac{2}{3} \times \frac{4}{4} = \frac{8}{12}$$

$$\frac{3}{12} + \frac{8}{12} = \frac{11}{12}$$

Again, while the students are finishing copying the information into their own notes, the teacher will copy the same information onto the bottom of the aforementioned anchor chart. In an effort to solidify the complex LCD strategy, the teacher will show an educational video on fractions

([http://teachertube.com/viewVideo.php?video\\_id=267745](http://teachertube.com/viewVideo.php?video_id=267745)).

### **Guided Practice/Group Application**

Once the video has concluded, the teacher will write various problems (addition and subtraction of fractions with like and unlike denominators) one at a time on a white board projected for the students to see. The teacher will work through the problem with explicit instruction on the mathematical processes given by various student volunteers.

### **Independent Practice/Application**

Once the students begin to get comfortable with completing the problems as a whole class, the teacher will switch to independent practice. On the same whiteboard, the teacher will display a problem for the students to solve individually. Students are expected to show their work in the work section of their math notebooks. The teacher will solicit information from students about their answers, and how they came to their answers, after an allotted time for working has passed.

### **Closure/Expansion**

Students will be given an exit ticket to assess their knowledge of adding and subtracting fractions with like and unlike denominators.

### **DIFFERENTIATION**

Over the course of the lesson, students are learning through a variety of multiple intelligences, instead of just focusing on traditional mathematics. In addition, during the Independent Practice section of the lesson students are permitted to work at their own pace.

## Appendix A

Name \_\_\_\_\_

$\frac{3}{7} + \frac{1}{7}$	$\frac{3}{8} + \frac{2}{5}$
$\frac{6}{11} - \frac{2}{11}$	$\frac{5}{12} - \frac{1}{6}$

Name \_\_\_\_\_

$\frac{3}{7} + \frac{1}{7}$	$\frac{3}{8} + \frac{2}{5}$
$\frac{6}{11} - \frac{2}{11}$	$\frac{5}{12} - \frac{1}{6}$

## Lesson Plan 3 out of 11

### **GOALS**

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.
  - Understand, learn, and use new vocabulary that is introduced and taught directly through informational text, literary text, and instruction across the subject areas (Oregon State Standards EL.05.RE.09).

### **OBJECTIVES**

- **Content Objective:**
  - During the independent work station, SWBAT complete the Fraction Avenue worksheet with a minimum of 6 out of 7 correct fraction map additions.
- **Literacy Objective:**
  - After the lesson, SWBAT identify the numerator and denominator of a fraction on the given exit ticket.
- **Learning Strategy:**
  - Workshop model
    - Incorporates independent, small group, and teacher-led activities
    - Allows students to experience a variety of intensive workshop activities to help facilitate learning target skills

### **MATERIALS**

- *Marvelous Math: A book of poems* by Lee Bennett Hopkins
- Document camera/Projector
- White board and marker
- Rotation schedule posted, preferably on chart paper (see Appendix A)
- Workshop station materials (see Group Practice/Independent Practice section)
- Exit ticket (see Appendix E)

### **PROCEDURE**

#### **Anticipatory Set**

The teacher will begin by reading the poem “Take a Number” from the poem collection *Marvelous Math: A book of poems* to get students thinking about the real world application of math.



### **Teaching (and modeling)**

Using a white board on projection for the students to see, the teacher will briefly revisit the topic of adding and subtraction fractions with unlike denominators using the Least Common Denominator (LCD) model learned in Lesson 2.

After this, the teacher will explain the various workshop rotations (see below) and the expectations from the students in regards to the quality of their work and behavior in the classroom. The class will be formatted in the following rotations (see Appendix A):

<i>Rotation</i>	<i>Group Work 1</i>	<i>Group Work 2</i> <i>[Smart Board]</i>	<i>Computers</i>	<i>Independent Practice</i>	<i>Games</i>
Rotation 1 10:10-10:23	Red*	Orange	Green	Blue	Purple
Rotation 2 10:23-10:36	Orange	Purple	Red	Green	Blue
Rotation 3 10:36-10:49	Purple	Blue	Orange	Red	Green
Rotation 4 10:49-11:02	Blue	Green	Purple	Orange	Red
Rotation 5 11:02-11:15	Green	Red	Blue	Purple	Orange

*\*Colors denote differentiated math workshop groups*

### **Guided Practice AND Independent Practice:**

Workshop [5 rotations back-to-back]:

1. Group Work 1
  - a. Teacher-led
  - b. Small-group intensive practice adding and subtracting fractions with like and unlike denominators
    - i. Materials: white boards and markers for students in each group
2. Group Work 2
  - a. Co-Teacher, Student teacher, or IA led
  - b. Small-group intensive practice with understanding fraction equivalence
    - i. Materials: Math-Whizz Worksheet (see Appendix B), pencils, one set of plastic fraction bar pieces, white boards and markers for all students
3. Computers
  - a. Independent, student-facilitated
  - b. Educational software (Math-Whizz): Grade 5, Numbers and Operations-Fractions
    - i. Materials: computers, Math-Whizz software, Math-Whizz directions (see Appendix C)
4. Independent Work
  - a. Independent, student-facilitated
  - b. Independent work on given worksheet

- i. Materials: pencils, Fraction Avenue worksheet (see Appendix D)
- 5. Math Games
  - a. Partners/small-groups, student facilitated
  - b. Students play Fraction War game
    - i. Materials: Fraction cards (e.g., Investigations<sup>®</sup> curriculum)

### **Closure/Expansion**

At the closure of the last workshop rotation, students will clean up their stations and return to their seats. The whole class will engage in a brief conversation about what they learned from the various stations. Before the students move onto the next lesson, they will complete the given exit ticket (see Appendix E).

### **DIFFERENTIATION**

The workshop model has built-in differentiation due to its inherent nature. The math groups (i.e., red, orange, green, blue, and purple) are separated by differing levels of mathematical abilities; red is students with the lower skills and purple is students with the higher skills. This allows the teacher to target specific skills with groups at the appropriate and necessary pace to ensure learning.

## Appendix A

A hand-drawn rotation chart on a piece of paper, divided into five columns and five rows. Each cell contains a colored circle. The first column has a checkmark in a circle next to the colored circle. The columns are labeled as follows:

GROUP WORK (FRONT TABLE)	COMPUTERS (COMPUTERS)	INDEPEND. PRACTICE (RED TABLE)	GAMES (GREEN/YELLOW TABLE)	SMART BOARD (GREEN CARPET)
✓ (Red)	Green	Blue	Blue	Orange
✓ (Orange)	Red	Green	Blue	Blue
✓ (Blue)	Orange	Red	Green	Blue
✓ (Blue)	Blue	Orange	Red	Green
○ (Green)	Blue	Blue	Orange	Red

Math workshop rotation chart

## Appendix B



Math-Whizz  
Teachers' Resource

Friday, 25 January, 2013, 2:04 pm

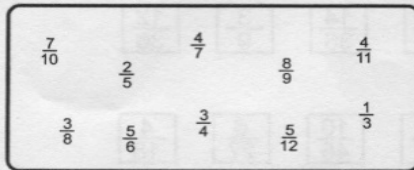
Name: \_\_\_\_\_ Class: \_\_\_\_\_

**Extend understanding of fraction equivalence and ordering. - Grade 4** answers :

Draw a CIRCLE around all the fractions that are GREATER than a half.

Draw a SQUARE around all the fractions that are LESS than a half.

Q1



Write < or > to show if the left fraction is greater than or less than the one on the right.

Q2

$$\frac{7}{10} \square \frac{3}{8}$$

Q3

$$\frac{5}{12} \square \frac{5}{6}$$

Q4

$$\frac{2}{5} \square \frac{4}{7}$$

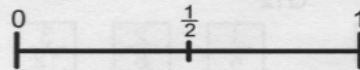
Q5

$$\frac{8}{9} \square \frac{4}{11}$$

Mark and label on the number line roughly where these fractions lie.

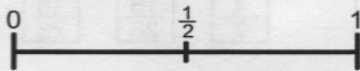
Q6

$$\frac{1}{3} \text{ and } \frac{3}{4}$$



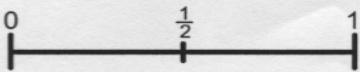
Q7

$$\frac{5}{12} \text{ and } \frac{5}{6}$$



Q8

$$\frac{3}{8} \text{ and } \frac{7}{10}$$



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## Appendix C

(T) DAY 3

**Computer Group  
Math Whizz**

**Directions: Go to grade 5, Numbers and Operations - Fractions.**

1. Choose Add and Subtract Fractions. Complete activities #1, 2, 3, 4, 5

If you don't get a 100%, please redo the activity.


**Computer Group  
Math Whizz**

**Directions: Go to grade 5, Numbers and Operations - Fractions.**


1. Choose Add and Subtract Fractions. Complete activities #1, 2, 3, 4, 5

If you don't get a 100%, please redo the activity.

## Appendix D




## Fraction Avenue



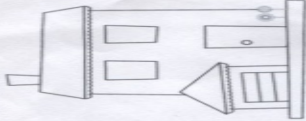
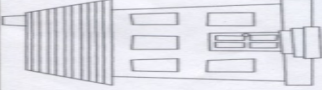
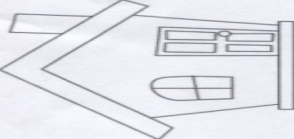
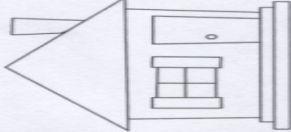
**Congratulations!** You have just moved to Fraction Avenue, which is a street full of fractions. Use the following information to complete the map of your new street.


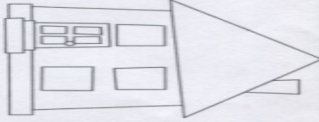
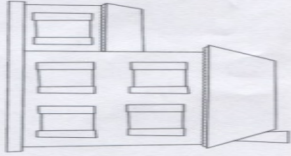
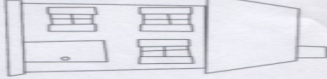
- $\frac{1}{8}$  of the houses are for sale
- There are trees in the front yard of  $\frac{1}{2}$  of the houses
- $\frac{2}{8}$  of the homes have dogs outside.
- You can see a person in  $\frac{1}{4}$  of the windows
- $\frac{3}{8}$  of the homes have a red door
- There are cars parked outside of  $\frac{3}{4}$  of the houses
- $\frac{1}{8}$  of the houses have a blue roof



**Bonus**

Write your own fraction problems on the back and add those details to your neighborhood too!

## Appendix E

Name \_\_\_\_\_

Date \_\_\_\_\_

(1) Choose the correct vocabulary from the words provided, and write it in the appropriate box.

<u>1</u>	←	<input type="text"/>	Denominator	Minuend
3	←	<input type="text"/>	Decimator	Numerator

Name \_\_\_\_\_

Date \_\_\_\_\_

(1) Choose the correct vocabulary from the words provided, and write it in the appropriate box.

<u>1</u>	←	<input type="text"/>	Denominator	Minuend
3	←	<input type="text"/>	Decimator	Numerator

Name \_\_\_\_\_

Date \_\_\_\_\_

(1) Choose the correct vocabulary from the words provided, and write it in the appropriate box.

<u>1</u>	←	<input type="text"/>	Denominator	Minuend
3	←	<input type="text"/>	Decimator	Numerator

Lesson Plan 4 out of 11**GOALS**

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.

**OBJECTIVES**

- **Content Objective:**
  - After the lesson, SWBAT demonstrate comprehension of parts to a whole relationship by creating a piece of fraction art and labeling it with 100% accuracy.
- **Learning Strategy:**
  - Think-Pair-Share: Students will be engaged in TPS activities during the anticipatory set of the lesson.
  - Technology: Students will be learning about fractions via the use of integrated technologies.

**MATERIALS**

- Document camera/Projector
- SMART Board technologies
- SMART Board presentation (see Appendix A)
- White cardstock, backing for fraction art
- Glue sticks
- $\frac{1}{4}$  Fraction pieces (see Appendix C), printed on a variety of colored cardstock

**PROCEDURE****Anticipatory Set**

The teacher will build interest and engagement by going through the first eight slides of the SMART Board presentation (see Appendix A).

**Discussion with the SMART Board presentation:**

- Slide 1
  - Introduce the topic of fractions in art.
- Slide 2
  - Before the second slide, the teacher will pose the question, “What is an artist?” and allow 45 seconds for students to conduct a Think-Pair-Share activity with an elbow partner(s). After this, students will engage in a



whole class discussion of their predictions/prior knowledge, before proceeding.

- Slide 3
  - Have a class discussion about the wide variety of artists/occupations that are artistic.

### **Teaching (and modeling)**

The teacher should continue with the SMART Board presentation as the means for delving into the connection between art and math.

- Slide 4
  - Introduce the concept that art is global. Have students guess/infer which country each of the pictures in the slide is from, and explain why/how they knew.
    - From left to right (clockwise): Japan, South Africa, Mexico, Russia, New Zealand
- Slide 5
  - Briefly read the text to the students on this slide.
- Slide 6
  - Discuss how art principles are highly connected to mathematics.
    - Repetition, shapes, patterns, etc
- Slide 7
  - Discuss how artistic occupations, such as architects, rely heavily on mathematics for structural purposes and aesthetic purposes.
    - Golden ratio, repetition, structure/foundations
    - Discuss a variety of global architecture (pictures from Greece, Spain, and Italy)
- Slide 8
  - Discuss artwork that is based entirely on fractions of art.
    - Abstract expressionism

### **Guided Practice/Group Application**

After Slide 8, the teacher should pause the presentation. The teacher will then have a brief question and answer session with the whole class to review the relationships of parts to a whole (i.e., Fraction Name Art). The whole class will also review the chant for adding fractions with like denominators (see Lesson 2).

Next, the teacher will explain to the students that they will be creating their own fraction artwork, using like fractional pieces with like denominators. Students will be shown what the finished fraction art may look like (see Appendix B), asking for student input on how the fraction pieces within the art represent the relationship of parts to the whole (i.e., fractions of colors within the artwork, similar to abstract expressionism). The teacher will then resume the last two slides of the SMART Board presentation, modeling the expectations with the students' input. It is important at this point for the teacher to

inform the students that they may create any design they choose, as long as they only use the  $\frac{1}{4}$  fraction pieces provided (see Appendix C).

