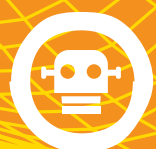
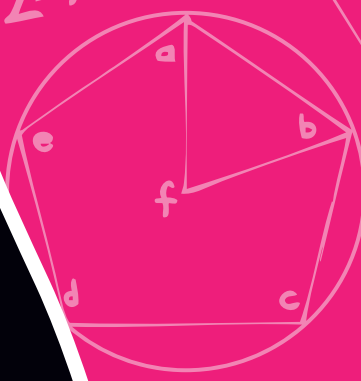


MATHALIVE! ELEMENT LIST



$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\sqrt{2-x^2}$$



$$f(x) = \frac{1}{3} + \dots$$

1.0 INTRO GALLERY – Marquee Title and Entry Passage

An overarching passage introduces the exhibition. A freestanding video introduces the BotZ characters who “hand you” the magical math goggles that allow you to see the math behind all actions and objects you encounter in the exhibition. Enter a darkened space punctuated by a dynamic montage of bold, vibrant images which dissolve and cycle to reveal the underlying math graphically, emphasizing how math is a part of the world around us, and that math opens doors and takes you places.

Who are the BotZ:

Three character guides who act as a cool and creative team throughout the exhibition, using humor, clear communication and useful tools to help visitors discover how math relates to the world around us. The BotZ introduce how the interactive activities work, with fun exchanges and small details that bring out their personalities and relationships. Each Bot has expertise in at least two subjects covered by the exhibition galleries, so a Bot helps explain the featured mathematical concept in many of the activities. They provide humor, communication, and helpful tools or devices.

2.0 OUTDOOR ACTION ... ADVENTURE SPORTS

• **Boardercross ... Snowboard Experience**

Description:

Race others in a snowboard ride. Jump onto a pivoting snowboard and twist and torque your body, angle your board and fly over obstacles while you race against other players. Watch the action on an immersive screen to coordinate your body movements along with the action.

Main Idea:

This interactive gives visitors a better understanding of angle size and provides concrete comparisons of different sized angles. The idea of “acute” angle is emphasized.

Curricula Connection:

This interactive provides practice in identifying angle types, including acute, right, and obtuse angles. It connects with students’ study of the measurement of angles.

• **Ramp It Up ... Build a Skateboard with POP**

Description:

At a virtual design station, using real skateboard parts as the interface, design a skateboard that performs an *Ollie* and set the variables to perform the best tricks with your board. Determine the best shape and length of your board; choose the best wheel size and position of the trucks. A skateboard is a kind of lever and the wheels and trucks act as fulcrums. Test the ability of your board to perform an *Ollie*.

Main Idea:

Two variables can be manipulated and tested in combination in order to get closer to the optimal effect.

Curricula Connection:

The understanding of “variables” is crucial to algebraic thinking and should be developed starting in the elementary grades and continuing into formal algebra.

• **Get a Grip ... Rock Climbing; Measure Up ... Scatter Plot; It’s a Stretch ... Arm Span**

Description:

Test your mountaineering ability with a horizontal climb around a rock wall. But first, measure your height and arm span. Plot the results for your ratio of arm span to height on a scatter plot. If your arm span is greater than your height, you may be a better rock climber.

Main Idea:

There may be a correlation between two variables. This relationship can be seen on a mathematical representation called a scatter plot.

Curricula Connection:

Making and interpreting scatter plots are central to units on data analysis.

• **Pedal to the Peak ... Mountain Bike Challenge**

Description:

Compete against others in a mountain bike race. Jump on a stationary bike, or use a hand pedal. As you pedal, match the shaded areas on two linked graphs. One graph represents speed on one axis and time on the other, while the other graph shows distance on one axis and time on the other. The more accurately you match the areas shaded around the lines plotted on the graphs, the higher your score.

Main Idea:

Line graphs can show changes in distance over time and changes in speed over time. These two graphs are interrelated.

Curricula Connection:

Analyzing graphs of speed and distances is essential to both algebra and physical science courses. These graphs provide an ideal way for connecting science and math, because “telling the story of the graph” necessitates an understanding of the phenomenon of motion.

