Maplesoft
Mathematics • Modeling • Simulation
A Cybernet Group Company

Clickable Math:

Easy to Do, Easy to Learn, Easy to Teach

In a digital era that is becoming faster-paced by the day, instructors must carefully consider the technology they choose to meet the unique needs of technical education. As technology increasingly offers the promise of instant gratification, the demand for quicker and more powerful educational delivery methods is increasing as well, and institutions are striving to meet this demand while catering to students on a global scale. The technology that institutions choose must be convenient, easily accessible and user friendly, creating an efficient and streamlined learning environment. This is especially true in science, technology, engineering and mathematics (STEM) education, where the needs are unique and complex.

Students today are growing up with technology, both in their personal lives and in the classroom. They are proficient with technological tools and are accustomed to a certain level of speed and convenience. These days, students and teachers alike have little use for tools that are difficult to learn and use, as they take up class time and mental energy that is better directed towards studying course materials and mastering concepts. Modern, easy-to-use software tools for STEM education allow instructors to bridge learning gaps, resulting in greater student engagement and feedback.

Benefits of Using Modern Technology Solutions for STEM Education

Teaching and learning technology has come a long way in recent years. Solutions like those offered by Maplesoft, make it possible for students to visualize and interact with the materials they are studying in advanced online environments that facilitate a two-way learning process.

The benefits of such an environment are many and varied. Following are just a few examples:

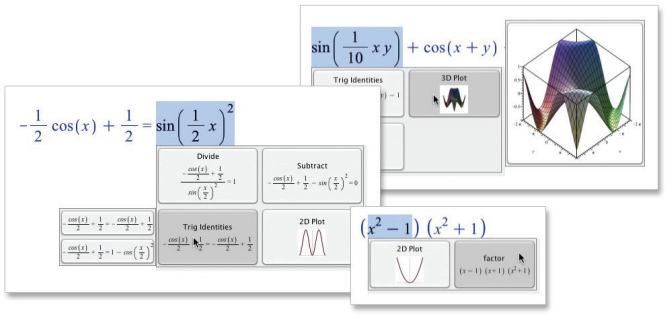
- Students can complete problems using tools designed specifically for STEM courses, allowing them to learn concepts and solve complex problems more efficiently while still using standard mathematical notation so problems and solutions appear exactly as they would in a textbook – no complicated syntax required.
- Questions that test understanding can be presented as assignments or embedded at the appropriate place in a video lecture, when using online education tools, ensuring that students are grasping key concepts before moving on.
- Using testing and assessment tools, students can attempt questions multiple times, receiving immediate feedback on their responses to help them address and strengthen areas of weakness before proceeding.
- Graphs, plots and 3-D animations can also be easily developed to visualize formulas and data, and then manipulated to see the impact of changing factors and parameters.

These interactive features, and many more, foster a deeper understanding of core materials and complex ideas, allowing students to develop greater competency and confidence in dealing with STEM subjects. The advantages are two-fold - the technology provides greater efficiency, while permitting instructors and students to devote more time to complex concepts and deeper learning.

Clickable Math and the Continuing Wave of Technology Innovation for Education

New and evolving technology tools are revolutionizing mathematics education and providing an even more streamlined learning experience. One such example is Clickable Math, an innovative concept developed by Maplesoft, which is unique to its learning solutions. The ability to teach powerful mathematics using visual, interactive, point-and-click methods has ushered in a new era of learning techniques in STEM education. In addition to a powerful computational math engine, Maplesoft's learning solutions offer a unique user interface that allows students and new users to become proficient without the burden of learning commands and any related syntax. The result is a learning environment that minimizes misused time and resources, and promotes increased focus on the ideas and materials that matter.

The Clickable Math concept originated nearly 20 years ago with the introduction of context-sensitive menus in Maple, Maplesoft's math software, to support math operations. The software continued to evolve over time and now includes task templates, Math Apps, numerous interactive elements and even built in tutors to guide students and instructors through the various tools and features. In general, Clickable Math features are designed to streamline the experience as much as possible for users, allowing them to dedicate all of their focus on educational elements. These features let students very easily perform mathematical operations by, for example, clicking on an expression and selecting a desired operation from a list of relevant options on a context-sensitive menu, or by dragging and dropping terms within an equation. The operations are all fully documented, which means students can go back later and review each step to verify their work and have a full understanding of how they reached their solution.



Clickable Math **Features**

- Drag-to-solve
- Easy-access pallets for selecting functions and symbols
- Interactive 3-D plots, graphs and animations
- Compare and annotate figures
- Self-documenting record of steps and operations
- Numerous Math Apps
- Built-in tutors to guide users through features

Maple also includes various palettes that allow students to enter desired functions and symbols with one click, and the resulting equations, formulas and expressions appear exactly as they would in a textbook or on a blackboard. There is also a range of interactive plots, graphs and animations that allow students to pan, zoom and rotate 3-D figures to visualize concepts and the impact of changing parameters. Users can drag equations and expressions directly into a plot area to create and compare graphs and shapes, and then annotate each figure with text or arrows to highlight any points of significance. This allows students to visualize concepts and ideas and see a physical manifestation of how each figure is affected by altering different values and specifications.

These examples demonstrate how Maplesoft's Clickable Math functionality ensures that students stay focused on learning the mathematics, not the software.