### **Independent Practice/Application**

Students will work on creating their own fraction art with the remainder of the lesson time. The project is completed when a student glues the given  $\frac{1}{4}$  fraction pieces into the desired pattern on a piece of white cardstock. Once this has been completed, the student must write the fractional value of each color used (i.e.,  $\frac{1}{20}$  of the pieces are blue). Finally, students must ensure their math is correct by adding all of the numerators, since the fractions have like denominators, to ensure that their parts equal their whole.

### **Closure/Expansion**

For the last five minutes of the lesson, allow students to clean up their desks and discuss their art within their table groups. A possible extension would include allowing students to create multiple pieces of artwork.

### **DIFFERENTIATION**

The differentiation in this lesson mainly lies in the Independent Practice section. Students are allowed the freedom to create their own patterns, as simple or complex as they prefer. In addition, if students create a complex pattern and still have time left over, they may create multiple pieces of artwork. This lesson also incorporates art into mathematics, which may be useful for students who struggle with Gardner's "Logical/Mathematical" intelligence.

# Appendix A

We see fractions in...

# ART



# ARTIST

Definition:  
A person who practices any of the various creative arts.

Sculptors      Painters  
Photographers      Clothing designers  
Architects      Pastry chef      Animated film creators  
Flower arrangers      Stained glass window makers

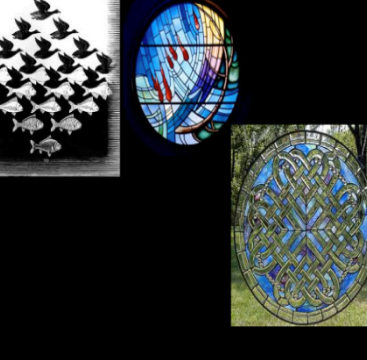
## Types of artists...

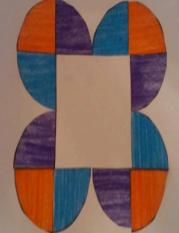
Makeup artists      Origami folders      Comic book authors  
Landscape architects      Video game designers  
Jewelry makers      YouTube video makers      Poet

Art around the world...




Okay Ms. Keithley...  
I get that art is everywhere. But  
how is it related to math?



(1) How many pieces do I have in TOTAL?  
(2) How many of each color do I have?



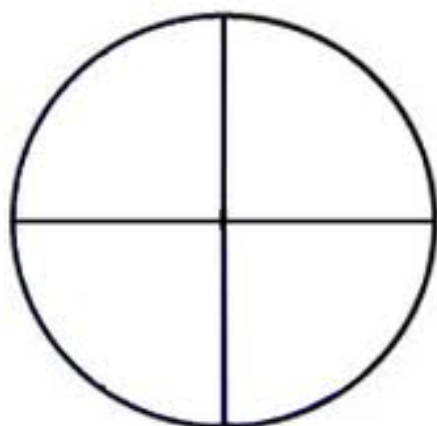
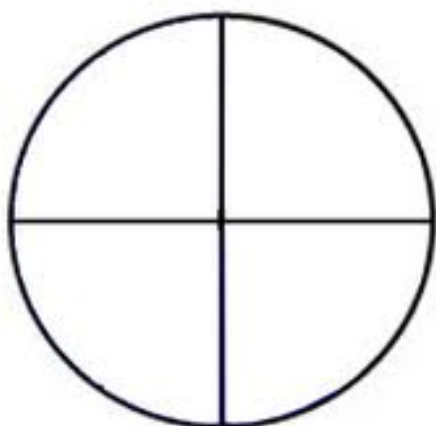
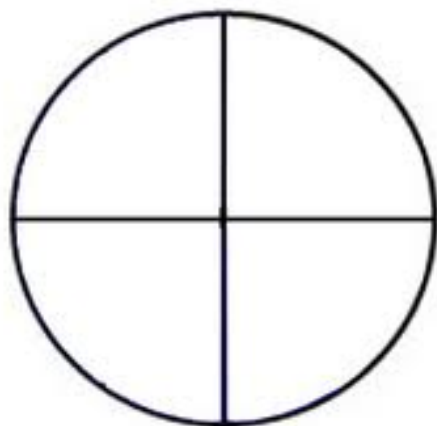
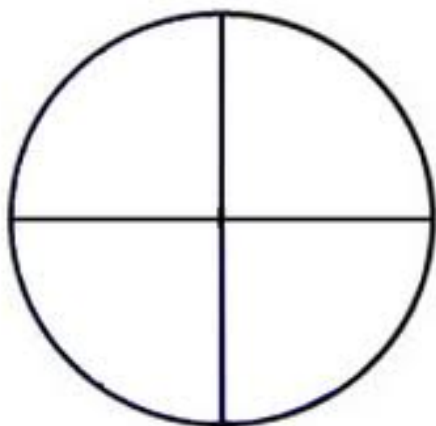
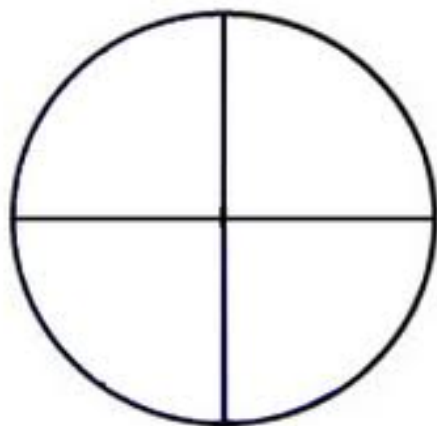
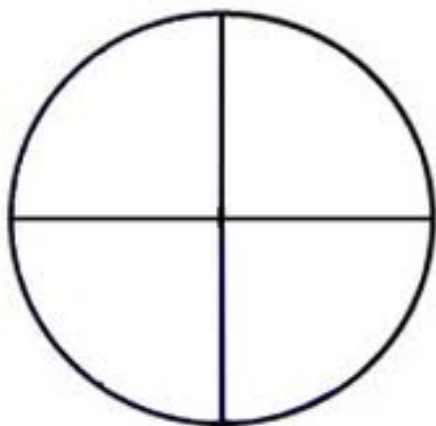
(1) How many pieces do I have in TOTAL?  
(2) How many of each color do I have?

## Appendix B



Variety of examples of fraction art using fractional pieces with like denominators (i.e., all  $\frac{1}{4}$  pieces).

## Appendix C



## Lesson Plan 5 out of 11

### **GOALS**

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.

### **OBJECTIVES**

- **Content Objective:**
  - After explicit instruction, SWBAT apply the butterfly method to find the total fractional value of the Fraction Bird Art with 100% accuracy.
- **Learning Strategy:**
  - Chants: Students will be learning and using chants to help them remember specific mathematical processes for solving fraction problems.
  - Total Physical Response: Students will be incorporating gestures into the chants to help them fully remember the steps of the chants.
  - Visual: Several visual aids are provided for students, which is especially helpful to visual learners and as scaffolding for English Language Learners.
  - Interdisciplinary Content: Students have the opportunity to incorporate art and creativity into their math art projects.

### **MATERIALS**

- *Marvelous Math: A book of poems* by Lee Bennett Hopkins
- *The Art Teacher's Survival Guide* by Helen D. Hume
- Document camera/Projector
- White board and marker
- Art supplies: Watercolor paints and paintbrushes, plastic color trays, cups with water, paper towels, crayons, salt, baking sheets, glue sticks, white cardstock, fractional pieces (see Appendix B), computer paper, and pencils
- Anchor Chart (see Appendix C)
- Finished artwork (see Appendix D), to serve as a model

### **PROCEDURE**

#### **Anticipatory Set**

The teacher will begin by reading the poems “Fractions” and “Nature Knows Its Math” from the poem collection *Marvelous Math: A book of poems* to get students thinking about the real world application of math. In addition, the teacher will also show students

specific text features of *The Art Teacher's Survival Guide* by Helen Hume to tie into their current studies of non-fiction texts.

Next, the teacher will lead a brief discussion of the art project completed in Lesson 4, and review the chants for adding/subtracting fractions with like denominators (see Lesson 2).

### **Teaching (and modeling)**

The teacher will use the document camera and projector to show students the explicit teaching process for adding and subtracting fractions with unlike denominators on a white board using the butterfly method (see Appendix A). Once the students have been exposed to several practice examples and are familiar with the concept, the teacher will teach a chant to the students to remember the process of the butterfly:

When you have fractions where the bottoms AREN'T the same,  
 First you draw the wings,  
 Then you multiple them out,  
 Add/Subtract the tops,  
 Times the bottoms, then you shout:  
 "Do the butterfly! Do the butterfly!"

*Gestures: When you have fractions where the bottom's aren't (shake head, make a swift "x" motion with both arms) the same, First you draw the wings (use pointer fingers of both hands to draw imagination wings), then you multiple them out (use pointer fingers to show the motion of multiply the numbers inside the wings), add/subtract the tops (both pointer fingers gesturing up to the top), times the bottoms (both pointer fingers gesturing to the bottom), then you shout: "Do the butterfly! Do the butterfly!" (Students flap their arms like butterfly wings).*

It is important for the teacher to update the anchor chart that the students originally completed during Lesson 2 to show the butterfly method (see Appendix A).

### **Guided Practice/Group Application**

The teacher will model practice problems, one at a time, on the white board projected to the students, and as a whole class, the students will work through the process of using the butterfly method to solve them. Students will then transfer to an area where they can begin their next, and final, piece of artwork.

The teacher will model the procedure for creating the artwork:

1. Model the different techniques for creating the background:
  - a. Watercolor use: dip the brush into the cup of water before apply it to the watercolor paint, gently brush the bristles to the cardstock; more water will lesson the color; colors can be mixed on the plastic color trays; brushes must be cleaned between color changes
  - b. Background techniques:

- i. Draw on the cardstock with crayon in a specific design before overlaying with watercolor; the crayon will show through any color
  - ii. Use watercolors to paint the background—while still wet, place cardstock in a baking sheet and lightly sprinkle with salt. Once the page has dried, gently brush off the salt to reveal texture.
2. Using chart paper/poster board, create an anchor chart with the needed fraction pieces. After writing and drawing the needed pieces, model a finished piece of artwork (see Appendix D). With guidance from the students, model how to find the fractional value of the Bird Art (i.e., beaks/feet are worth  $\frac{1}{8}$ , snow mounds are worth  $\frac{2}{4}$ , etc). Work through the problem explicitly using/modeling the butterfly method with the class on the same anchor chart (see Appendix C).

### **Independent Practice/Application**

Allow students the time to design/draw/paint the background onto the cardstock. Next, have the students follow the same process as modeled whole group to find the appropriate pieces to create the Fraction Bird Art—gluing them together as seen in the modeled example by the teacher. The “bird” will then be glued on the background.

### **Closure/Expansion**

The lesson will come to closure when students, using given computer copy paper, write down the explicit process of finding the total fractional value of the Fraction Bird Art. This piece will be glued onto the Fraction Bird Art before being laminated to ensure all of the pieces remain together.

### **DIFFERENTIATION**

Students were allowed to go with any form of creativity that they felt was appropriate, from designing their own background to adding additional fractional pieces if they so desired to. In addition, there was a second animal to work through to find the total fractional value of in case students worked quickly and finished their projects early (see *Picture Pie 2* by Ed Emberley for additional fractional animal art ideas).

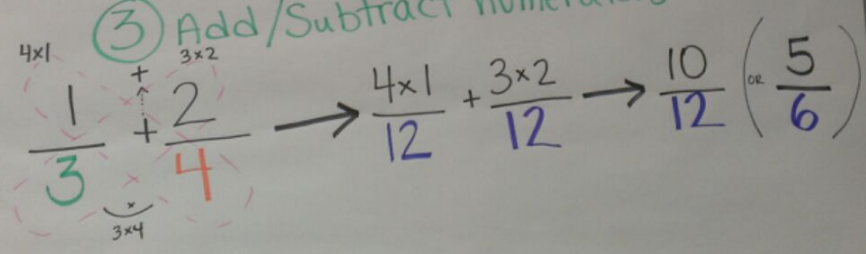


## Appendix A

ADDING & SUBTRACTING UNLIKE FRACTIONS:

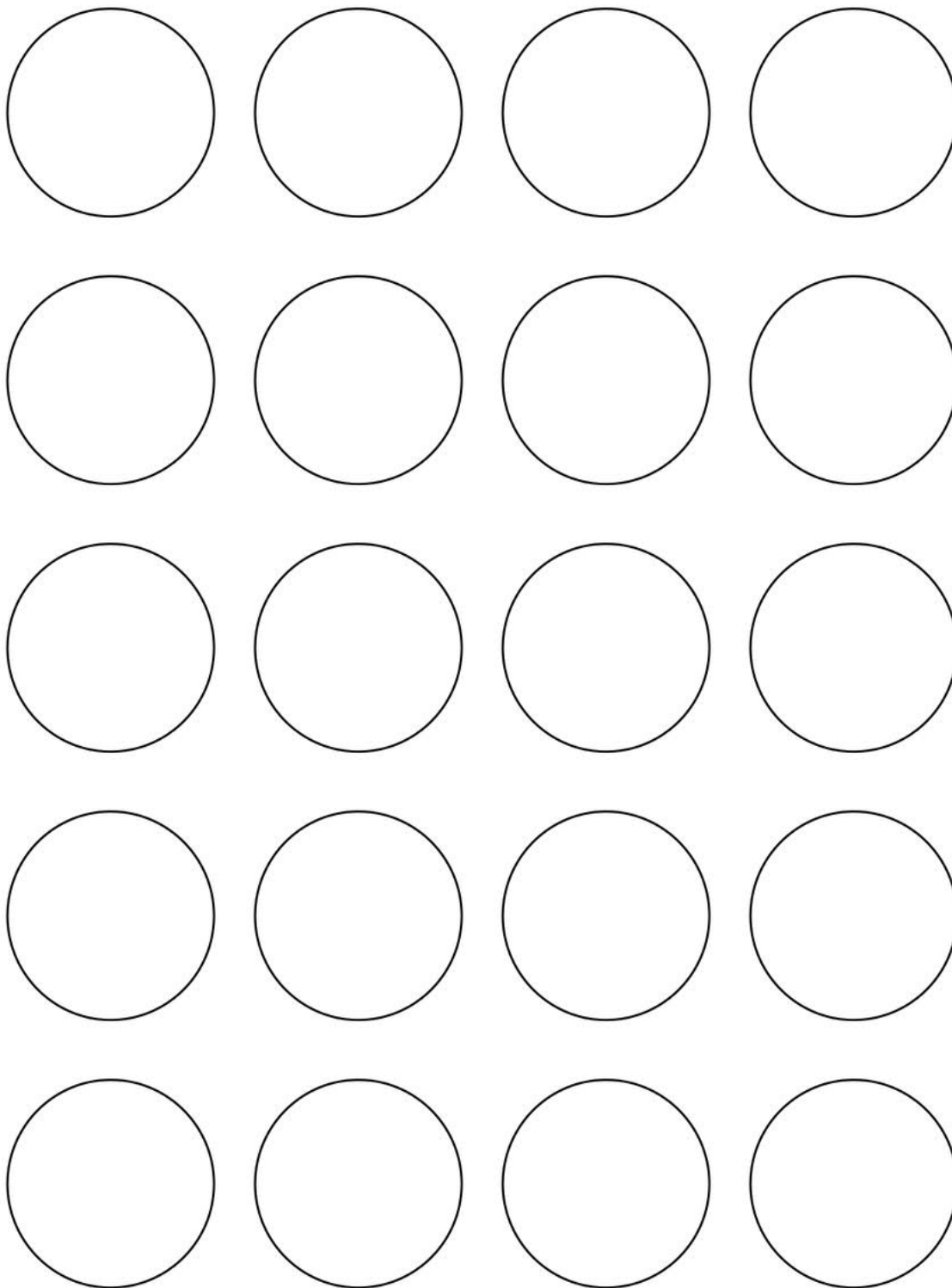
\*Only do this when you have different denominators

- ① DRAW A "BUTTERFLY" → "CRISS-CROSS"
- ② MULTIPLY the "wings" & the denominators
- ③ Add/Subtract numerators


$$\frac{1}{3} + \frac{2}{4} \rightarrow \frac{4 \times 1}{12} + \frac{3 \times 2}{12} \rightarrow \frac{10}{12} \left( \text{or } \frac{5}{6} \right)$$

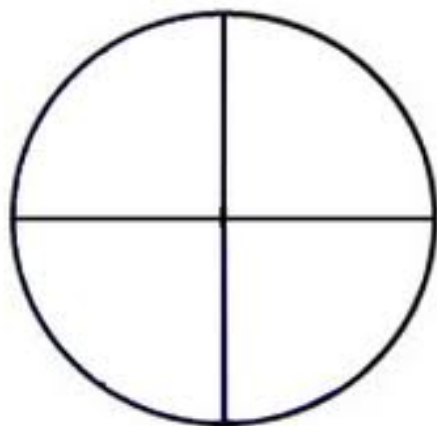
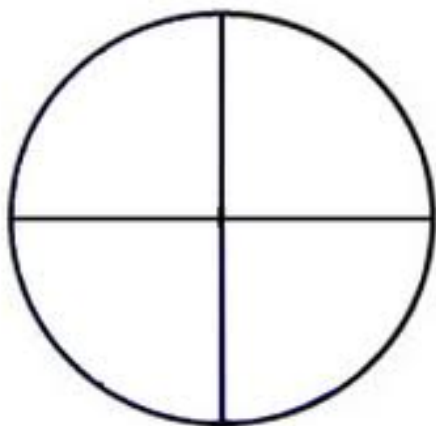
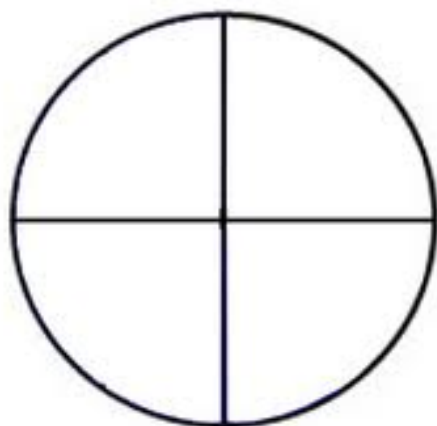
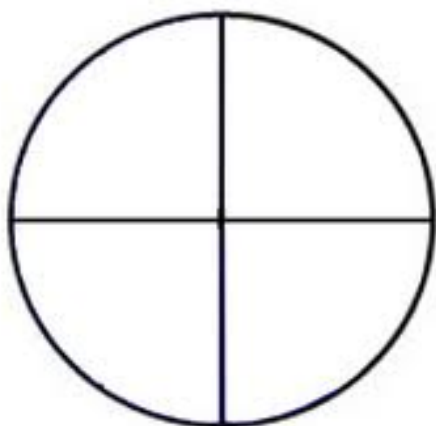
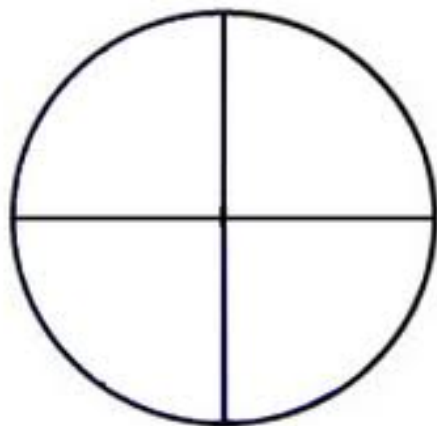
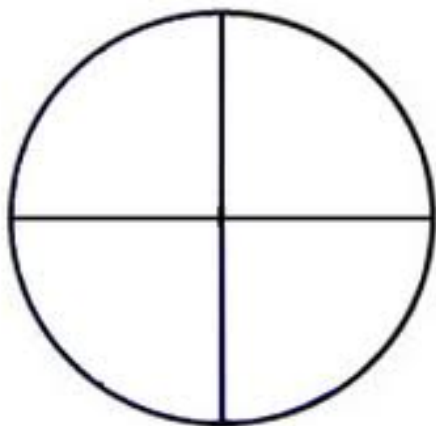
# Appendix B

“Heads”



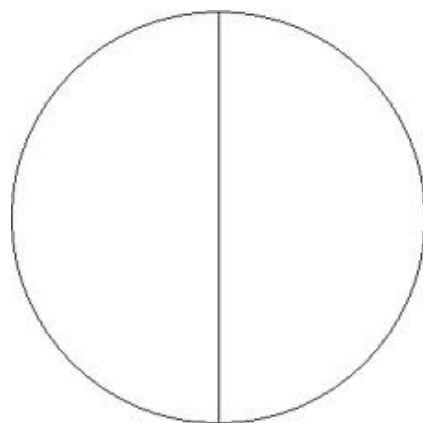
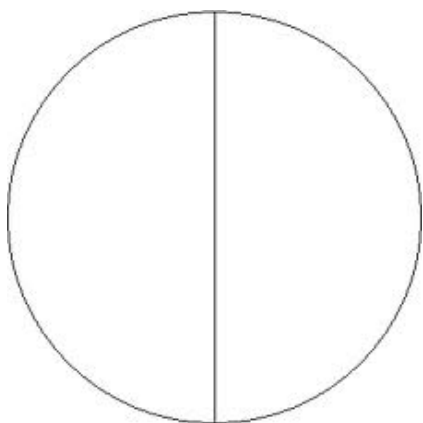
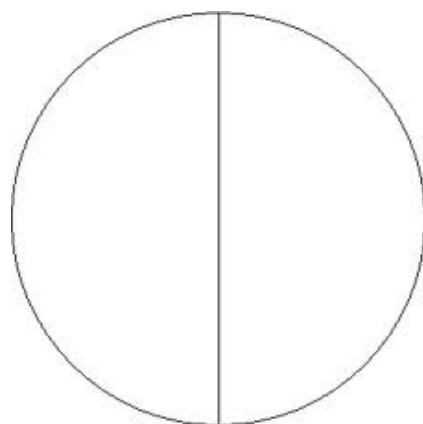
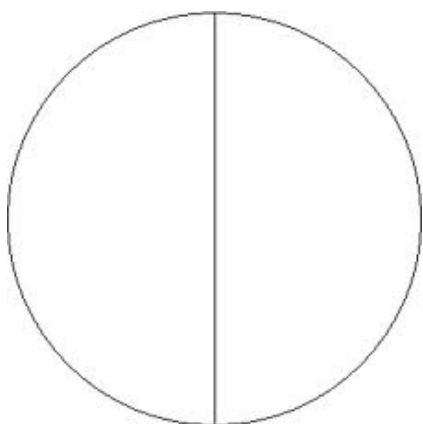
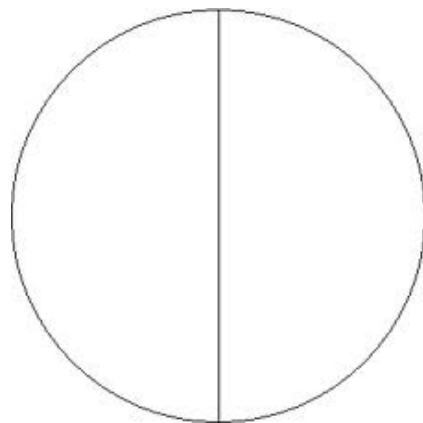
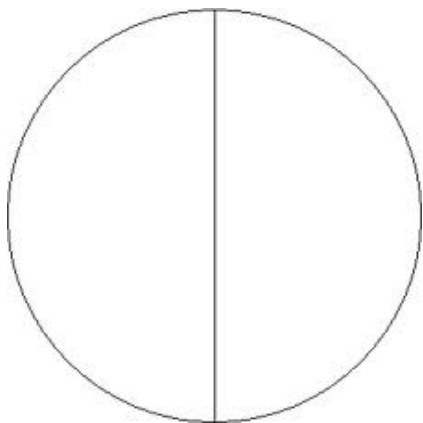
### Appendix B (cont.)

“Wings/Bodies”



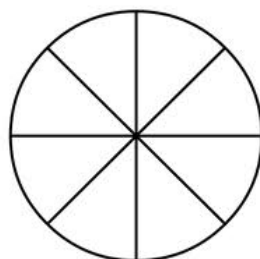
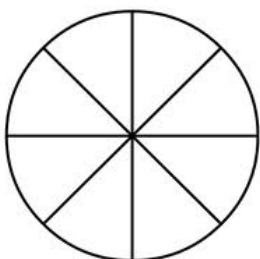
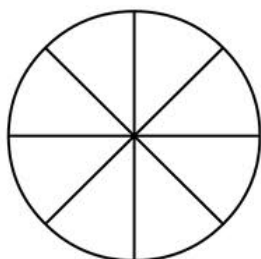
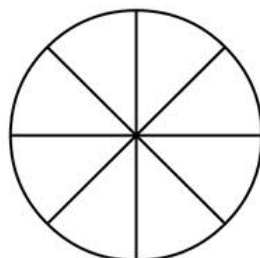
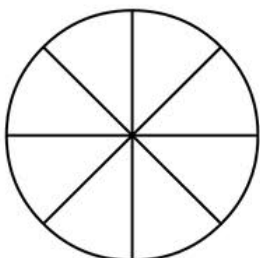
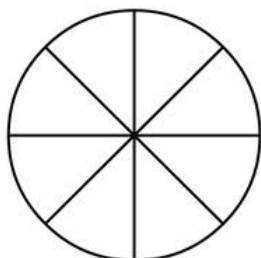
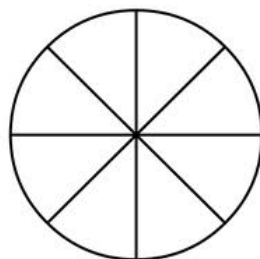
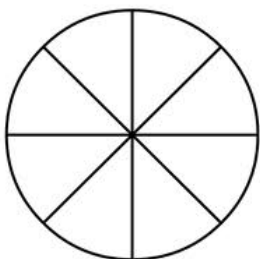
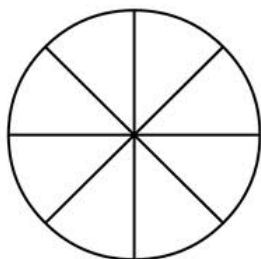
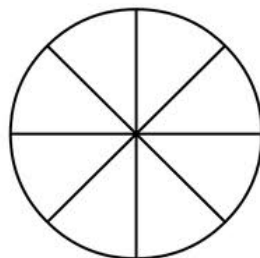
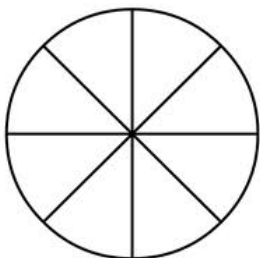
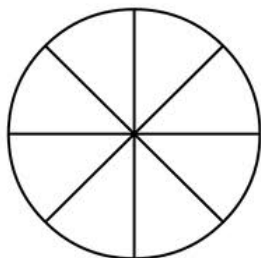
## Appendix B (cont.)

