

Apps for teaching, not just reviewing



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via displaying information or applying their knowledge (Kurz, Middleton, and Yanik 2005). An extensive search through the apps in the App Store indicates that many of the apps are designed with the goal of allowing students to review and practice; and in fact, other research has found this to be true as well (e.g., Murray and Olcese 2011). However, using technology to create understanding is essential for its effective implementation (Hooper and Hokanson 2000). Specifically, allowing students to create foundational algebraic knowledge, such as developing generalizations, will allow them to deepen their understanding of algebraic concepts in middle and high school (Baek 2008).

Because we were interested in an app that we could use to teach—not just review—multiplication and could not find one, we decided to develop our own. The result is Fruit Plate Math (Rogers 2013), a free iPad app (see fig. 1). The plates and fruits illustrate the equal-size-groups model of multiplication. Students can see groups as fruits on a plate or as fruits arranged in an array. The app also shows four different ways of representing the number of fruits:

1. As a “groups of” statement
2. As a multiplication expression
3. As the total number of fruits
4. As a repeated addition expression

Developing foundational knowledge

With Fruit Plate Math, the *Array* view of the *Basic Multiplication* tab allows students to use a slider to change the number of rows and columns in the array. Moving the slider simultaneously modifies the array, enabling an immediate visualization that is impossible with concrete manipulatives. Students can also tap on *Count*, and the app audibly skip-counts the fruits, simultaneously highlighting the fruit and displaying a repeated-addition expression and the running total.

Are you fortunate enough to have a classroom set of iPads® or another type of mobile technology? Perhaps you have only one iPad linked to a projector, and you organize students in teams to take turns. What kinds of applications (apps) do you have on your classroom iPads? Looking through the iTunes App Store, one will find many apps designed to allow students to practice basic fact fluency—essentially fancy electronic flash cards. Are these truly the only types of apps that are available?

In fact, various approaches to technology use in education have been identified. Among these approaches are those that review and practice concepts as opposed to those that teach new content, whether specific to a certain content area or topic or generalizable to multiple disciplines. Additionally, technologies are available to help students demonstrate learning either

Guiding questions: As you move the slider, what do you notice about the array? What are some different methods we could use to determine how many bananas are in the array? Compare and contrast using skip counting and repeated addition to find the total number of bananas in the array.

Connecting foundational knowledge to basic multiplication concepts

Understandings related to multiplication progress from second grade through third grade. Beginning in third grade, students must conceptualize multiplication as repeated addition of the same quantity and must visually represent multiplication as equal-size groups and arrays. The *Plate* view on the *Basic Multiplication* tab allows students to create equal-size groups of fruit on plates. The sliders allow students to manipulate the number of plates and the number of fruits on each plate.

Guiding questions: Using the sliders, create four plates with two oranges on each plate (or a similar problem). How could we figure out how many oranges we have? Which other ways are there to determine the number of oranges?

After changing the number of plates and fruits multiple times and asking similar questions, alert students to the “four groups of two” and the 4×2 expressions:

- As you adjust the sliders, what do you notice about these two expressions?
- Where would we need to set the sliders so that the app reads “two groups of three” and 2×3 ?
- Now tap on *Array* and watch the plates disappear and the fruits rearrange into an array. Compare and contrast the *Plate* and *Array* views.
- To show an array that had four rows and five columns, how many plates and fruits on each plate would we need?

Using properties of multiplication

When students are comfortable with basic multiplication (e.g., 4×2), learning the distributive

FIGURE 1

Wanting more than a practice app for their students and unable to find an app to teach multiplication, the authors developed Fruit Plate Math (Rogers 2013), a free iPad app. Using plates and fruits to show the equal-size-groups model of multiplication, the app allows students to see groups as fruits on a plate or as fruits arranged in an array.

