

# *Increasing the Accessibility of Math Tools to Align with Universal Design for Learning Principles*

## Introduction

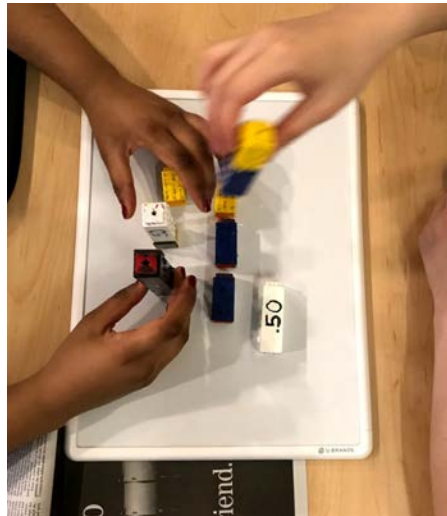
In elementary school, students begin learning basic math concepts, like operations in base ten and operations. To represent these topics, there are a variety of math tools available to bring these abstractions into the physical domain. For instance, take fraction blocks, blocks that can be pushed together to add up to 1 in divisions of  $1$ ,  $\frac{1}{2}$ ,  $\frac{1}{3}$ ,  $\frac{1}{4}$ , and so on. While these blocks would be helpful for some students, they do not accommodate everyone. The blocks are typically rainbow colored, but this would not be workable for students with colorblindness. Also, the blocks have small font, so students with other visual disabilities would have difficulty reading the blocks. Furthermore, since the blocks have to be pushed together to connect, students with motor issues may have trouble manipulating the blocks. For these reasons, we have proposed modified blocks, that would be accessible to a wider spectrum of students.

## User and context

The intended users are early education students learning their fractions. The modified blocks would be used in the math classroom, and could be used to complete assignments at home as well. Specifically, the perceived best use of these modified fraction blocks are in individual or group practice, though they could be used in a demonstrative context to a lesser effect. The blocks are designed to be utilizable by any student regardless of ability, and to be used as manipulatives to provide a physical manifestation of a complex abstract subject (fractions). Thus, the intended context is in an individual/small group work, so that each student has the opportunity to manipulate the blocks for themselves.

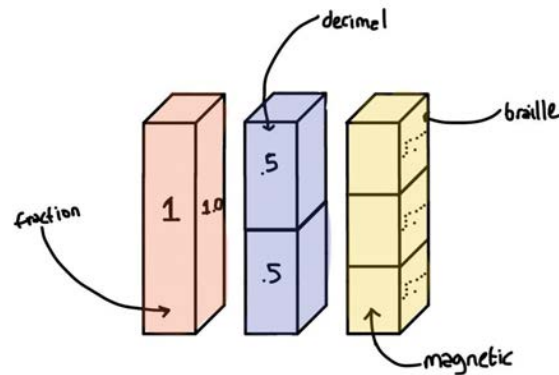
## Learning Objective & Universal Design for Learning

Common Core math standards state that fractions should be introduced in the third grade, and recommend several substandards within fractions. Students should be able to explain the equivalence of fractions, understand fractions in terms of a number line, and understand that fractions represent parts of a whole (“Grade 3 » Number & Operations—Fractions<sup>1</sup> | Common Core State Standards Initiative,” n.d.). With these standards in mind, fractions block are a great way to demonstrate these concepts, and to make them align with UDL standards, we examined on how to provide options for multiple means of representation and providing multiple means of physical action (“UDL: The UDL Guidelines,” n.d.).



**Figure 1.** Students playing with the modified fraction blocks.

A design mockup of the altered blocks is pictured in Figure 2. The use of the magnetic strips and magnetic board are for manipulation considerations; students with motor-control issues, as is common with younger children, are able to push the blocks around without fine finger motor control being necessary. Additionally, both the written text and base block colors are color-blind accessible; the text and background colors offer sharp contrast, and the overall set of blocks is a color-blind friendly palette.



**Figure 2.** Design mock-up of modified fraction blocks, rotated to show all sides.

The last set of design considerations and technologies are on fraction representations: each side (apart from the magnetic side) offer different representations of fractions. The font on the two written representations (fraction and decimals) has been enlarged, and on light colors (namely, the yellow blocks), the writing color has changed to black to provide better visual contrast for students that are visually impaired. Lastly, the third side has fractions written in braille for blind students. A picture of the final prototype set-up is included in Figure 3.



**Figure 3.** Prototype of altered fraction blocks to better employ UDL principles.

There do exist limitations in this use of technology; the braille makes the blocks inaccessible manipulatives for blind students who are unable to read braille. However, due to the differentiable size of the blocks, it may be possible for such students to be able to tell different sizes by touch, though they may not be able to know that a block represents  $\frac{1}{4}$  versus  $\frac{1}{3}$  without additional help from a group member or teacher.

## Use of Technology

The driving force behind the use of this technology was creating a manipulative that can be used by any early math student. A physical manipulative is useful because fractions are a highly abstract concept that can be difficult to grasp at an early age. Blocks are additionally easier to manipulate than computers, and the cost of purchasing enough blocks for a classroom is much less of a load than tablets or computers for a simulation of fractions. We also believe that the modifications proposed here could apply to any math tangible to allow for higher levels of accessibility. We suggest the math tool designers consider moving away from inaccessible colors and provide more options for students with vision disabilities, such as braille or raised surfaces on the tools that make the blocks discernable by touch.

## References

Grade 3 » Number & Operations—Fractions<sup>1</sup> | Common Core State Standards Initiative. (n.d.).

Retrieved April 15, 2019, from <http://www.corestandards.org/Math/Content/3/NF/>

UDL: The UDL Guidelines. (n.d.). Retrieved April 15, 2019, from <http://udlguidelines.cast.org/>

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