“Snow Mounds”



### Appendix B (cont.)

“Beaks/Feet”



Appendix C

## FRACTION BIRD ART

NEED:

2 ⊕ (2/4, 2/4)      ①  $\frac{2}{4} + \frac{2}{4} + | + \frac{1}{2} + \frac{2}{8} + \frac{1}{8}$   
body      wings      neck      "tail"      feet      beak

1 ○ (1 whole)      ②  $| + (\frac{2}{4} + \frac{2}{4}) + (\frac{2}{8} + \frac{1}{8}) + \frac{1}{2}$   
neck      left denominator      right denominator      be "whole"

1 ◐ (1/2)      ③  $| + (\frac{4}{4}) + (\frac{3}{8}) + \frac{1}{2}$   
neck      whole      whole

1 ⊗ (1/8, 1/8, 1/8)      ④  $(| + |) + (\frac{3}{8} + \frac{1}{2}) \rightarrow \frac{3}{8} + \frac{1}{2} \rightarrow \frac{6+8}{16}$   
neck      whole      whole      like denominators      (3x2)      (8x1)      6+8

"TOP + TOP & THE BOTTOM STAYS THE SAME"  
 (LIKE DENOMINATORS)

Do the BUTTERFLY (UNLIKE DENOMINATORS)  
 ↓

① MAKE WINGS  
 ② MULTIPLY WINGS  
 ③ + WINGS  
 ④ X DENOMINATORS

⑤  $2 + \frac{14}{16} \rightarrow 2 \frac{14}{16} \rightarrow 2 \frac{7}{8}$   
wings      can be reduced

# Appendix D



## Lesson Plan 6 out of 11

### GOALS

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.

### OBJECTIVES

- **Content Objective:**
  - After the SMART Board lesson, SWBAT create mathematical fraction problems using music notes, and their respective values, with 100% accuracy.
- **Learning Strategy:**
  - Musical: Students will be accessing their prior knowledge of music in a variety of ways throughout the lesson.
  - Bodily/Kinesthetic: Students will be moving, while singing/chanting, during the beginning of the SMART Board presentation.
  - Interdisciplinary: This lesson provides interdisciplinary studies in an authentic environment.

### MATERIALS

- Computer with access to internet
- Scratch paper
- SMART Board technologies
- SMART Board presentation (see Appendix A)
- Guest Speaker, musician

### PROCEDURE

#### Anticipatory Set

The teacher will pass out blank pieces of scratch paper to each student. The student must create three columns labeled: (1) Song Number, (2) What Country is This From?, and (3) Bonus Points. The teacher will play 8 songs back-to-back (see song URLs below), allowing the students to listen to each song for 20 seconds and then have a 10 second extra response time. Using their prior knowledge of music and culture, students must try their best to accurately guess which country each song is from. The songs are to be played in a manner in which students can only hear the song, with no visual stimulus the first time around.



The Bonus Points section of the paper can be used by the teacher if there are any additional questions or points they wish to cover. Some examples are:

- Song #1: Bonus points if you can name the main instrument being played in this song. [*Bag pipes*]
- Song #4: Bonus points if you can name the genre of this song. [*Jazz*]
- Song #5: Bonus points if you can name the instrument being played in this song. [*Didgeridoo*]
- Song #8: Bonus points if you can name the movie that this song is from. [*Princess and the Frog*]

The teacher can use the following playlist:

1. Scotland:
  - a. <http://www.youtube.com/watch?v=vHj0etrp4hY>
2. Honduras
  - a. <http://www.youtube.com/watch?v=5Ewa8t1agxI>
3. South Africa
  - a. <http://www.youtube.com/watch?v=s8rsEodZ8tc>
4. United States
  - a. <http://www.youtube.com/watch?v=bR3K5uB-wMA>
5. Australia
  - a. <http://www.youtube.com/watch?v=5YM5nohSh6c>
6. New Zealand
  - a. <http://www.youtube.com/watch?v=q27BymeaTwA>
7. Japan
  - a. <http://www.youtube.com/watch?v=k4X48EAEVUE>
8. United States (New Orleans)
  - a. <http://www.youtube.com/watch?v=qUf7pD2iWzU>
    - i. \*\*Start at 1:51

Once all of the songs have been played, the students will get one minute to discuss with their table groups their predictions to see if they had any similarities or differences. At the end of this one-minute period, the teacher will show the corresponding YouTube video links, tell the students what country the songs are from, and the answers to any Bonus Questions. Students should tally the amount of predictions they got correct.

### **Teaching (and modeling)**

After the anticipatory set, the teacher will begin teaching with the aid of a SMART Board presentation (see Appendix A).

Discussion with the SMART Board presentation:

- Slide 1
  - Introduce the topic of math in relationship to music.
- Slide 2
  - Get the students engaged and interested by doing a kinesthetic rhythm chant with the corresponding movements.

- Slide 3
  - Discuss time signature, in laymen terms, and begin a brief class discussion on how time signatures are similar to the fractions they have been working with in class.
- Slide 4
  - Explain each of the note values in terms of fractional value
    - Whole note = 1 whole or  $1/1$
    - Half note =  $1/2$
    - Quarter note =  $1/4$
    - Eighth note =  $1/8$

### **Guided Practice/Group Application**

Continue working through the SMART Board slides:

- Slide 5-7
  - Ask students questions about the note values prior to clicking on the interactive note changes:
    - How many half notes equal a whole note?
    - How many quarter notes equal a half note? A whole note?
    - How many eighth notes equal a quarter note? A half note? A whole note?
- Slide 8
  - Have student volunteers “roll” the interactive die several times to create a string of notes. Denote each of the notes’ fractional value under them, and as a class, find either the sum or difference of the notes given.

### **Independent Practice/Application**

Continue working through the SMART Board slides:

- Slide 9
  - On scratch paper, students can create their own music note “fraction math problems.” They then swap problems with peers and solve them.

### **Closure/Expansion**

The last 15-20 minutes of the lesson should be reserved for a musician to provide authenticity to the idea that music and math are interdependent. Preferably the speaker will play a mix of music for the student that is both published and their own creation, and can field questions about the musical occupation.

### **DIFFERENTIATION**

The lesson provides outlets for students to learn through a variety of learning strategies. In addition, students have the opportunity to create, and solve, fraction music problems with a varying degree of difficulty. If a student needs a challenge, he/she can add more notes to their equations, and if the concept is too complex the student can use less notes.



# Appendix A

Fractions are in...

# MUSIC


Let's get the rhythm of the game,  
Snap, Snap.  
Let's get the rhythm of the hands,  
Clap, Clap.  
Let's get the rhythm of the feet,  
Stomp, Stomp.  
Let's get the rhythm of the hips,  
Swing, Swing.  
Let's get the rhythm of the knees,  
Slap, Slap.  
Let's get the rhythm of the head,  
Shake, Shake.  
Now you've got the rhythm of the game!


**Rhythm:** strong repeated pattern of movement or sound


 


**Time Signature**      # of beats per bar  
Types of beats


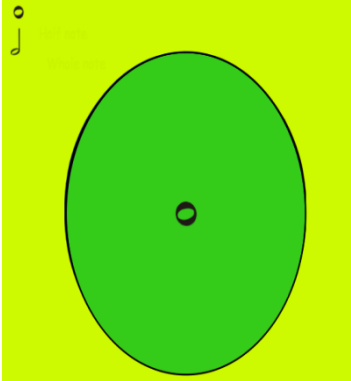
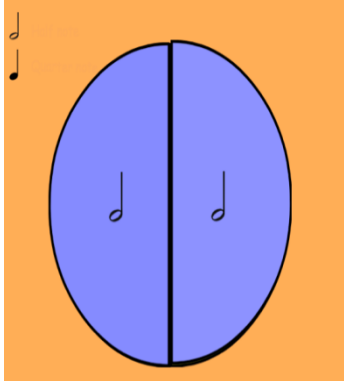
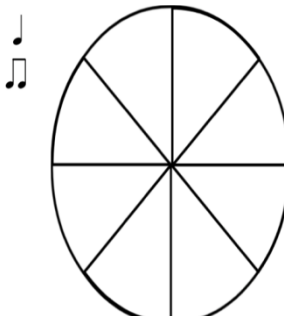
4	3		
4	8	6	3
	2	8	4
	4		

 ○ 1 (whole)

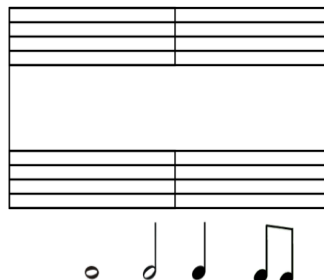
 ♩ 1/2 (half)

 ♪ 1/4 (quarter)

 ♫ 1/8 (eighth)

○ 1 (whole)    ♩ 1/2 (half)    ♪ 1/4 (quarter)    ♫ 1/8 (eighth)

Lesson Plan 7 out of 11**GOALS**

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.
  - EL.05.RE.09: Understand, learn, and use new vocabulary that is introduced and taught directly through informational text, literary text, and instruction across the subject areas.

**OBJECTIVES**

- **Content Objective:**
  - After the guided and individual practices, SWBAT orally identify given numbers with the correct mathematical terminology (mixed number, improper fraction, proper fraction) with 100% accuracy.
- **Learning Strategy:**
  - Mnemonic Device: Students will use the mnemonic device of M.A.D. to help remember the steps of changing a mixed number into an improper fraction.
  - Visual: Students will be provided with several visual aids to help scaffold their learning.
  - Repetition: Students will be using repetition to remember the process during the guided and individual practices.

**MATERIALS**

- Document camera/Projector
- White board and marker, for teacher
- White boards and markers, for all students
- Math notebooks and pencils
- Chart paper and colorful markers
- Guest speaker, chef

**PROCEDURE****Anticipatory Set**

The teacher will begin with a class discussion by asking students: “Why might fractions be important in cooking?” It is important that during this discussion the teacher makes explicit connection to mixed numbers and improper fractions if the students do not bring it up.

### **Teaching (and modeling)**

The students will get out their math notebooks and open to the back where they take notes. The teacher will model the notes in his/her own notebook under a document camera that is projecting on a screen for the students to see. While the students are copying down the notes verbatim into their math notebooks, the teacher can transfer an exact copy of the notes onto the chart paper to serve as an anchor chart (see Appendix A). It is important that the teacher makes a point to explicitly teach the necessary vocabulary (mixed number, improper fraction).

A good trick to help students remember how to change mixed numbers into improper fractions is to say, “Changing mixed numbers into improper fractions makes me MAD! I need to **M**ultiply, **A**dd, and my **D**enominator stays the same!” From there, the teacher can model exactly how to apply the M.A.D. model.

### **Guided Practice/Group Application**

Once all of the students have their notes written down, they may send their team leaders to collect whiteboards and markers for each of the students. After all of the students have the necessary supplies, the teacher will write a mixed number on his/her personal white board (with suggestions from student volunteers), and the class will work together to change the mixed number into an improper fraction. Throughout this process, the teacher will call on a variety of students to supply numbers to work with, to explain the process, and to describe vocabulary given.

### **Independent Practice/Application**

Next, the teacher will switch from guided group practice into individual practice. The teacher will provide a number, and the students will have to show their work on their individual white boards. When they have completed the problem, they may hold their boards in the air for the teacher to proof their work. After all of the students have answered the question, the teacher will write another problem for them to solve.

### **Closure/Expansion**

The closure will be the teacher having the team leaders from each group collect and return all of the materials. From there, the teacher will spend five minutes orally quizzing students on related vocabulary and record on a checklist if the student was able to give the vocabulary or not; this allows for the teacher to assess the comprehension of vocabulary from all students in a relatively quick process.

The last 20 minutes of the lesson will be dedicated to a chef guest speaker. The teacher will take a backseat for instruction, as to give the full floor to the speaker. Preferably, the guest speaker will have a variety of culinary experiences, be able to demonstrate safe/healthy cooking practices, and be able to field questions about cooking and the importance of math to cooking. This is the ideal time for students to learn about

equivalent fractions as they relate to measuring and how to properly use measurement devices.

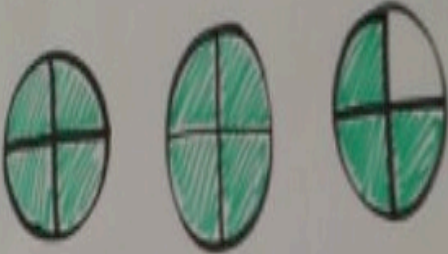
### **DIFFERENTIATION**

The differentiation comes from the variation of difficulty level in the problems provided to the students to solve. For students who solved the questions quickly, another problem was written on the side for them to complete as well. This allowed for appropriate pacing at a whole group level.

## Appendix A

MIXED NUMBERS  $\rightarrow$  IMPROPER FRACTIONS

**M**ULTIPLY  
**A**DD  
**D**ENOMINATOR

$$2\frac{3}{4} \rightarrow 2 \times \frac{4}{4} + \frac{3}{4} \rightarrow \frac{(4 \times 2) + 3}{4} = \frac{8 + 3}{4} = \frac{11}{4}$$


Lesson Plan 8 out of 11**GOALS**

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.

**OBJECTIVES**

- **Content Objective:**
  - During Independent Practice, SWBAT demonstrate how to change improper fractions into mixed numbers a minimum of 4 times.
- **Learning Strategy:**
  - Chants: Students will be singing chants to help their brains solidify the mathematical processes needed to add and subtract fractions.
  - Total Physical Response (TPR): Students will be adding gestures to the chants in order to help them best remember the processes of adding and subtracting fractions.
  - Structured Notes: Students are provided with a graphic organizer to help structure notes into clear and defined categories of knowledge.

**MATERIALS**

- Document camera/projector
- Math notebooks, folders, and pencils
- Fractions Cheat Sheet (see Appendix A)
- Improper fractions to mixed number notes (see Appendix B)
- Mixed number to improper fractions notes (see Appendix B)
- Fraction Cheat Sheet anchor chart (see Appendix C)
- White boards and markers (one per student)
- White board erasers (one per pair of students)

**PROCEDURE**

Prior to the lesson, the teacher should set out materials on the students' desks in the aforementioned amounts:

- Fractions Cheat Sheets (one per student)
- White boards, white board markers, and white board erasers

**Anticipatory Set**

Students will do a review of prior knowledge from previous lessons in this unit. All students will stand next to their desk and use TPR to show fraction terminology:



Numerator over denominator  
 Parts of a whole  
 These are the fractions  
 That I know!

*Gestures: Numerator (reach high in the sky) over (flat line with both hands) denominator (reach low to the ground), Parts (hands miming parts) of a whole (“draw” a full circle with both hands), These are the fractions (dancing in any fashion) that I know (point to head).*

When you add fractions with like denominators,  
 Top plus the top and the bottom stays the same.