• **Featured Personalities in OUTDOOR ACTION:**

- Eric “Tuma” Britton, Professional Skater/Instructor, Venice, California
- Liza Brooks, Co-owner and Technical Director at True Snowboards, United Kingdom
- Skip Garibaldi, Mathematician and Rock Climber from Emory University, Atlanta, Georgia

3.0 BUILD YOUR WORLD ... ENVIRONMENT

• **Bridge to the Future ... The Engineered City**

Description:

A futuristic bridge fans out stretching across the room. The bridge is surrounded by stations where visitors take on different engineering roles as they design a more sustainable infrastructure for a city. Throw a beach party and discover through your mobile device the systems that engineers create to allow us to do the planning. Lights on the bridge illuminate the system infrastructures.

• **Easy on the Gas ... Transportation**

Description:

As the city keeps growing, the TRANSPORT network has to ensure traffic circulates efficiently. At this design challenge station, try to come up with a plan to reduce gridlock and fuel consumption.

Main Idea:

Mathematics enables us to simultaneously consider several “what if” questions about the impact of several variables.

Curricula Connection:

Algebra in 8th and 9th grades includes an emphasis on modeling. Working with transportation systems is an important application of modeling.

• **Power Play ... Energy**

Description:

Reducing ENERGY USE keeps down costs and improves air and water quality. A major storm is racing toward the city. Which essential services need a constant supply of power? At this design challenge station, faced with the problem of limited power supply in an emergency situation, visitors will solve the equation by choosing which services need to continue while staying within the power limit.

Main Idea:

Examining real-time graphs of electrical use provides engineers with immediate mathematical information that is used to maintain the functioning of the grid in emergencies.

Curricula Connection:

The science of energy conservation is connected with the ability to read and interpret graphs that change in real time. Science laboratory “probes,” such as those that measure temperature, motion or electrical energy usage, demand that students use real-time graphs.

• **Going Viral ... Communications**

Description:

Find out how much server space is needed when your video goes viral through digital networks. At this design challenge station, work through a linear animation that demonstrates the powers-of-ten formula through digital communication.

Main Idea:

Exponents are a key way of expressing the size of numbers and provide a way to simplify calculations involving very large and very small numbers.

Curricula Connection:

High school study of math and science depends upon having a solid understanding of exponents.

- ***Test the Waters ... Water***

Description:

Test the water to determine whether it is safe enough for swimming. At this design challenge station, virtually test water samples, and use really small numbers like parts per million in three different ways: fractions, decimals and exponents, and determine whether to open the beach for swimming.

Main Idea:

Very small numbers can be expressed in multiple ways, using the notions of “parts per million” decimals and scientific notation.

Curricula Connection:

High school study of math and science depends upon having a solid understanding of exponents. Understanding of parts per million is especially important in the study of biology, as well as in the emerging field of nanotechnology.

- **Featured Personalities in *BUILD YOUR WORLD:***

- Rondi Davies, Geologist and Champion Marathon Swimmer, New York
- Tanya Martinez, Electrical Engineer, Albuquerque, New Mexico
- Christine Outram, Director, City Innovation Group, Los Angeles, California and Research Associate, Senseable City Lab, Massachusetts Institute of Technology (MIT), Cambridge, Massachusetts
- Yemarshet Yemane, Engineer and Business Owner, Ethiopia
- Francisca Rojas, Communication/Migration Specialist, Cambridge, Massachusetts

4.0 FUTURE STYLE ... STYLE AND DESIGN

- ***Style Revolution ... 360-degree Photo Shoot***

Description:

Strike an action pose and have your image captured in 360 degrees, using the same freeze-motion technique made famous in contemporary action movies. At a viewing station, manipulate your image and choose to play back your 360 with all cameras, half the cameras, or shuffle.

Main Idea:

There is an inverse relationship between the number of cameras taking photos and the size of the angles between the cameras.

Curricula Connection:

The study of geometry, number, and measurement are integrated in this interactive.

- ***Make It Fit ... Tessellations***

Description:

Work with edge-lit acrylic shapes on a backlit table lined with mirrors. Move shapes to create tessellating patterns that fit together and repeat without gaps or overlaps.

Main Idea:

Identifying the attributes of certain two-dimensional shapes, which in combination, tessellate or fit together without any overlaps or gaps.

Curricula Connection:

Geometric shapes can be used in combination to create pleasing artistic patterns that have defined mathematical properties.

