

Todo Math: Designed for Effective, Accessible Instruction

While Todo Math contains over 20 different games, a common design philosophy runs through them all. Primary to that philosophy is to incorporate instructional methods that have been shown to be most beneficial, especially for struggling learners. Also critical is that our design ensures accessibility for a wide range of students.

Best-Practice Instructional Methods Incorporated in Todo Math:

1. Use of Virtual Manipulatives and Multiple Visual Representations

“Research shows that the systematic use of visual representations and manipulatives may lead to statistically significant or substantively important positive gains in math achievement”¹

Visual representations and virtual manipulatives are included in many Todo Math games, including: Counting, Number Tracing, Tallies, Cookies, Equation Maker, Word Windows, and Light It Up.

Example 1: Cookies uses animation to illustrate the meaning of addition and subtraction as adding to or taking away from a set of items. Using the resulting final image, counting strategies can be readily used by students as support when solving problems in Cookies.

In Cookies, as well as Counting and Falling Blocks games, we utilize the 10-frame visual model for arranging and counting objects. This choice was made based on benefits especially for children with special needs. “Ten-frame tiles offer special needs students a rich, visual tool for developing understanding of number, place value, and computation. The visual model helps students connect each number name and the quantity it represents.”²

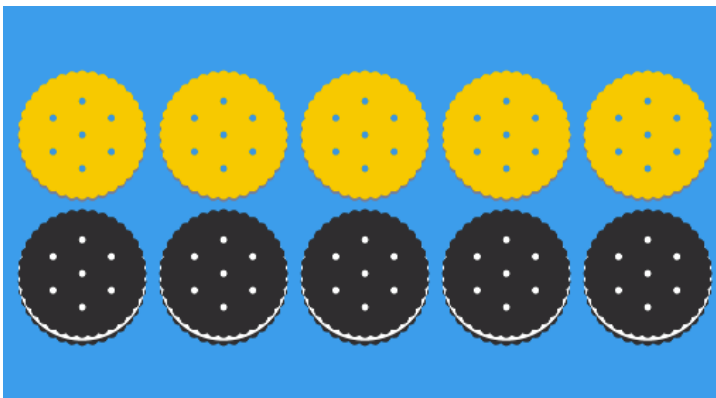


Figure 1: Representation of $5+5$ in Todo Math's Cookies game

Modeling addition in Cookies:

In time with a narrator reading aloud the sum “Five plus five”, animated paws place 5 yellow cookies, then 5 black cookies to model the sum, $5 + 5$. Students who are using counting strategies for addition, can use the end result image (Figure 1, at left), to solve the sum by counting the total number of cookies, or by counting on from the original 5 yellow cookies using the black cookies.

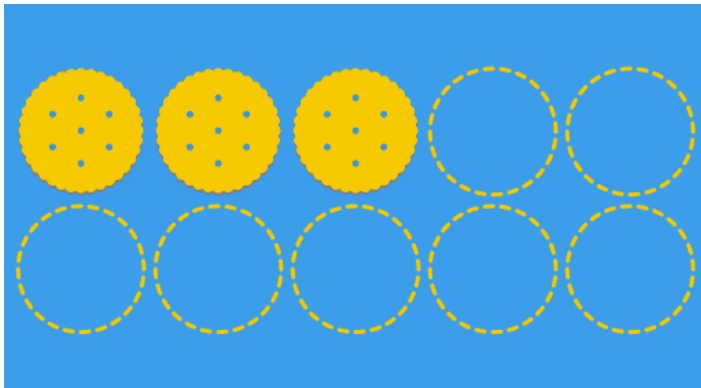


Figure 2: Representation of $10 - 7$ in Cookies.

Subtraction in the Cookies game:

For “ $10 - 7$ ”, the animated paws place 10 yellow cookies, then take away 7 of the cookies to model the problem. Students again can count the remaining cookies (Figure 2, at left) to solve the problem, or count back from 10 using the blank spots to find the answer.

Example 2: Light it Up uses the number line as a model for addition and subtraction. Virtual manipulatives, in this case colorful blocks, are put together for addition and taken apart for subtraction.

For addition, students see a block of a given length lined up on top of a number line. They need to find the correct additional length needed to get to a target value. In Figure 3 (left) below, the initial block is 7 units long, and the target is 9 total units.