*Gestures: When you add (hands in a plus sign) fractions with like (both fists up together) denominators, top (right hand palm away from the body) plus the (hands in a plus sign) top (left hand palm away from the body) and the bottom stays the same (hands creating a flat line).*

When you subtract fractions with like denominators,  
 Top minus top and the bottom stays the same.

*Gestures: When you subtract (right hand in a minus sign) fractions with like (both fists up together) denominators, top (right hand palm away from the body) minus (right hand in a minus sign) top (left hand palm away from the body) and the bottom stays the same (hands creating a flat line).*

When you have fractions where the bottoms AREN'T the same,  
 First you draw the wings,  
 Then you multiple them out,  
 Add/Subtract the tops,  
 Times the bottoms, then you shout:  
 “Do the butterfly! Do the butterfly!”

*Gestures: When you have fractions where the bottom's **aren't** (shake head, make a swift x motion with both arms) the same, First you draw the wings (use pointer fingers of both hands to draw imagination wings), then you multiple them out (use pointer fingers to show the motion of multiply the numbers inside the wings), add/subtract the tops (both pointer fingers gesturing up to the top), times the bottoms (both pointer fingers gesturing to the bottom), then you shout: “Do the butterfly! Do the butterfly!” (Students flap their arms like butterfly wings).*

### **Teaching (and modeling)**

Students will return to their desks, get their math notebooks out and set them to the side, and get out a pencil. Next, students will put the Fractions Cheat Sheet (see Appendix A)

in front of them and be ready to take notes. The teacher will put a blank copy of the Fractions Cheat Sheet on the document camera and proceed to write notes, with examples, in the top four boxes (i.e., adding and subtracting with like and unlike denominators, respectively). Students will copy the notes down exactly onto their own Fractions Cheat Sheet. While the students are copying down the notes, the teacher will copy the notes verbatim onto an anchor chart (see Appendix C).

Students will put the Fractions Cheat Sheet away in their math folders and place their math notebooks in front of them. They will be open to their Fractions notes and review the previous lesson's notes (mixed numbers to improper fractions, see Appendix B). The teacher will write one problem down on a white board (under the document camera) to solve with the whole class.

Next, the teacher will model writing notes on how to change an improper fraction into a mixed number, by dividing the numerator by the denominator. Although there is not a set mnemonic device to help students remember this process, students must be aware that to get the correct answer:

- Answer = whole number
- Remainder = becomes the numerator
- Denominator = stays the same

### **Guided Practice/Group Application**

Once all of the students have copied the notes into their notebooks, the teacher will write student-generated problems on the white board (shown under the document camera). Each student will copy exactly the same problem on his or her own white boards. The students will work together as a class to go through the prescribed steps to change the mixed number into an improper fraction.

### **Independent Practice/Application**

The teacher will write several practice problems (one at a time) down on a white board (under the document camera). Students will write the same problem on their white boards and solve them individually. During this time, the teacher will quickly assess with a checklist, how many questions each student answers correctly.

### **Closure/Expansion**

After the independent problems have been completed, the students will be given time to write their own practice problems to solve using the prescribed steps. A possible expansion could include doing an Around the World activity with the student generated problems.

### **DIFFERENTIATION**

This lesson focuses on helping students learn with various teaching methods (i.e., TPR, chants, prescribed note taking). Students will be allowed to work at their own pace during the Independent Practice/Application. The level of difficulty for their independently created problems will also vary depending on their math aptitude.

## Appendix A


**Fractions**

	<b>Like Denominators</b>	<b>Unlike Denominators</b>
<b>Addition (+)</b>		
<b>Subtraction (-)</b>		
<b>Multiplication (x)</b>		
<b>Division (<math>\div</math>)</b>		

## Appendix B

MIXED NUMBERS → IMPROPER FRACTIONS

**M**ULTIPLY  
**A**DD  
**D**ENOMINATOR

$$2\frac{3}{4} \rightarrow 2 \times \frac{3}{4} \rightarrow \frac{(4 \times 2) + 3}{4} = \frac{8 + 3}{4} = \frac{11}{4}$$


IMPROPER FRACTIONS → MIXED NUMBERS

**D**IVIDE (D|N)  
**A**NSWER = WHOLE NUMBER  
**D**ENOMINATOR = SAME  
**R**EMAINDER = NUMERATOR

$$\frac{21}{5} \rightarrow 5 \overline{) 21} \begin{array}{r} 4 \\ \cdot 20 \\ \hline 1 \end{array} \rightarrow 4\frac{1}{5}$$

## Appendix C

FRACTION 'CHEAT SHEET'	<u>LIKE</u> DENOMINATORS	<u>UNLIKE</u> DENOMINATORS
ADDITION (+)	$\frac{1}{4} + \frac{2}{4} = \frac{3}{4}$ <p>TOP + TOP, AND THE BOTTOM STAYS THE SAME</p>	$\frac{1}{3} + \frac{2}{5} = \frac{5+6}{15} = \frac{11}{15}$ <p>① BUTTERFLY WINGS ② MULTIPLY THE WING #S ③ + WINGS ④ X DENOMINATORS</p>
SUBTRACTION (-)	$\frac{10}{11} - \frac{6}{11} = \frac{4}{11}$ <p>TOP - TOP, AND THE BOTTOM STAYS THE SAME</p>	$\frac{11}{12} - \frac{1}{2} = \frac{22-12}{24} = \frac{10}{24}$ <p>① BUTTERFLY WINGS ② MULTIPLY THE WING #S ③ - WINGS ④ X DENOMINATORS</p>

Lesson Plan 9 out of 11**GOALS**

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.

**OBJECTIVES**

- **Content Objective:**
  - During the Independent Practice, SWBAT double a smoothie recipe, using principals of multiplying fractions, with 90% accuracy.
- **Learning Strategy:**
  - Visual: A variety of visuals are presented to help scaffold and support the learning during this lesson.
  - Total Physical Response: TPR is incorporated in the lesson through the gestures, which accompany each of the given chants.
  - Chants: Students will be using chants to help remember how to multiply and divide fractions.
  - Graphic organizers: Students will be provided with a structured graphic organizer (Fraction Cheat Sheet) in order to help organize the given information.
  - Authentic activities: Students will be engaged in the practical and authentic application of cooking (fraction measurement) and doubling (multiplying) recipes.

**MATERIALS**

- Student friendly standards
- Document camera/Projector
- White board and marker
- Chart paper and colorful markers
- Fraction Cheat Sheet (see Lesson 8)
- Fraction Cheat Sheet anchor chart (see Appendix A)
- Multiplying and Dividing Fractions chants (see Appendix B)
- Smoothie Time! worksheet (see Appendix C)
- Smoothie materials (blender, rubber spatulas, plastic cups, measuring cups, honey, frozen berries, fruit juice, and yogurt)
- Pancake Time! worksheet (see Appendix D)
- Fraction worksheet (see Appendix E)

**PROCEDURE**

### **Anticipatory Set**

Students will review prior knowledge from previous lessons in this unit. All students will stand next to their desk and use TPR to show fraction terminology (see Lesson 8 for a complete list). Next, the teacher will update the student friendly standards on the board to read: “I can add (+), subtract (-), multiply (x) and divide ( $\div$ ) fractions with like and unlike denominators.”

### **Teaching (and modeling)**

Students will return to their desks and retrieve their Fraction Cheat Sheets from Lesson 8. The teacher will put his/her copy of the partially filled Fraction Cheat Sheet under the document camera so that all of the students can see what he/she is writing. The teacher will explain that the students will be learning two new concepts today: multiplying and dividing fractions. Next, the teacher will proceed to write down notes for how to multiply fractions with like and unlike denominators. While the students are finishing copying their notes, the teacher will add the new multiplication notes onto the Fraction Cheat Sheet anchor chart (see Appendix A). Then, the teacher will post the chants written prior to the lesson (see Appendix B) and teach the students the new chant to remember how to multiply fractions:

Multiplying fractions?  
 No big problem!  
 Top times the top, over  
 Bottom times the bottom.

*Gestures: Multiplying fractions? No big problem! (shakes head and makes a quick “x” motion with arms). Top (right hand up, palm away from body) times (hands make an “x”) the top (left hand up, palm away from body) over (both hands make a straight sweeping line in front of the body) bottom (right hand lower, palm away from the body) times (hands make an “x”) the bottom (left hand lower, palm away from the body).*

Once students are familiar with the chant and its accompanying TPR gestures, the teacher will resume note taking on the Fraction Cheat Sheet. The teacher will proceed to write down notes for how to divide fractions with like and unlike denominators. Again, while the students are finishing copying down the notes, the teacher will add the notes to the same anchor chart. After both boxes are filled out on the Cheat Sheet, the teacher will return to the chants and teach the students a chant to remember how to divide fractions:

Dividing fractions?  
 As easy as pie!  
 Flip the second fraction,  
 Then multiply!



*Gestures: Dividing fractions? As easy as pie! (shakes head) Flip (right hand makes a peace sign horizontally with knuckles away from the body and flips it so the knuckles are facing the body) the second fraction then multiply (hands makes an “x”).*

### **Guided Practice/Group Application**

Once the students have their entire Fraction Cheat Sheet filled out and are generally familiar with both of the new chants, the teacher will write student-generated problems on the white board (shown under the document camera). The students will work together as a class to go through the prescribed steps to multiply and divide fractions.

From there, the teacher will pass out the Smoothie Time! worksheet (see Appendix A) to each of the students. The teacher will read the directions and explain to the students that the worksheet is asking them to **double** the recipe; this will open a class discussion on how to double a recipe. Working together as a class, the teacher will go through the doubling the first ingredient (frozen berries).

### **Independent Practice/Application**

Students will individually complete the rest of the recipe transcription for double the smoothie recipe. All of the math work should be provided in the work space on the worksheet.

### **Closure/Expansion**

The closure will be split into two distinct groups:

1. Cooking group:
  - a. Students will be working together, in their assigned differentiated math groups, to use the transcribed recipe and create actual smoothies with the provided ingredients. When a student’s group is not officially cooking, each member will be working on the Fraction worksheet (see Appendix E). Students are permitted to drink their smoothies once they are made.
2. Transcribing group:
  - a. Students will be working on transcribing the Pancake Time! (see Appendix D) worksheet. It will initially be teacher-led, beginning with a discussion on how to half recipes (i.e., divide by  $\frac{1}{2}$  or multiply by  $\frac{2}{1}$ ), and the students will work together to find the amount for the first ingredient (flour). From there, students will work individually to find the amounts for the rest of the ingredients, with availability for support from the teacher when necessary.

<b>Rotation Time</b>	<b>Transcribing</b>	<b>Cooking</b>
10:30-10:50	Red, Orange	Green, Blue, Purple
10:55-11:15	Green, Blue, Purple	Red, Orange

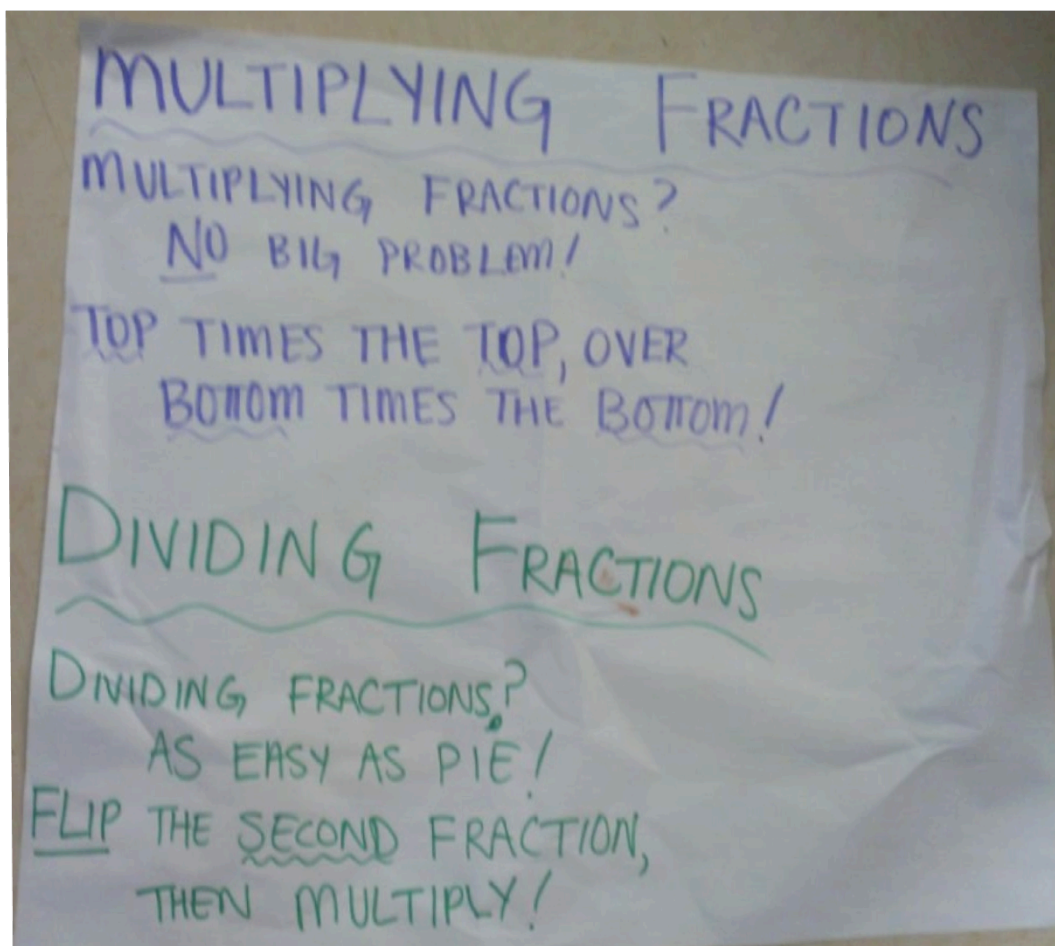
**DIFFERENTIATION**

The differentiation in this lesson primarily occurs during the Independent Practice and Closure sections. During Independent Practice, students are allowed to work at their own pace with the opportunity for help/scaffolding if necessary. During the Closure, students are working within their differentiated groups, which allows the teacher to monitor and assist more one-on-one if necessary.