- ***Nature’s Numbers ... Nature’s Patterns***

Description:

Spectacular patterns from the natural world with a mathematical foundation are featured. At the attached workstation, discover how to calculate numbers in the Fibonacci sequence. Enjoy a video of Dutch artist and designer Theo Jansen’s Strandbeests, wind-powered kinetic sculptures that look and behave like fantasy animals.

Main Idea:

Some number patterns can be represented by a ratio that has interesting geometric properties.

Curricula Connection:

This interactive connects number theory, namely the relationship in the golden ratio, with geometry. It enables students to make connections between different areas of mathematics.

- ***Shadow Play ... Shadows***

Description:

Artist Kumi Yamashita uses the light shining on this seemingly random arrangement of numbers to throw shadows that produce the unexpected.

- ***Chandelier ... Sculpture***

Description:

The work of Neri Oxman, artist architect, and designer, is the design inspiration for this sculptural chandelier.

“Make things, be in nature, study irreverently and originally what fascinates you most and be guided by the idea that wonder is math’s currency.” – Neri Oxman

- **Featured Personalities in *FUTURE STYLE:***

- Neri Oxman, Artist, Designer, Architect, Massachusetts Institute of Technology (MIT), Cambridge, Massachusetts
- Theo Jansen, Artist and Designer, Netherlands

5.0 KICKIN’ IT ... ENTERTAINMENT

- ***Mix It Up ... Giant Musical Instrument***

Description:

Adjust the controls on a mixing desk to add or subtract one of the instruments on a giant superinstrument into a continuously looping soundtrack. Watch the instrument light up as the music track plays. Explore the mathematical relationship involved in rhythm as well as the relationship between pitch and frequency in music.

Main Idea:

Fractions play a vital role in understanding music.

Curricula Connection:

Fractions are a major area of study in upper elementary grades, and this exhibit provides a familiar context for making sense of equivalent fractions.

- ***Flicker Fusion ... Make a Movie***

Description:

Artful figures are attached to a circular platform visible through viewing windows. Turn a dial and watch the figures as the platform rotates. Create a perfect animation by choosing the optimum frequency of rotation and optimum frequency of flashing light.

Main Idea:

The idea of frequency, both with respect to number of light flashes per second and with respect to number of times

a platform rotates, is explored. This is a particular type of ratio, namely the number of flashes per second.

Curricula Connection:

Rate of change is an important topic in algebra as well as in science, and this interactive provides grounding for the study of rate of change.

- ***Step Up ... Dance Motion***

Description:

As you dance, watch rainbows and fractals fan out from your reflected silhouette. Discover how mathematical functions can be used to create moving color effects. Created by artist Ed Tannenbaum.

Main Idea:

Transformations in real time. Move your body and watch the changes on screen.

- **Featured Personalities in *KICKIN’ IT:***

- Daniel Ferguson, IMAX Film Director and Screenwriter, Montreal, Canada
- Ajay Kapur, Musician and Computer Scientist, California Institute of the Arts, Valencia, California

6.0 GAME PLAN ... VIDEO GAMES AND OTHER GAMES

- ***Game Developer***

Description:

Race against a timer to design and program a game object at a touch screen workstation. Choose from a set of variables that determine the object’s properties and movements. Launch your object into the game and see how the properties you assigned the object affect its survival.

Main Idea:

Graphing can happen in three dimensional space, using positive and negative numbers on the X, Y, and Z dimensions to locate and move an object.

Curricula Connection:

- Geometry: Recognize and apply geometric ideas and relationships in areas outside the mathematics classroom, such as art, science, and everyday life.
- Investigate conjectures and solve problems involving

two- and three-dimensional objects represented with Cartesian coordinates.

- **Crack the (Binary) Code**

Description:

Five large switches correspond to the first five binary bits, or digits 16, 8, 4, 2, and 1. Turn the switch on to indicate “1”. Turn it off to indicate “0”. Challenge yourself to create binary equivalents of the “Target Number”. See how many codes you can crack. The target number is in Base 10. Translate it into Base 2 (binary).

Main Idea:

There are different number systems used for different purposes: Binary or Base 2 is commonly used in computer programming.

Curricula Connection:

Mathematics is rarely connected with computer science in elementary and middle school. This interactive provides an important opportunity to connect number theory (mathematics) with real life applications in computer science.