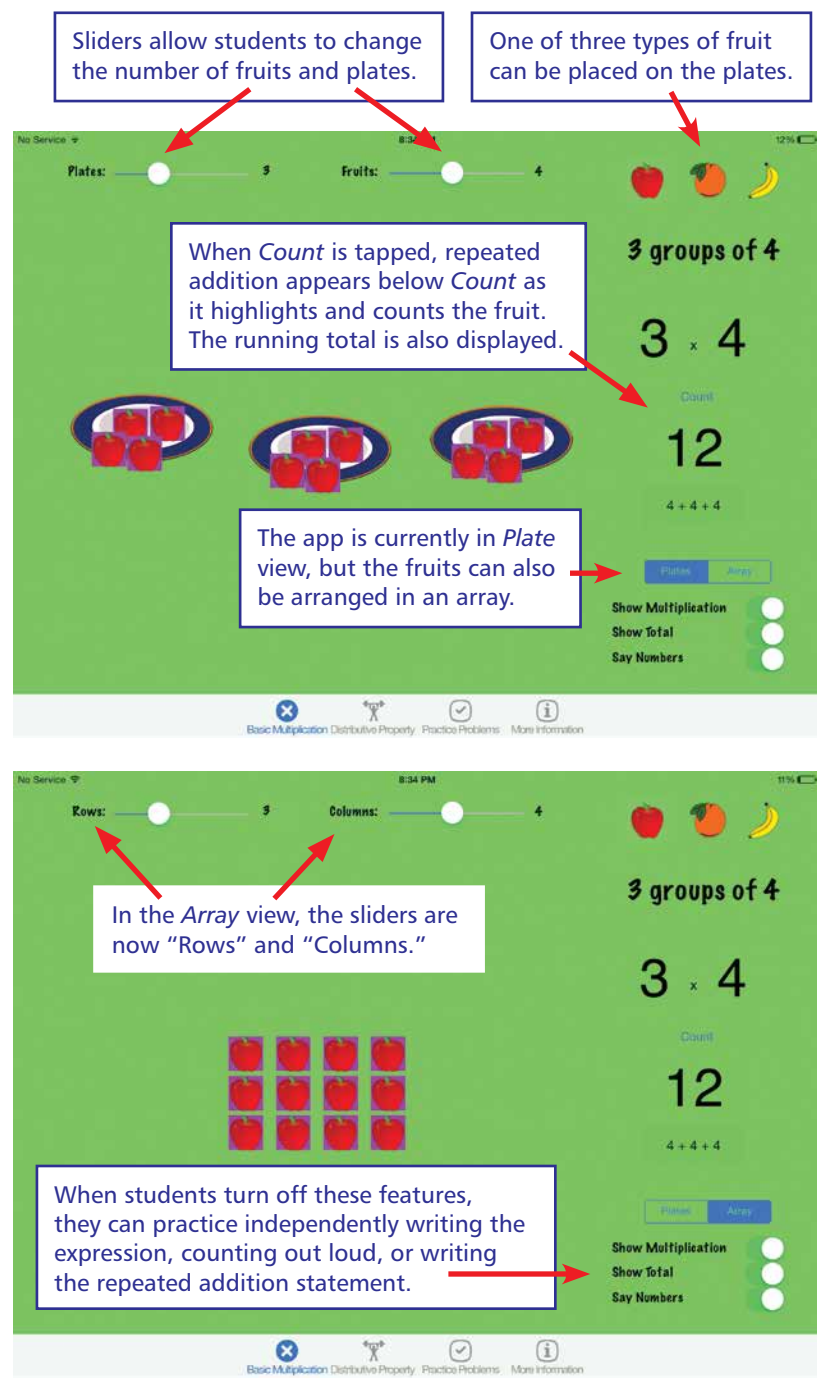
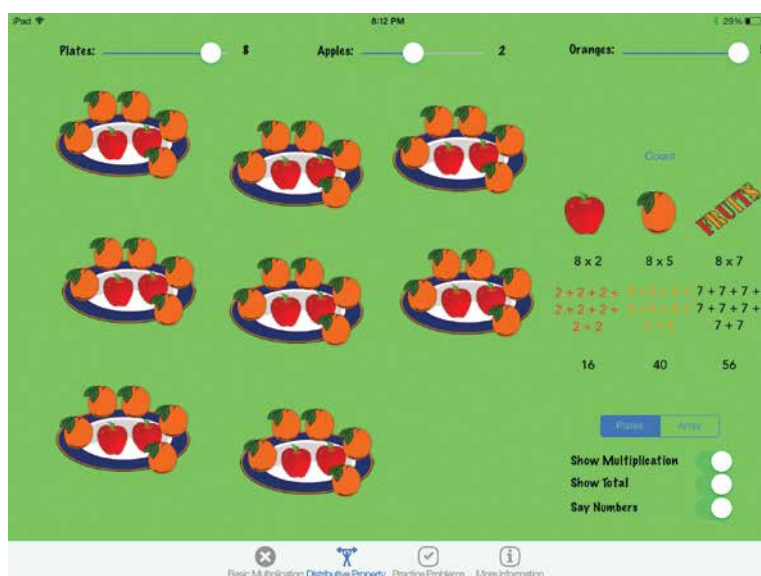