## Appendix A

FRACTION "CHEAT SHEET"	LIKE DENOMINATORS	UNLIKE DENOMINATORS
ADDITION (+)	$\frac{1}{4} + \frac{2}{4} = \frac{3}{4}$ <p>TOP + TOP, AND THE BOTTOM STAYS THE SAME</p>	$\frac{1}{3} + \frac{2}{5} = \frac{5+6}{15} = \frac{11}{15}$ <p>① BUTTERFLY WINGS ② MULTIPLY THE WING #S ③ + WINGS ④ X DENOMINATORS</p>
SUBTRACTION (-)	$\frac{10}{11} - \frac{6}{11} = \frac{4}{11}$ <p>TOP - TOP, AND THE BOTTOM STAYS THE SAME</p>	$\frac{11}{12} - \frac{1}{2} = \frac{22-12}{24} = \frac{10}{24}$ <p>① BUTTERFLY WINGS ② MULTIPLY THE WING #S ③ - WINGS ④ X DENOMINATORS</p>
MULTIPLICATION (x)	$\frac{2}{4} \times \frac{1}{4} = \frac{2 \times 1}{4 \times 4} = \frac{2}{16}$ <p>TOP x TOP, BOTTOM x BOTTOM</p>	$\frac{2}{3} \times \frac{1}{4} = \frac{2 \times 1}{3 \times 4} = \frac{2}{12}$ <p>TOP x TOP, BOTTOM x BOTTOM</p>
DIVISION (÷)	$\frac{3}{4} \div \frac{1}{4} \rightarrow \frac{3}{4} \times \frac{4}{1} = \frac{12}{4}$ <p>① FLIP IT ÷ TO X AND RECIPROATE</p>	$\frac{2}{3} \div \frac{1}{2} \rightarrow \frac{2}{3} \times \frac{2}{1} =$ <p>① FLIP IT ÷ TO X AND RECIPROATE</p>

## Appendix B



## Appendix C

**Smoothie Time!**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

This chart lists the ingredients for making Ms. Keithley's berry smoothie. The amounts that are needed to make enough smoothies for 3 people are provided in the table. For 6 people, however, you will need to adjust the recipe. Fill in the amounts of each ingredient that will be needed to make smoothies for 6 people.

<b>Ingredients</b>	<b>Smoothies (3 people)</b>	<b>Smoothies (6 people)</b>
Berries (frozen)	$\frac{5}{8}$ cup	
Fruit Juice (any flavor)	$\frac{1}{2}$ cup	
Yogurt (vanilla)	$\frac{1}{2}$ cup	
Honey	$\frac{3}{8}$ cup	

**Work Space:**

## Appendix D

**Pancake Time!**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

This chart lists the ingredients for making delicious pancakes. The amounts that are needed to make 16 pancakes are provided in the table. For 8 pancakes, however, you will need to adjust the recipe. Fill in the amounts of each ingredient that will be needed to make 8 pancakes.

<b>Ingredients</b>	<b>16 pancakes</b>	<b>8 pancakes</b>
Flour	3 cups	
Baking powder	7 teaspoons	
Sugar (white)	2 tablespoons	
Salt	2 teaspoons	
Milk	$2\frac{1}{2}$ cups	
Eggs	2 eggs	
Butter	6 tablespoons	

**Work Space:**

## Appendix E

**Fractions**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

$$\frac{1}{2} + \frac{2}{3}$$

$$\frac{2}{4} + \frac{1}{3}$$

$$\frac{1}{3} + \frac{3}{5}$$

$$\frac{2}{5} - \frac{1}{4}$$

$$\frac{11}{20} - \frac{3}{8}$$

$$\frac{1}{3} - \frac{1}{5}$$

$$\frac{5}{6} \times \frac{1}{2}$$

$$\frac{1}{8} \times \frac{1}{4}$$

$$\frac{3}{5} \times \frac{3}{4}$$

$$\frac{1}{2} \div \frac{2}{3}$$

$$\frac{4}{9} \div \frac{1}{2}$$

$$\frac{1}{7} \div \frac{1}{5}$$

## Lesson Plan 10 out of 11

### **GOALS**

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.

### **OBJECTIVES**

- **Content Objective:**
  - After this lesson, SWBAT complete the given worksheet solving a minimum of 9 out of 12 problems correctly.
- **Learning Strategy:**
  - Literacy integration: The integration of literacy serves as a support for language and great anticipatory set for students to become interested and engaged.
  - Workshop model: The workshop model allows students the freedom to participate in a variety of activities.
  - Authentic learning: Students will be engaged in the practical and authentic application of cooking (fraction measurement) and dividing (halving) recipes.

### **MATERIALS**

- *Pancakes, Pancakes* by Eric Carle
- Document camera/Projector
- White board and marker
- Multiplication and Division chants (see Lesson 9)
- Practice 10 worksheet (see Appendix A)
- Pancake supplies: griddle, mixing bowls, spoons, measuring cups, flour, baking powder, white sugar, salt, milk, eggs, food coloring, syrup, plates, forks, knives, juice, cups, jams, and butter

### **PROCEDURE**

#### **Anticipatory Set**

The teacher began by reading *Pancakes, Pancakes* by Eric Carle to set the tone and mood for cooking pancakes.

#### **Teaching (and modeling)**



The teacher will explicitly model, and reiterate, examples of how to half a recipe and how to double a recipe. The examples will be written by the teacher on the white board (shown under the document camera) so all students can see the process. It is important for the teacher to describe halving a recipe as cutting it in half, or dividing by 2. When a fraction is divided by 2, it is exactly the same as multiplying a fraction by  $\frac{1}{2}$ . When a recipe is doubled, the fractions are being multiplied by two. Students need to also understand that whether they are halving or double a recipe, a whole number (i.e., 3 cups of flour) should be written as  $\frac{3}{1}$  to help make the multiplication process simpler.

### **Guided Practice/Group Application**

The teacher will lead two practice examples to be solved by the whole class: (1) a fraction in a recipe that needs to be doubled and (2) a fraction in a recipe that needs to be halved. The students and teacher will then together review the Multiplication and Division chants.

### **Independent Practice/Application**

Students will be working on finishing the Fraction worksheet (from Lesson 9) before the closure begins.

### **Closure/Expansion**

The closure will be separated into two distinct groupings:

1. Cooking group:
  - a. Students will be working together, in their assigned differentiated math groups, to use the transcribed recipe and create actual pancakes using the provided ingredients. Only one group will be pulled to the back at a time. Each of the group products will be colored their respective group color (i.e., green group will have green pancake batter). Students are allowed to eat their pancakes once their batter done cooking on the griddle, made by the teacher.
2. Fraction Equivalency/Simplification practice
  - a. When a student's group is not called back to be cooking, they will be involved in a large group discussion about fraction equivalences and simplification. This group will be teacher-led (by student teacher, co-teacher, or IA), and the students will be working through the Practice 10 worksheet (see Appendix A).

### **DIFFERENTIATION**

The differentiation in this lesson primarily occurs during the Independent Practice and Closure sections. During Independent Practice, students are allowed to work at their own pace with the opportunity for help/scaffolding if necessary. During the closure, students are working within their differentiated groups, which allows the teacher to monitor and assist more one-on-one if necessary.

## Appendix A

## Equivalent Fractions

## Practice 10

**Equivalent fractions** are fractions that name the same amount, such as  $\frac{1}{2}$  and  $\frac{2}{4}$ . To tell if fractions are equivalent, reduce each fraction to its simplest form by dividing both the numerator and denominator by the same, largest possible number.

**For example:**  $\frac{2}{3}$  and  $\frac{6}{9}$

$$\frac{6}{9} \div \frac{3}{3} = \frac{2}{3} \text{ so } \frac{2}{3} \text{ and } \frac{6}{9} \text{ are equivalent fractions}$$

**Directions:** Circle the fractions in each row that are equivalent to the fraction in the first column. The first one has been done for you.

1.	$\frac{3}{12}$	$\frac{1}{4}$	$\frac{8}{11}$	$\frac{2}{8}$	$\frac{3}{10}$
2.	$\frac{1}{8}$	$\frac{4}{8}$	$\frac{3}{24}$	$\frac{4}{12}$	$\frac{2}{16}$
3.	$\frac{5}{6}$	$\frac{5}{8}$	$\frac{25}{30}$	$\frac{5}{7}$	$\frac{10}{12}$
4.	$\frac{1}{4}$	$\frac{4}{16}$	$\frac{10}{11}$	$\frac{9}{11}$	$\frac{3}{12}$
5.	$\frac{3}{5}$	$\frac{4}{5}$	$\frac{6}{10}$	$\frac{11}{12}$	$\frac{15}{25}$
6.	$\frac{2}{7}$	$\frac{8}{28}$	$\frac{5}{12}$	$\frac{5}{9}$	$\frac{6}{21}$
7.	$\frac{2}{3}$	$\frac{3}{8}$	$\frac{6}{9}$	$\frac{8}{12}$	$\frac{8}{10}$
8.	$\frac{3}{4}$	$\frac{7}{10}$	$\frac{9}{12}$	$\frac{6}{7}$	$\frac{18}{24}$
9.	$\frac{1}{6}$	$\frac{5}{26}$	$\frac{1}{5}$	$\frac{5}{30}$	$\frac{3}{18}$
10.	$\frac{1}{4}$	$\frac{2}{11}$	$\frac{5}{20}$	$\frac{2}{8}$	$\frac{1}{12}$

Lesson Plan 11 out of 11**GOALS**

- **Content Area:** Mathematics
- **ODE Core Standard:**
  - 5.1 Number and Operations and Data Analysis: Develop an understanding of and fluency with addition, subtraction, multiplication, and division of fractions and decimals (to the hundredths) to solve multi-step problems.

**OBJECTIVES**

- **Content Objective:**
  - During the lesson, SWBAT demonstrate their knowledge of dividing fractions through halving a cookie recipe with 100% accuracy.
- **Learning Strategy:**
  - Chants: Students will be using chants as a tool to remember how to add, subtract, multiply, and divide fractions.
  - Total Physical Response (TPR): Students will be using TPR with the gestures in the given chants.
  - Manipulatives: Students will be able to practice cook through the use of actual manipulatives.
  - Think-Pair-Share: Students will be doing a think-pair-share with an elbow partner or partners.

**MATERIALS**

- Anchor charts of chants (see Appendix A)
- White board and white board marker
- Document camera/Projector
- Cookie recipe
- Cookie ingredients and tools (depends on recipe used)
- Cookie Time! worksheet (see Appendix B)
- Fraction Word Problem worksheet (see Appendix C)
- Award to commemorate students' hard work

**PROCEDURE****Anticipatory Set**

The teacher will lead the students in a review of basic concepts learned from the previous lessons using anchor charts and chants (see Appendix A). He/she will also lead a review of mixed numbers/improper fractions and having/doubling a recipe by modeling on a white board under a document camera so all students can see.

**Teaching (and modeling)**

The teacher will pass out the Cookie Time! worksheet to every student. He/she will then put their own blank copy of the worksheet under the document camera so all of the students can see. Next, the teacher will model how to complete halving the second ingredient on the worksheet (baking soda). This will allow students to see the process done completely while the teacher actively models by thinking aloud during process.

### **Guided Practice/Group Application**

Once the second ingredient has been shown (I Do) by the teacher, the teacher will elicit students' knowledge and help in completing the rest of the recipe ingredients. The teacher will call on students randomly, select individuals who may be seemingly off task, or use popsicle sticks with the students' names on them. This helps to guarantee active student engagement in the learning process. The teacher will operate on a "No Opt Out" policy, meaning that if a student is called on they must answer the question. If a student is shy or unsure, they may 'phone a friend' to help them out, but they must be the one to present the final answer orally.

After the recipe has been completed, the class will move into a rotating workshop model. The students who are called on (one group will be called upon at a time) will go to the back and work with the teacher on actually measuring and creating their batch of cookie dough. The students who are not cooking will be transitioning into the independent practice section of the lesson.

### **Independent Practice/Application**

While the workshop model is occurring with the specific individual groups, the rest of the class will be working on a worksheet with fraction word problems. Students will have to show their ability to add, subtract, multiply, and divide fractions (proper and improper) as well as mixed numbers. They will only be required to complete one side, however if the students finish early they may work on the backside.

### **Closure/Expansion**

Once all of the dough has been made, students will all gather back together as one group. The teacher will lead a brief discussion with the students outlining a review of all of the material that they covered throughout the entirety of the lesson (i.e., fractions in art, music, cooking). The focus will be on a positive perspective and acknowledge how much the students have worked hard to learn and have completed. The teacher will ask the students to do a "Think-Pair-Share," where students discuss their experiences during the Teacher Work Sample with their partner. Three or four groups will be selected to reveal their discussion to the whole class.

All students will then be presented with an award. This award is a representation of all of the time, energy, effort, motivation, and self-managing skills shown by the students over the course of the last few weeks of lessons.

**DIFFERENTIATION**

Each of the students will be working in their own differentiated (leveled) math groups, based on their math scores and work shown during the year. This allows students to be at the (relatively) same level as their peer groups, and the teacher to accurately pace the lesson/activities. Scaffolding is provided with review, gradually releasing responsibility during the recipe transcription, and during the actual cooking activities. If students finish early with their independent practice, they may work on the additional worksheet provided on the back or finishing the fraction worksheet from the previous lesson.

## Appendix A

### **Adding Like Fractions**

When you add fractions with like denominators,  
Top plus the top, and the bottom stays the same.

### **Subtracting Like Fractions**

When you subtract fractions with like denominators,  
Top minus top, and the bottom stays the same.

### **Adding/Subtracting Unlike Fractions**

When you have fractions where the bottoms **aren't** the same,  
First draw the wings,  
Then multiply them out,  
Add/Subtract the tops,  
Times the bottoms, and then you shout,  
“Do the butterfly! Do the butterfly!”