The idea of a point-and-click interface is driven by the objective of improved performance and competence. One need not be proficient with Maple to use it, as the Clickable Math concept is about designing an interface that guides the user through various steps and features, creating a simplified experience that lets students maximize their time for learning and study. With Clickable Math, students can create and solve a seemingly limitless number of problems, even complex mathematical equations, in a seamless and easy-to-use environment.

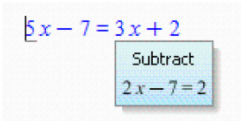
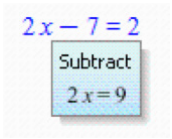
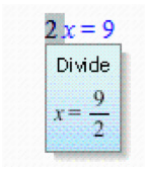
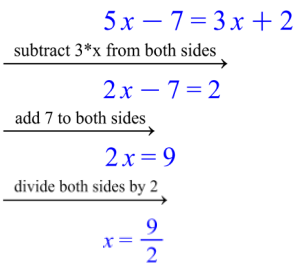
Drag *3 x* from the right side of the equal sign to the left side. A Smart Popup window is displayed, previewing the results of this manipulation.	
Next, in the resulting output equation, drag -7 from the left side of the equation to the right side.	
Drag and drop the factor of *2* , in front of *x* , to the right side of the equal sign.	
The result of the above steps is a fully worked out solution.	

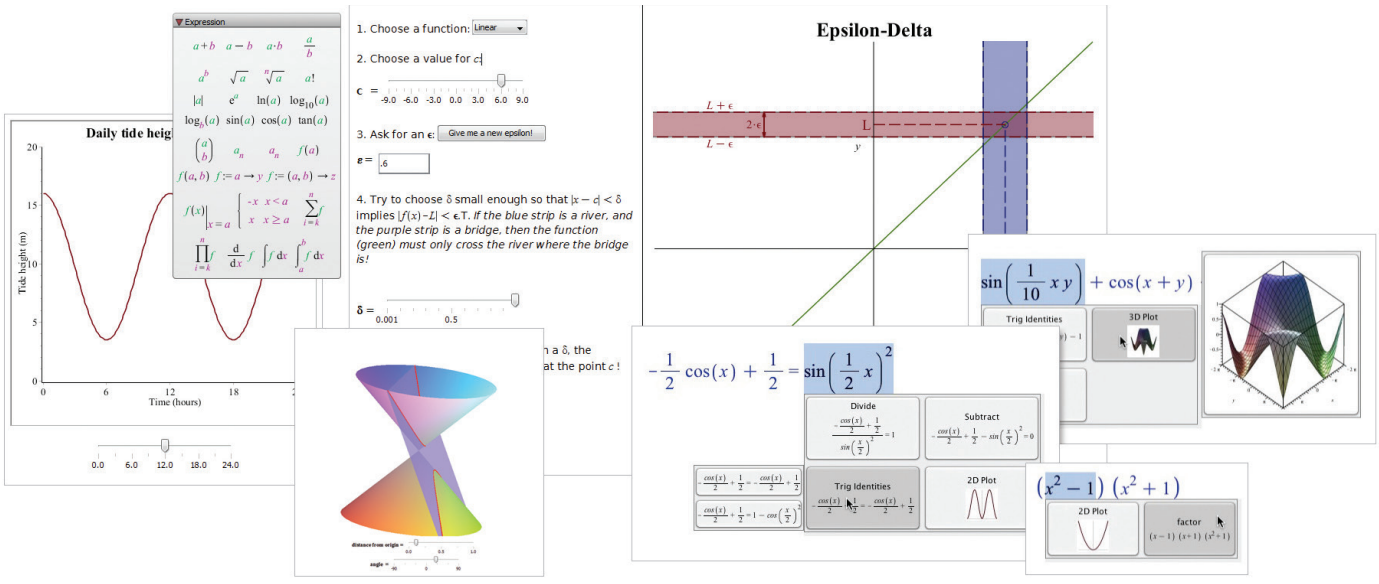
Figure 1: The above example uses Drag-to-Solve in Maple to solve this linear equation in the way students are taught to do it, moving terms around and performing operations on both sides of the equation. To move a term from one side of the equal sign to the other, the student simply drags the term across, and Maple understands what the student means by the action.

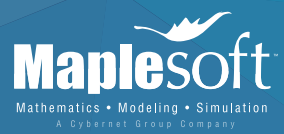
While the Clickable Math concept originated with Maple, it is increasingly being adopted in other Maplesoft academic solutions. Clickable Math applies to math applications across a number of disciplines, including but not limited to: precalculus, calculus, algebra, geometry, cryptography, numerical analysis, differential equations and quantum mechanics.

What Clickable Math Means for Education

Modern educational solutions have revolutionized and will continue to shape how materials are taught and learned. The measure of truly successful technology is one that allows you to make use of it without being conscious of it.

Technology that is intuitive and allows students to explore mathematical ideas with confidence is an invaluable resource, increasing student understanding and shortening the time required to teach difficult concepts. Powerful, easy-to-use mathematical software can even give educators in STEM courses the opportunity to rebalance conceptual understanding with the traditional development of manipulative skills. This rebalancing arguably enhances student learning and better prepares them for future careers where capacity of understanding is more valuable than mechanical tasks that can be done by a computer.





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