- **Flip It ... Probability**

Description:

Zero out the counter. Strike a pressure point to flip a disk inside a tube. The result of the flip is recorded with a camera. Repeat several times. A display shows your results. Compare these with the results for the flips for the entire life of the exhibition (or some combination). The more times the coin is flipped, the closer the probability moves to 50%.

Main Idea:

Coin flipping is an important context for understanding independent events: The probability of a fair coin coming up heads remains $\frac{1}{2}$ no matter how many times it is flipped.

Curricula Connection:

Probability is an important part of the study of many types of data. For example, understanding genetics depends on understanding the notion of independent events.

- **Game Box Kids**

Description:

Real game play on video games created by kids. In interviews

and on graphic panels, the game designers and developers talk about the math they used and learned in order to create their games.

- **Featured Personalities in GAME PLAN:**

- Robin Hunicke, Game Developer, Los Angeles, California
- Michael Mateas, Game Developer, University of California, Santa Cruz

7.0 ROBOTICS AND SPACE

- **On Target ... NASA Robot Space Walk**

Description:

A viewing camera is mounted to the end of a Robotic Arm that extends from a 3-D version of the International Space Station. A cupola provides work stations along with views of the surrounding space station. Control the robotic arm movement and camera as they check different targets on the outside of the Space Station. Stay within your time limit.

Main Idea:

The coordinate system is a clear way of locating objects in 2-D space.

Curricula Connection:

The coordinate system involves geometry and making/communicating about mathematical representations.

- **Curiosity Rover**

Description:

Control the movements of a virtual Curiosity Rover on a flat tabletop touchscreen as it moves across a Mars landscape. Enter a series of commands and maneuver past obstacles to collect rocks for analysis.

Main Idea:

Programming a robot involves carefully planning a sequence of steps. In programming, mathematical language is used to make communication clear and efficient.

Curricula Connection:

A variant of the Logo programming language, designed to enable children to learn rudimentary programming and its connection to math, is highlighted in this interactive.

- **Robot Rally ... Robot Artifact Display**

Description:

Winning entries from the FIRST Robotics or other robotics competitions are on display. *Neri Oxman inspiration: “When you create something, you give context to your curiosity; design provides opportunities for asking questions about the world, and about what it means to be human; and math is one language by which to decode such speculations into design innovations.”*

- **Picture This ... Hubble Telescope**

Description:

At ‘universe’ viewing stations, select a short exposure photograph taken from the Hubble telescope. Initially, the image is dark and grainy apart from 2 or 3 dots of light. By adding and averaging (co-adding) multiple images of the same length of the same shot of the universe, you increase the accuracy and clearness of the image. Your final image shows a dense, bright, multi-colored star field. Experiment with “sampling” and mathematical formulas that lead to extraordinarily detailed images captured in space.

Main Idea:

The greater the number of images, the more that “noise” or variation can be minimized.

Curricula Connection:

The idea of “sampling” in math and science is highlighted here: The basic concept is that multiple samples produce a better approximation of the phenomenon. In this case, the more astronomical time sample photos that are taken and added together, the better the image.

- **Featured Personalities in ROBOTICS AND SPACE:**

- Robonaut 2, Dexterous Humanoid Robot, NASA
- Dennis Hong, Robotics Engineer, Blacksburg, Virginia
- Robin Murphy, Robotics Engineer, College Station, Texas
- Kathryn Gray, Student and Supernova Searcher, Fredericton, Canada

8.0 RESOURCE CENTER

- **Explore ... Math Programs, Competitions, etc.**

Description:

On a touch screen monitor, explore Raytheon’s exciting MathMovesU initiative designed to engage students in math and science through interactive learning programs, contests, live events, scholarships, tutoring programs, and more. See video clips of kids participating in various math programs. View MATHCOUNTS award winning video entries from the upcoming “REEL MATH CHALLENGE” program.

- **Play ... Sum of All Thrills, MathMovesU game videos**

Description:

Explore the *MathMovesU* classic online interactive game, a mathematical virtual world of Music, Sports, Fashion, and Travel. Explore the *Sum of All Thrills* online interactive game where you can design and virtually ride your own thrill ride in a computer simulation—a simplified version of the full Epcot ride.

- **Connect ... Local Events, Activities Center**

Description:

A regularly updatable electronic schedule provides information about local programs, events, and activities about math.