### **Multiplying Fractions**

Multiplying fractions?  
No big problem!  
Top times the top over  
Bottom times the bottom!

### **Dividing Fractions**

Dividing fractions?  
As easy as pie!  
Flip the second fraction,  
And multiply!

## Appendix B

# Cookie Time!

Name: \_\_\_\_\_

Date: \_\_\_\_\_

You and your group are entering the finals round of the Ultimate Cooking Competition. You've mastered smoothies. You've braved pancakes. Now you must face the final creation—chocolate chip cookies. The amounts that are needed to make 24 cookies are provided in the table. Unfortunately, you will only need to make 12 cookies to wow the judges, so you will need to adjust the recipe. Fill in the amounts of each ingredient that will be needed to make 12 cookies.

<b>Ingredients</b>	<b>24 cookies</b>	<b>12 cookies</b>
Flour	$2\frac{1}{4}$ cups	
Baking soda	1 teaspoon	
Sugar (white)	$\frac{3}{4}$ cup	
Sugar (brown)	$\frac{3}{4}$ cup	
Salt	$\frac{1}{2}$ teaspoon	
Eggs	1 egg	
Butter	1 cup	
Vanilla	1 teaspoon	
Semisweet Chocolate Chips	2 cups	

## Appendix C

**About** Name \_\_\_\_\_

<http://math.about.com>

Fraction Word Problems.  
Show your work.

1. I had  $5\frac{1}{2}$  gallons of paint and used  $1\frac{3}{6}$  to gallons paint my bedroom. How much paint do I have left?
2. Jill has  $4\frac{2}{4}$  granola bars and Jim has  $4\frac{3}{8}$  granola bars. How many granola bars do we have altogether?
3. We had  $1\frac{2}{5}$  of a pizza left when we went to bed. The next morning  $\frac{3}{4}$  of what was left had been eaten. How much pizza is left?
4. If you have  $1\frac{1}{4}$  cookie tarts and added  $3\frac{2}{8}$  cookie tarts to them, how many cookie tarts would you have?
5. My glass had  $\frac{4}{8}$  of a cup of apple juice left in it. I drank  $\frac{2}{8}$  of it, how much is left?
6. My recipe calls for  $6\frac{5}{8}$  cups of white flour and and  $4\frac{1}{8}$  cups of whole wheat flour. How many cups of flour does the recipe need?

**About** Name \_\_\_\_\_

<http://math.about.com>

Fraction Word Problems - Mixed Operations  
Show your work.

1. At my birthday party, the girls ate  $3\frac{1}{2}$  pizzas and the boys ate  $7\frac{1}{2}$  pizzas. How many pizzas were eaten at my party?
2. I bought  $2\frac{1}{2}$  gallons of paint but I only used  $\frac{2}{4}$  gallons of the paint. How much paint do I have left?
3. My recipe calls for  $\frac{2}{3}$  cups of white flour and  $2\frac{1}{5}$  cups of whole wheat flour. How much flour do I need in total for my recipe?
4. My dog is  $5\frac{1}{2}$  years old. My cat is  $4\frac{1}{2}$  years younger than my dog. How old is my cat?
5. During the pie eating contest my dad ate  $5\frac{4}{4}$  pies and my mom ate  $2\frac{1}{4}$  pies. How many pies did they eat altogether?
6. I need to drink  $8\frac{2}{4}$  cups of whater and  $2\frac{1}{5}$  cups of milk every day. How much fluid do I have to drink?



## Corresponding Literacy Lesson Plan 1 out of 2

### GOALS

- **Content Area:** Literacy—English Language Development (ELD)
- **ODE Core Standard:**
  - ELP for ELD: Comparing and Contrasting (Physical Characteristics)

### OBJECTIVES

- **ESOL Objective:** After Independent Practice, SWBAT use comparative adjectives to compare and contrast types of chocolate and write a minimum of two sentences using the given sentence frames.
  - EP.BG.09:
    - \_\_\_\_\_ is \_\_\_\_\_.
  - EP.EI.10:
    - \_\_\_\_\_ is/has \_\_\_\_\_. \_\_\_\_\_ is/has \_\_\_\_\_.
  - EP.IN.10:
    - \_\_\_\_\_ is \_\_\_\_\_, but \_\_\_\_\_ is \_\_\_\_\_.
  - EP.EA.11:
    - Both/Each \_\_\_\_\_ are/have/is/has \_\_\_\_\_, but \_\_\_\_\_ are/have/is/has \_\_\_\_\_.
  - EP.A.11:
    - The \_\_\_\_\_ and \_\_\_\_\_ resemble each other because they both are/have \_\_\_\_\_ and \_\_\_\_\_.
    - A notable difference is that the \_\_\_\_\_ is/has \_\_\_\_\_, whereas the \_\_\_\_\_ is/has \_\_\_\_\_.
- **Learning Strategy:**
  - Sentence Frames: Students will be able to use the given sentence frames to articulate proper English comparative and contrasting sentences.
  - Venn Diagram: Students will be able to use the given Venn diagram to organize their ideas.
  - Visual: Students will be able to watch a YouTube video, go through a presentation, and see/utilize a posted anchor chart.
  - Think-Pair-Share: Students will be given the opportunity to share their ideas with a partner during a TPS activity.
  - Busy-Bees: Half of the students are stationed permanently around the room as “flowers,” and the other half of students are the “bees.” The bees move around the room buzzing until the teacher says, “land.” At that point, the bees meet with the flower closest to them and discuss their ideas via the given sentence frames.

### MATERIALS

- Computer with access to the internet

- SMART technologies
- SMART board presentation (see Appendix A)
- *The Chocolate Connoisseur: For Everyone With a Passion for Chocolate* by Chloe Doutre Rousset
- Chocolate Tasting Form and Venn Diagram (see Appendix B)
- Chart paper and colorful markers (see Appendix C)
- Tasting materials: Chocolate (white, milk, 64%, 72%, and 99%), saltine crackers, plates, and napkins
- Student privacy folders

### **Anticipatory Set**

The teacher will put only the first slide of the SMART board presentation up for the students to see. The teacher will ask for a volunteer to read the slide, helping the student if they struggle with the word connoisseur. For approximately one minute, the teacher will tell the students to get with an elbow partner and discuss what they predict the meaning of the word connoisseur is. Afterwards, several student volunteers will share their predicted meaning with the class and how they predicted the meaning.

Once all of the students who wanted to volunteer a definition have spoken, the teacher will reveal the second slide with the technical definition of connoisseur (“An expert in a field, especially in the fine arts”). The teacher will remind the students of their chef guest speaker and the importance of math in cooking. It is also important to note at this point that cooking is a global phenomenon.

### **Teaching (and modeling)**

The teacher will move on to the third slide and ask the students if anyone has an idea what the objects in the pictures are. Once several suggestions/ideas have been given, the teacher will reveal that it is a picture of cacao beans, which eventually turn into the chocolate candies that they eat. It is important to make the connection that terms cacao beans and cocoa beans are synonymous, depending on where they are being grown. From there, the teacher will go through the brief timeline of chocolate on slide four, only showing one bullet point at a time.

After the timeline has been shown in its entirety, the teacher will move onto the fifth slide. If the teacher has experience with seeing a chocolate factory, they may share it with the class. The students will then watch a video on how cocoa beans are changed from their natural state into the chocolate regularly consumed by humans ([http://www.youtube.com/watch?v=nfczfl0G\\_30](http://www.youtube.com/watch?v=nfczfl0G_30); start the video at 2:11).

### **Guided Practice/Group Application**

At this point, the teacher will pause and explain to the students what the process will be for the rest of the lesson. The students will be getting the opportunity later in the lesson to become a true connoisseur of chocolate. Each student will be getting five different

types of chocolate, and they must write details about each type using adjectives for each of the five senses.

To avoid the use of only repeated vocabulary such as “yummy” and “chocolate-y,” the students will work together as a class to discuss various alternative adjectives to describe chocolate in reference to the five senses. The teacher can minimally interject when needed, however his/her role is mostly to record the students’ answers onto an anchor chart (see Appendix C).

Next, the teacher will hand every student a Chocolate Tasting Form (see Appendix B). The students will write their name on it, and label the Chocolate Types column in the following order: white, milk, 64%, 72%, and 99%. The teacher will explain that as the students try the different chocolate types, they will record relevant adjectives in the boxes corresponding to that specific chocolate. Between each chocolate, the students will be able to eat one saltine cracker to cleanse their palate. The final column, Overall Score, will be left blank until the activity is finished.

The last piece of the lesson before commencing the tasting will be the teacher showing the final slide of the SMART board presentation and reading a brief excerpt from *The Chocolate Connoisseur* on how to professionally taste chocolate.

### **Independent Practice/Application**

All of the students will put up their privacy folders as the teacher passes out plates, napkins, and saltine crackers. Once all of the students are ready to begin the activity, the teacher will walk around and distribute a small piece of the first chocolate (white) to every student. The students, with voices off, will model the process of professional tasting and record their details. After they are done, the students may grab a drink of water or eat a saltine cracker. This process repeats until every type of chocolate has been tasted.

### **Closure/Expansion**

When a student has finished tasting every chocolate and has his/her grid completely filled out, they may rate the types of chocolate from one to five—one being their favorite and five being their least favorite.

All students, when finished, will help clean up their tables. Next, the teacher will have the students flip to the backside of their Chocolate Tasting Forms. If the students are unfamiliar with using a Venn diagram, the teacher can provide a mini-lesson, otherwise the students will immediately label the left circle with their favorite chocolate and the right circle with their least favorite chocolate. Using the adjectives recorded during the tasting, the students will complete the Venn diagram. For students who struggle with writing, they can copy a minimum of three items in each circle while the more advanced students may write a minimum of five details.

Next, the students will be given five minutes to use the given sentence strips they are most comfortable with and write down a minimum of two comparing and contrasting the chocolates. As an extension, students can participate in a Busy Bees activity (see Learning Strategy section).

### **DIFFERENTIATION**

This lesson has differentiation in the sentence frames, writing, and Venn diagram activities. The students will select the sentence frames at the level that they are most comfortable using. For the writing and Venn diagram, the number of details required can be increased or decreased depending on the level of students participating.

## Appendix A

Get ready to  
put on your  
connoisseur hat

Connoisseur:



An expert in a field, especially in the  
fine arts.

The brief history of...



600-1500 AD: Mayas/Aztecs use cocoa beans as currency; only the rich can afford to make it into a chocolate drink

1528: Spanish explorer Cortes introduces this chocolate drink to Spain, which spreads around Europe

1652: London, England opens its first coffee house; still only the rich could afford the chocolate drink

1765: Chocolate arrives to America!

1831: Cadbury chocolate is born

1847: First chocolate bar is invented

1875: MILK chocolate is invented

1894: First affordable chocolate bar is invented by Hershey!

1930's: Kit Kat and Mars Bars are invented

2004: ~600,000 cocoa beans are eaten in a single year



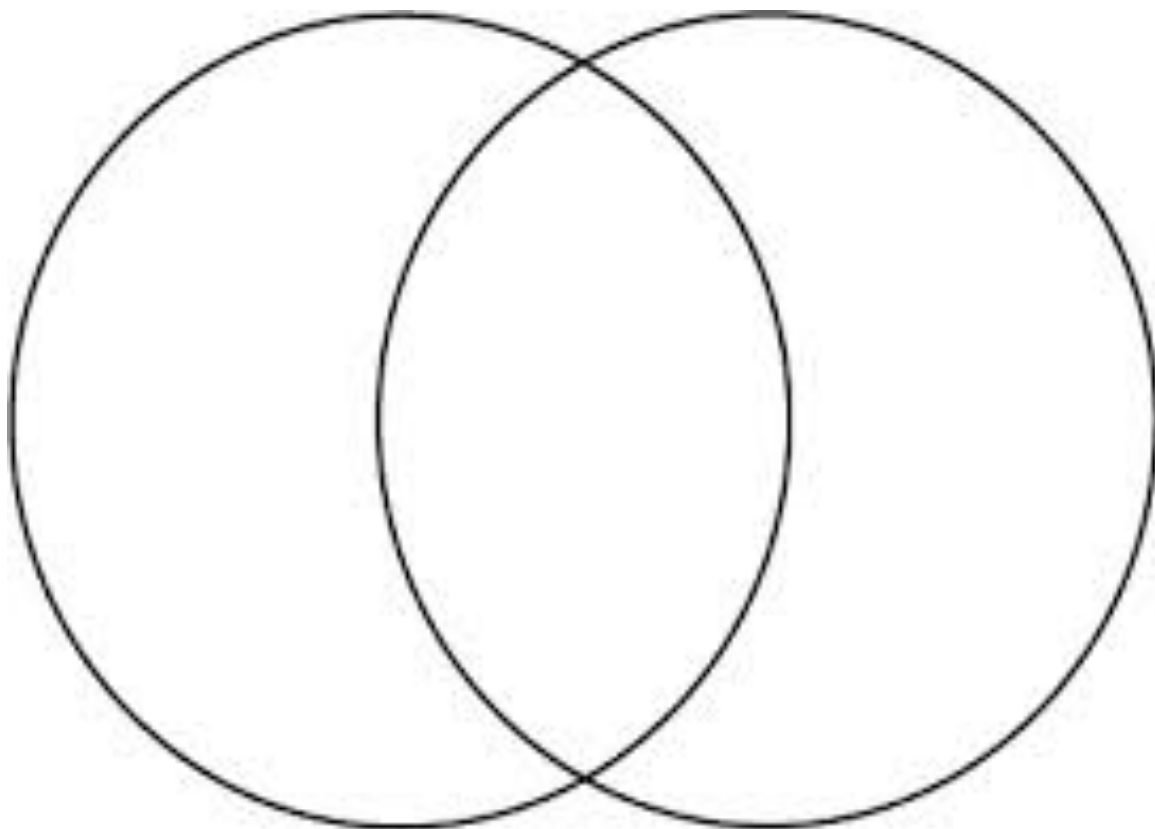
### How to Taste

- (1) Use your eyes
- (2) Smell the chocolate
- (3) Touch the chocolate
- (4) Listen to it
- (5) Taste it

