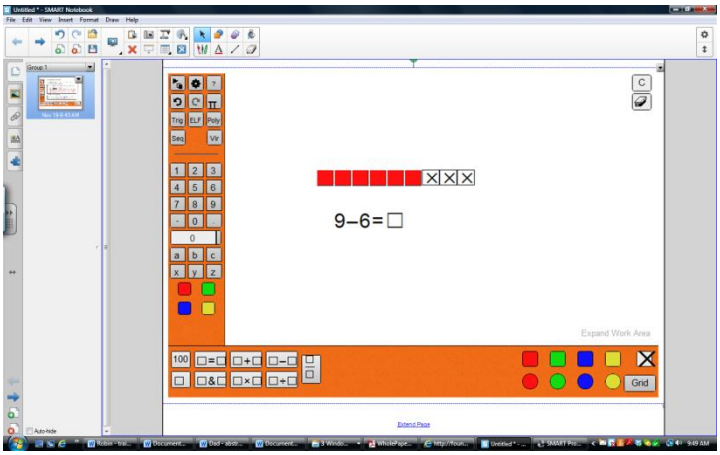
Mathematical Language: Deep, Early Understanding through Technology

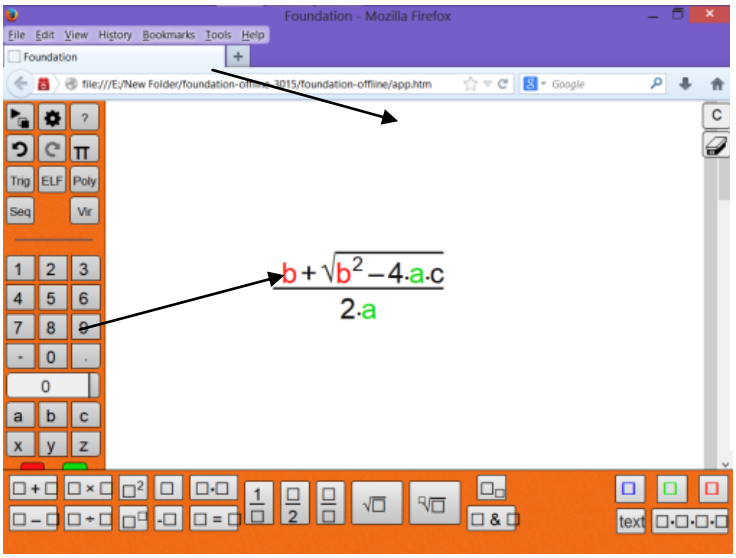
Don Watson and Rachel Le Neve

Remarkable results have been achieved in Grades 1 and 2 with a tool that breaks new ground. Mathematics notation was turned into a simple computer language with major and universal side-benefits. It has application throughout the whole school Mathematics curriculum from Grade 1 addition and subtraction to Grade 12 Calculus.



The tool is called "Foundation", because it is a foundation upon which both arithmetic expressions and algebraic expressions can be built.

Foundation expressions are built from functions such as the addition function (□+□) and the multiplication function (□×□). These are located on the bottom toolbar.



Numbers are on the left toolbar and can be dragged into a variable or onto an algebraic variable. For example:

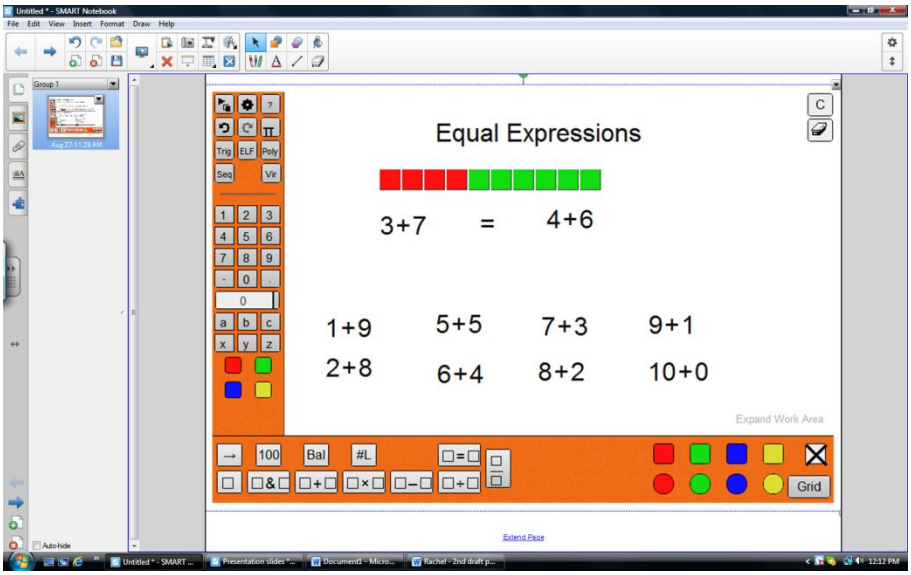
5 → □ + □

to give: 5 + □

Although the tool had originally been intended for use in older grades, it has successfully been used in grades 1 and 2 to teach abstract Algebra concepts like expressions, equality and variables. It was also used to teach symmetry, basic arithmetic operations (*addition, subtraction, multiplication, division*), fractions, area, perimeter, and data management.

Seeing Arithmetic as functions as well as seeing it as operations enables both Arithmetic and Algebra to be introduced with less abstract processes, which research suggests are much easier for children to understand. These concrete processes are created through the motion of mathematical notation and manipulatives on the screen.

As well calculating any school mathematical expression directly, functions appear to make Arithmetic a much better preparation for Algebra. Usage is expected to show that the use of functions in the elementary grades is an improved process for developing the literacy in Mathematics notation needed in high school.



The following were considered benefits of having used Foundation in the Grade 1 and 2 pilot classes: the ability to drag entire expressions helped students see them as whole entities rather than a sequence of individual parts; starting with the function ⬚+⬚ helped students see the plus sign as representing an operation (*the*

process of addition) rather than as an arbitrary symbol, avoiding any confusion about which operational sign to use.

Effort has been devoted to keeping Foundation simple, consistent and mathematically intuitive, making it easy to learn. Apart from the need to contain nothing but mathematical notation, manipulatives and text, Foundation offers as much freedom as a blackboard or whiteboard. The teacher can place anything anywhere on the board and use it for any mathematics lesson in any grade. The whole application of Foundation is under the control of the teacher or student, not the computer. It places no limitation on curriculum - nor does it influence curriculum - it supports the whole curriculum and any lesson plans, both commercial and personal, in any grade.

The range of manipulatives and other features is being expanded grade by grade to maximize the potential benefits. High school functions are already in place, including polynomials, trigonometric functions, logarithmic functions, the exponential function and factorials.

A paper documenting the presentation, with examples of practical classroom applications and sample lessons, is posted at the website www.FoundationNotation.com . The means of contacting the authors and the means of accessing the software are available at the website.