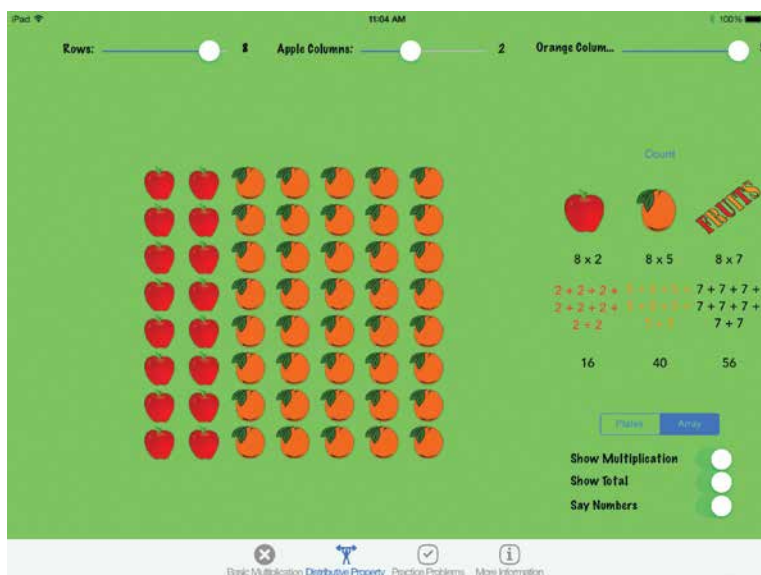
FIGURE 2

Third-grade students are more likely to know multiples of 5 and 2 than multiples of 3 and 4. A guided discussion about whether 8×5 and 8×2 are easier to calculate than 8×3 and 8×4 when multiplying 8×7 can show students the benefits of the distributive property.

(a) Students can see that 8×7 is the sum of the oranges and the apples: $8 \times 7 = (8 \times 5) + (8 \times 2)$.



(b) The *Array* view also helps students make these connections: The area of the entire rectangle (all the fruit) is equal to the sum of the two smaller rectangles (the apple rectangle and the orange rectangle).



property aids in fact fluency and understanding as they progress to multiplication with larger factors (e.g., 8×7). Rather than being told this option, it is best if students develop the concept of the distributive property on their own (Benson, Wall, and Malm 2013). In the *Distributive Property* tab on the Fruit Plate Math app (see fig. 2), students can do just that.

Guiding questions: What are different ways you could use to find the total number of fruits? How many apples are there? How many oranges are there? How many total fruits are there? After finding multiple examples, tap on Array. Do those methods you used to find the total number of fruits in the Plate view apply now in the Array view? What are some other ways we could represent eight plates with seven total fruits?

The *Distributive Property* tab puts two types of fruit on each plate (e.g., eight plates with five oranges and two apples on each plate—or 8×7 total fruits; see fig. 2a). This allows students to see that 8×7 is the sum of the oranges and the apples. The accompanying *Array* view (see fig. 2b) also helps students make these connections.

One purpose of teaching the distributive property in third grade is to help students learn basic facts; they likely know multiples of 5 and 2 more readily than multiples of 3 and 4. So, guide a discussion about whether 8×5 and 8×2 are easier to do than 8×3 and 8×4 when multiplying 8×7 . Both methods might be easier than multiplying 8×7 , thus showing the benefits of the distributive property. When students begin multiplying two-digit numbers by two-digit numbers in fourth grade, their foundational understanding of the distributive property will aid in comprehending the expanded notation multiplication and, later, the standard algorithm (Benson, Wall, and Malm 2013).

Developing fact fluency

After obtaining conceptual understanding of multiplication, developing fluency with products of two one-digit numbers, up to 100, is important and is a grade 3 standard (CCSSI 2010). Although fluency can be practiced in any of the tabs, teacher-led opportunities are best in the *Basic Multiplication* tab and the *Distributive Property* tab, and student-directed problems are

available in the *Practice Problems* tab. The *Practice Problems* tab provides a scenario of a certain number of plates and of fruits on each plate. The student can drag plates and fruits onto the table and type in the total number of fruits. When prompted, the app checks both the picture and the numerical answer. Students progress to answering the problem without creating the visual representation, often without prompting.

Conclusion

The free Fruit Plate Math app allows students to discover foundational concepts and strategies for learning multiplication in the second and third grades. Developing conceptual knowledge will benefit students mathematically in years to come. Also, this transformational use of technology, allowing students to create knowledge, rather than solely practice previously learned skills, is crucial in effectively implementing technology in the classroom (Hooper and Hokanson 2000). As technology becomes more common in the classroom, teachers will need to equip themselves with best practices for successfully integrating such technologies. Using the guiding questions above in conjunction with Fruit Plate Math might help teachers begin to use technology in this way.

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Technology, at its best, enables students to learn new content rather than limiting them to only practicing what they already know.

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