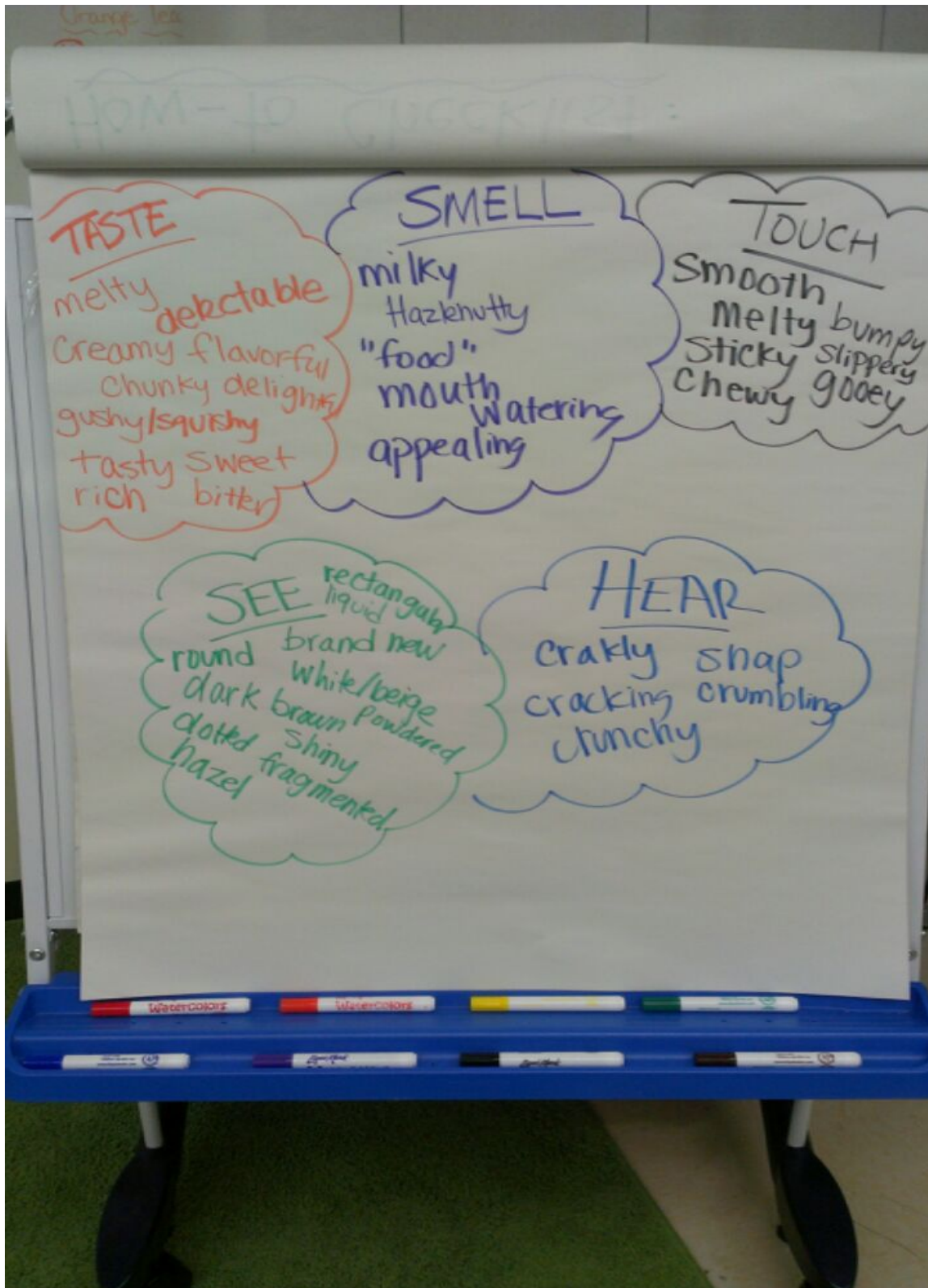
## Appendix B

<i>Chocolate Type</i>	<i>Looks</i>	<i>Smells</i>	<i>Feels</i>	<i>Sounds</i>	<i>Tastes</i>	<i>Overall Score</i>

## Appendix B (cont.)



## Appendix C





## Corresponding Literacy Lesson Plan 2 out of 2

### **GOALS**

- **Content Area:** Literacy
- **ODE Core Standard:**
  - Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace (Salem-Keizer School District Core Standards 5.SL.4).

### **OBJECTIVES**

- **Content Objective:**
  - After the Independent Practice, SWBAT create a persuasive speech using the O.R.E.O. method to deliver in groups to the class.
- **Learning Strategy:**
  - Visual: Students will be presented with a presentation incorporating text and illustrations to support the lesson. Students will be able to refer to it during the entire course of the lesson.
  - Verbal: Students will be presenting an oral speech at the end of this lesson.
  - Authentic learning: Students will have the opportunity to interact with authentic manipulative (i.e., food) during this lesson.

### **MATERIALS**

- *Freaky Foods from Around the World* by R. Winner
- SMART technologies
- SMART board presentation (see Appendix A)
- Foods Around the World worksheet (see Appendix B)
- Student privacy folders
- Tasting materials: plates, forks, small cups, napkins, Allsorts, Hungarian Salad, German sausages, Marmite, crackers, strudels, mochi, couscous, and Jarritos
- Slips of paper with each of the foods written on them

### **PROCEDURE**

#### **Anticipatory Set**

The teacher will begin the lesson by reading the book *Freaky Foods from Around the World*.

#### **Teaching (and modeling)**

The teacher will explain to the students what they will be doing for the lesson. Students will each be given a Foods Around the World worksheet (see Appendix B) and will write

their names on the top. The teacher will then explain that they will be going through a SMART Board presentation on foods from around the world. Students are expected to fill in the “Country” column when the appropriate slide is shown, and then they will be able to taste the food and write down what adjectives come to mind for the five senses. The first two slides (title, why) will be shown and discussed with the students.

### **Guided Practice/Independent Application**

The teacher will then go through each individual slide; the country slide always corresponds to the following food slide. While each slide is up, the teacher can add any personal experiences/stories if they have visited the country the food is from, and students should be encouraged to ask questions or add personal experiences. At the same time, all of the students will have their privacy folders up and write in their comments for each of the foods. The teacher will balance talking, moving through the slides, and passing out foods (one at a time) to the students.

### **Closure/Expansion**

Once every student has gone through the slides, tasted the foods, and written their comments, they will clear off their desks of everything except for their Foods Around the World sheets. Team leaders will come up to the front, and draw a slip of paper randomly with the names of the foods on them and return to their groups. Each group must then write a speech to persuade the class that the food they drew is the best food on the planet using the OREO (Opinion, Reason, Explanation, Opinion or double stuffed where there are two reasons and explanations) model that students have been using for their writing unit. Each student in the group is required to participate in the writing and to present at least one piece of the speech to the class. The directions are posted on the last slide and will be left up for the students to refer to.

After the allotted amount of time, students will come up one group at a time to present their speeches to the entire class. The teacher will be cognizant of the structure of the speech as well as if all members of the group present an idea. An extension is having the class vote on which speech they felt was the most persuasive.

### **DIFFERENTIATION**

During this lesson, students have the ability to pace themselves. They will be working to create a speech in heterogeneous groups, so students at all academic levels have the opportunity to work with and learn from a variety of students. If a group finishes writing the speech early, they can add additional reasons and opinions, or if the time was longer, groups could research using the student computers in the classroom.

# Appendix A

## Foods Around The World



### Doing this activity will...

1. Help us to better understand the world we live in and open our minds to try new things!
2. Help us with our world geography
3. Helps us with math (population!)
4. Helps us with build our vocabulary

## England




**Population:** 53,013,000 (2011)  
**Capital:** London  
**Official language:** English Language

### "Allsorts"

\*Licorice made of:  
 -liquorice, sugar, coconut, aniseed, fruit flavors, and gelatine




### Hungary



**Population:** 8.47 million  
**Capital:** Budapest  
**Official language:** Hungarian



### "Salad"

\*Made of:  
 -Gherkins, cabbage, onion, red pepper, green tomato, water, sugar, salt, & vinegar





### Germany





**Population:** 81,726,000 (2011)  
**Capital:** Berlin  
**Official language:** German



### "Sausage"

\*Made of pork  
 \*36+ different kinds of sausages!  
 \*Can be eaten cold or hot






### New Zealand




**Population:** 4,405,200 (2011)  
**Capital:** Wellington  
**Official language:** English Language, Māori language, and New Zealand Sign Language

### Australia



**Population:** 22,620,600 (2011)  
**Capital:** Canberra  
**Official language:** English



### "Marmite"

\*Usually spread very thin and eaten on breads or baked goods  
 \*\*I love Marmite/ hate Marmite\* websites





### Austria




**Population:** 8.47 million  
**Capital:** Vienna  
**Official language:** German



### "Strudels"

\*Pastries  
 \*Can be filled with:  
 -fruits, cottage cheese, soft sweet cheese, spinach, pumpkin, meat, etc





## Appendix A (cont.)

### Japan



**Population:** 127,817,277 (2011)  
**Capital:** Tokyo  
**Official language:** Japanese

### "Mochi"

\*Rice cakes with fillings  
 \*Can sometimes be filled with ice creams  
 \*Unflavored can be put in foods



### Middle East



### "Couscous"

\*Made of tiny grains of wheat  
 \*Eaten also in North Africa  
 \*Traditionally takes months to grow and hours to prepare



### Mexico



**Population:** 114,793,341 (2011)  
**Capital:** Mexico City  
**Official language:** Spanish Language

### "Jarritos"

\*Invented in 1950  
 \*Available in 14 flavors



## Persuasive Debates!

1. Each team leader will draw one slip of paper with a food on it.
2. Your job is to persuade your classmates that your food is the BEST FOOD on the planet.
3. You have 5 minutes to write your speech before coming up to present. EACH team member must say at least one part (i.e., Opinion, Reason, Explanation, Reason, Explanation, Conclusion)

## Appendix B

**Foods Around the World**

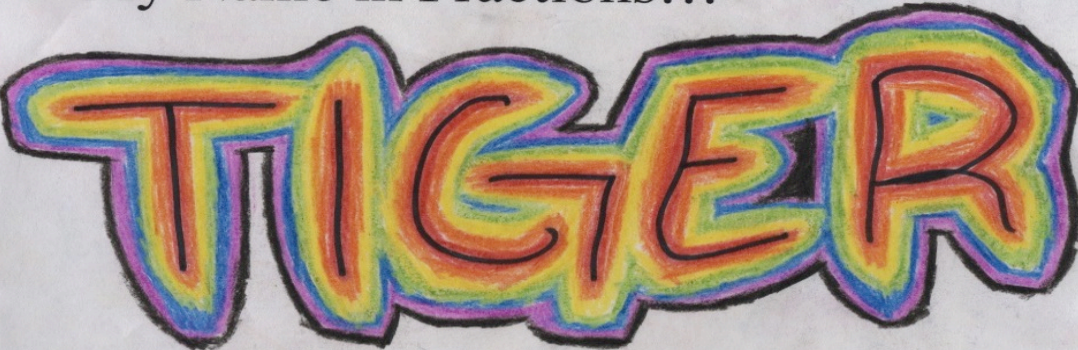
Name \_\_\_\_\_

Date \_\_\_\_\_

<b>Food/Drink</b>	<b>Country</b>	<b>Description</b>
Allsorts		
Salad		
Sausage		
Marmite		
Strudels		
Mochi		
Couscous		
Jarritos		


### Appendix J: Student Work Examples

My Name in Fractions...



My name has 5 letters!

$\frac{3}{5}$  are consonants and  $\frac{2}{5}$  are vowels!



$\frac{4}{20} \rightarrow$  pink pieces  
 $\frac{4}{20} \rightarrow$  purple pieces  
 $\frac{4}{20} \rightarrow$  Orange pieces  
 $\frac{4}{20} \rightarrow$  Green pieces  
 $\frac{4}{20} \rightarrow$  Baby blue pieces

20  $\rightarrow$  total pieces

STUDENT # 8







## REFERENCES

- Common Core State Standards Initiative*. (2010). Retrieved from National Governors Association Center for Best Practices website: <http://www.corestandards.org>
- Content Standards*. (n.d.). Retrieved 2013, from Oregon Department of Education website: <http://www.ode.state.or.us/home/>
- DePencier, I. (1996). *The history of the University of Chicago Laboratory Schools*. Quadrangle.
- Dewey, J. (1915). *Democracy and education*. New York, NY: Free.
- Dewey, J. (1938). *Experience and education*. New York, NY: Simon and Schuster.
- Dewey, J. (1900). *School and society*. Chicago, IL: University of Chicago.
- Dewey, J. (1902). *The child and the curriculum*. Chicago, IL: University of Chicago.
- Girod, M. (2001). *Teaching 5<sup>th</sup> grade science for aesthetic understanding*. East Lansing, MI: Michigan State University.
- Harms, W., & DePencier, I. (1996). *Experiencing education: 100 years of learning at the University of Chicago Laboratory Schools*. Chicago, IL: University of Chicago.
- Improving basic programs operated by local educational agencies*. (n.d.). Retrieved from US Department of Education website: <http://www2.ed.gov/programs/titleiparta/index.html>
- Mayhew, K. C., & Edward, A. C. (1936). *The Dewey School: The Laboratory School of the University of Chicago: 1896-1903*. New York, NY: Appleton-Century.
- Tanner, L. N. *Dewey's Laboratory School: Lessons for today*. New York: Teachers College, 1997. Print.
- The industrial revolution*. (2003). Retrieved from

<http://industrialrevolution.sea.ca/impact.html>

Thompson, T. L. (2004). *The learning theories of David P. Ausubel: The importance of meaningful and reception learning*. Retrieved from

<http://ww2.coastal.edu/dsmith/edet720/ausubelref.htm>

Zimmerman, B. J. (2000). Self-Efficacy: An essential motive to learn. *Contemporary Educational Psychology*, 25, 82-91. doi:10.1006/ceps.1999.1016