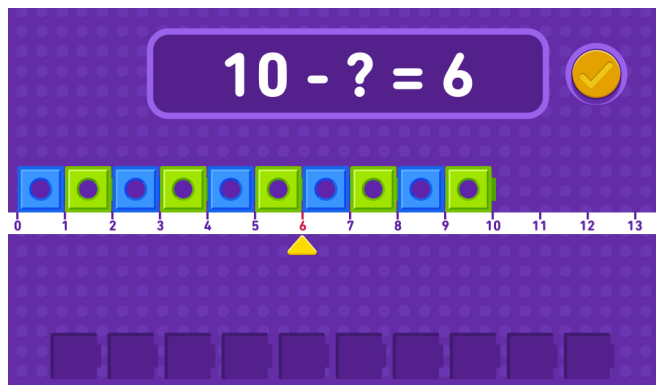
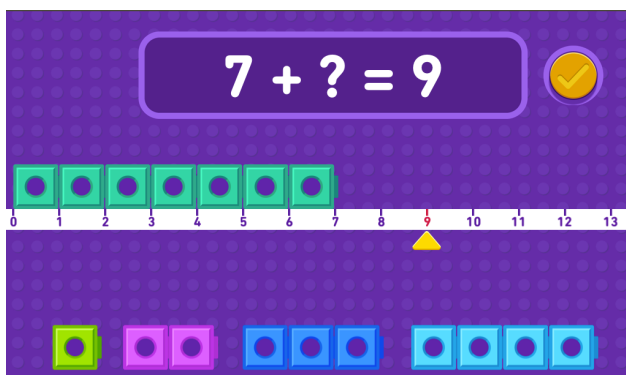


Figure 3: Addition (left) and subtraction (right) problems, Light it Up game

For subtraction, students will have to take away units of the given block to shorten it to the target value. In Figure 3 (right) above, the initial block is 10 units long, and the target value is 6 units.

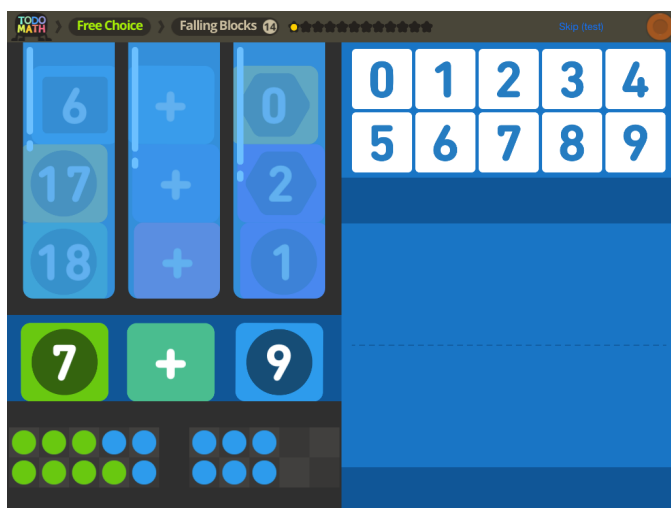
2. Opportunities to practice automatic retrieval of basic facts

“Quick retrieval of basic arithmetic facts is critical for success in mathematics.”³

With elementary math facts such as $2+7$, or $10-8$, the development of automaticity, or fluency, is widely accepted to be critical for further development. In their 2009 report on how to best help

students struggling with mathematics, the National Center for Educational Evaluation and Regional Assistance recommended allotting 10 minutes of any math intervention system to practice with basic facts.

As students move on to multi-digit multiplication, “long” division, and the study of fractions in the upper elementary grades, automatic retrieval of addition and subtraction facts frees up working memory for maintaining organization of these higher-order mathematical procedures and reasoning. For this reason, we have included several games (Falling Blocks, Quick Adding, Quick Subtracting, Quick Multiplying & Quick Facts) specifically for practicing quick retrieval of these math facts, and include these games regularly in the missions.



Addition Fact Practice in Falling Blocks
(At left - level 14 of 18)

In Falling Blocks, players quickly answer a set of 12 sum or difference questions. This game includes the visual support of 10-frames below the questions, illustrating the sum or difference. The 10-frame can be referred to as needed and supports self-correction.



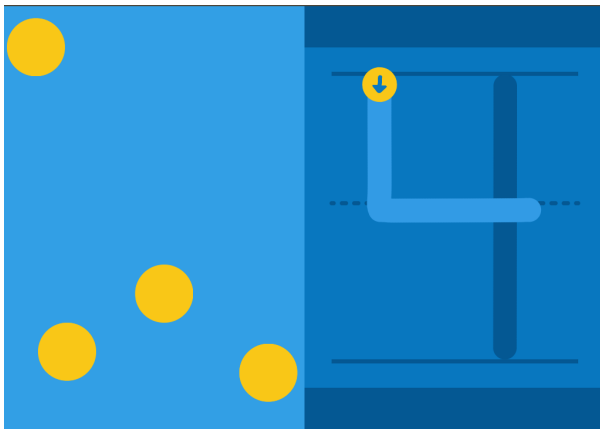
Subtraction Fact Practice in Quick Subtracting
(At left - level 4 of 20)

In Quick Subtracting, students answer 12 questions as quickly as they are comfortable without the support of visual models on screen. Todo Math also includes Quick Adding, Quick Multiplying, and mixed practice in the Quick Facts game.

