Project Rationale: Fraction Orange

By Dolly

**all names and identifiers have been masked/changed to retain anonymity*

Over the last few months of my own learning, I have come to realize (even more) the profound capacity for mathematical learning that children possess. Through my own experiences with math and through observation of students in the classroom, I began to make the priority of my manipulative the physical understanding and conceptualization of fractions. As a human, I imagine many things, mathematics or not, as an object or experience in space in my mind. Because we can only output translations of our own experiences, I wanted to make something that would hopefully assist students in dealing with mathematics through spatial information and tangible experience, as I have always found it an effective way to conceptualize mathematical processes. I chose fractions because from what I have seen in schools, fractions are taught in a very limited, rote capacity through rigid processes. In reality, learning fractions can be such an exciting part of math, and the idea of "the whole and its parts" is so heavily important in understanding so many concepts, far beyond that of fractions or even mathematics. This fraction orange is intended to help children understand how parts can interact with their whole in order to help them conceptualize dealing with fractions on a deeper level.

The orange is designed in a way that allows the user to discover and compare the parts, or fractions, of the whole. As the child starts to uncover (dare I say "peel") the different compartments of orange, they will discover how a whole can be divided into different parts (slices) equally. As they halve the whole orange, they will discover two different looking sides.

Through exploring the different halves, the user will begin to realize that one half is divided equally into two parts, and the other is divided equally into three parts. I will call them the "half of twos" and "half of threes". As the user explores the half of twos, they will be able take those smaller pieces (now dealing with quarters of the whole orange, or halves of the half), and remove them from their "nests". Upon doing so, they will discover that those quarters are also divided equally into parts (which become eights of the whole, or quarters of the half). They will be able to do the same with the half of threes, discovering that the pieces come apart first as thirds of the half or sixths of the whole, and then sixths of the half or twelfths of the whole. The user will be able to completely deconstruct and reconstruct the orange, lay its fractions side by side, see how parts and slices may or may not fit into other parts, etc.

Through physically dealing with the different slices of the half of twos and the half of threes, the user will hopefully begin to see the relationship between parts and how they can come together to make a whole. The nesting is an interesting part of the design because it puts forth a kind of sense of discovery for the user, and hopefully gives them an opportunity to have an "ah-ha!" moment with how a whole can be decomposed into parts, or fractions, and how they might fit together in an exciting way. The "skeleton" of the whole or larger part that remains also serves as a reminder to the user that the parts they are now holding came from the decomposition of the part or whole before them. The orange will also hopefully show the user what simple division of fractions looks and feels like. For example, they will be able to see that half of the half of twos will produce the same two pieces, which are simultaneously quarters of the whole and halves of the half. Therefore, they can make the connection that a whole divided by four is the same as a half divided into halves. The user will also be able to use the orange to think about how dividing by twos and threes (and their products) are all relational to one another. On some level, the orange begins to show the user the relationship between how wholes that are divided into fractions of two (or three) are all actually parts or wholes of one another. The absence of sevenths and elevenths, and so on (prime divisions of the whole) also indicates to the user that those types of fractions or slices do not "fit together" or "peel apart" in a way that dividing a whole and subsequently its parts into halves and thirds produces. They will also be able to compare sequences of halves and sequences of thirds side-by-side in a three-dimensional way. All of this exploration will hopefully aid the user in thinking about fractions in a consequential and (literally and figuratively) global way.

It was important to me to break half of the orange into halves and the other half in thirds, as well as to find a way to make them all nest within one another in a three-dimensional way rather than a two dimensional way. I feel that the comparison of the halves and thirds and how they ultimately fit into the same whole gives the user a basis for flexible thinking in terms of how objects can translate into different fractions (even within itself) and how written fractions can translate into a whole composed of different parts even within itself. The challenge that lies within having two different halves is that it asks the user to conceptualize a double of each in order to make sense of the pieces in relation to the *whole sphere*, rather than just the half. However, I believe (and hope) that is a gap in information that the user will be able to fill in with much more meaningful connection than if it were just placed in front of them. I also think that dealing with a three-dimensional sphere is exciting and challenging to a student who may be much more used to dealing with cubes and two-dimensional representations of pie charts and linear comparisons of fractions. I would have liked to have included one more halving/thirding in the orange, but ultimately it was not realistic to design, and I feel that it is currently effective enough to demonstrate the previously mentioned learning points to the user.

When thinking about using the fraction orange to help students solve mathematical problems, I feel it would be useful in dealing with equivalent fractions or simple division of fractions. For example, I might ask the user to use the orange to prove that $\frac{4}{8}$ is equal to $\frac{1}{2}$. The question could be: “Chance ate $\frac{4}{8}$ of his pizza. Janelle ate $\frac{1}{2}$ of her pizza. Who ate more?” The user could use the the half of twos to show that 1. The half is capable of having four parts 2. If a half has four parts, that means a whole can have eight 3. The entire half of twos obviously equals half of a whole, and it can be made up of four parts, so that means that having four of the total eight parts of a whole sphere will come together to make a half (that the user can hold in their hand). They can then use the half of threes as a physical representation of a half of a whole, and compare the half of twos (which represents four out of eight parts of a whole) and the half of a whole to realize that they are equal. Another story I might pose to a user would be: “It’s Molly’s birthday party. One half of her cake is chocolate, and the other half is vanilla. There are 6 guests at her part including her, and 3 want vanilla cake and 3 want chocolate. How can she divide the cake so that each guest can get ⅙ of the cake? Will there be enough chocolate and vanilla slices so that everyone gets what they want?” In this case, the user could look at the half of thirds and recognize it as either the chocolate or vanilla half of the cake. They would then be able to physically divide the half by three (which represents ½ divided by 3, or multiplied by ⅓). Since there are three slices in one half, and there are two halves in a whole, the user can deduce that each half would have to be divided by 3 (or into ⅓) in order to get 6 slices total, 3 being from the chocolate half and 3 being from the vanilla half.

If the fraction orange were to fail in terms of learning, I feel that the failure might lie in the fact that the fractions, or slices, do not necessarily appear to be “equal”, so it has the potential to be confusing to the user when placed against the lesson of “fractions are equal parts or divisions of a whole”. I also feel that the different halves (one being divided into halves and the other into thirds) and how differently their slices are shaped from one another could end up confusing a user more than helping them if they are unable to conceptualize the duplicate of each half. Students must be able to make the leap in conceptualizing the double of each half if they are working in terms of the whole, or simply have two fraction oranges. If this maker project were to be a success in terms of learning, it would build connections for children across what fractions mean in a very real, relatable way to being a person that exists in three-dimensional space. It would make the scary, rote world of fractions be a more flexible and adventurous place that is full of connections, patterns, and sequences that can be applied logically to solve an array of problems.