3. Allow for student choice and differentiated learning

“... a growing body of research shows positive results for full implementation of differentiated instruction in mixed-ability classrooms (Rock, Gregg, Ellis, & Gable, 2008). In one three-year study, Canadian scholars researched the application and effects of differentiated instruction in K–12 classrooms in Alberta. They found that differentiated instruction consistently yielded positive results across a broad range of targeted groups.”⁴

Todo Math stands apart from other math apps for the volume and range of content included. Our intention was to provide sufficient content to be able to meet the needs of the wide range of students in Kindergarten through 2nd grade. On the early side, a student may be working on their understanding of numerals and the values they represent (Number Tracing, Counting), developing number sense through playing with “one more” and “one less” activities (Tallies, Light it Up), or expanding their concentration and working memory through games (Little Farm, Same or Different).



In Number Tracing, students practice tracing numerals alongside enforced 1:1 counting practice. Narration counts aloud as the player touches each of the yellow balls, and marks each with its corresponding numeral in the count sequence.

On the high achievement end, advanced students can find challenges in the highest levels of games stretching their logic (Matrix), time telling (Train Time) and calculation (Multi-Digit Math, Quick Multiplication).

Accessibility and Universal Design for Learning

We utilize the *Universal Design for Learning (UDL)* framework as the theoretical underpinning for this project. UDL provides proactive scaffolds to curricula for students with diverse needs. The National Education Technology Plan affirms the importance of this framework by stating that

implementation of the three key UDL principles can lead to improved outcomes for diverse learners. Its key principles (CAST, 2012) and examples of how Todo Math meets them are:

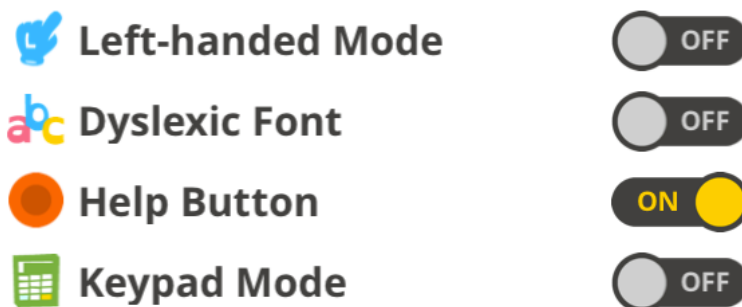
UDL uses multiple means of representation to demonstrate a concept. Todo Math uses multi-sensory representations (our games are highly visual, tactile and auditory) and concrete objects, such as ten-frames and real-life examples, to teach math concepts.

UDL uses multiple means of action and expression to demonstrate understanding and problem solving. Todo Math employs multiple means of action and expression such as including the option to use handwriting recognition pad, number tiles, or keypad entry; the option to see hints; settings for left-handed learners' ease of use; and special font for children with dyslexia.

UDL uses multiple means of engagement. Todo Early Math Promise engages early learners with over 20 different multi-leveled games in Free Choice mode, as well as over 30 curated Missions that provide a learning path and motivating display of progress to students who do well with more structured learning.

More on included Accessibility Options:

Accessibility Options



Left-handed mode swaps the screen so that the question is on the right side instead of left. This swap allows left-handed students to input their answer on the left side of the screen, avoiding reaching over to the right side, and blocking their view of the question.

Turning on **Dyslexic Font** changes the font used throughout Todo Math to one specifically designed to enhance readability. Many people with dyslexia have shown faster reading speeds with fewer errors when using “dyslexic” fonts, which adjust letter shapes and spacing to make similar letter shapes more distinguishable. We use the OpenDyslexic font, which you can read more about here: <http://opendyslexic.org/about/>

With the **Help Button** enabled, students can briefly display the answer for any question they have already attempted and gotten wrong. This prevents the problem of a student getting stuck and frustrated if a teacher or parent is not immediately available to help.

Selecting **Keypad Mode** changes the input system to a calculator-like keypad. Many students may prefer keypad to handwriting recognition or dragging the answer, for instance, those with fine motor control challenges.

¹ Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J. R., & Witzel, B. (2009). *Assisting students struggling with mathematics: Response to Intervention (RtI) for elementary and middle schools* (NCEE 2009-4060). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from <http://ies.ed.gov/ncee/wwc/publications/practiceguides/>.

² Loss, *Number Concepts and Special Needs Students: The Power of Ten-Frame Tiles*, Teaching Children Mathematics, Feb. 2005

³ *ibid*

⁴ Huebner, *What Research Says About Differentiated Learning*, Educational Leadership, Feb. 2010)