1. Learning Standards

1.1 Illinois Learning Standards [1]

1.1.1 Inter-standard themes:

Application of learning

Graphing system affords students to construct visual representations of math concepts. It is an engaging classroom activity where students not only learn new concepts, but apply their knowledge in constructing a graph.

Solving problems

A graphical representation of numerical data is a well-known problem solving tool. Relationships become clear which would otherwise be obscured in other representations such as lists or tables.

Communicating

Graphs are an excellent communication tool; ideas are easily conveyed graphically which would otherwise be difficult to describe. The whole class setting of the system promotes communication between students.

Using Technology

The standards specifically mention technology to create images, "dynamical geometry systems", and "graphing software to represent information, form conjectures, solve problems and communicate results."

Working on Teams

The whole-classroom nature of the system affords both large (whole class) and small team participation. Ideas can be discussed and shared openly mainly because of the large scale of the system.

Making connections

Connections will be made between mathematical representations such as tabular and graphic. Also, connections between mathematical disciplines such as algebra and geometry will be explored by graphing algebraic concepts such as linear equations and studying them from a geometric perspective (ie, slope of a line). Finally, connections between math and science can be formed by using the system to graph scientific data from an experiment.

1.1.2 Standards
State goal 6: Demonstrate and apply a knowledge and sense of numbers
B. Investigate, represent and solve problems using number facts, operations (addition, subtraction, multiplication, division) and their properties, algorithms and relationships
6.B.3a Solve practical computation problems involving whole numbers, integers and rational numbers

Activity: Set up the graphing system for the 1-dimensional number line, origin in the center so that positive and negative integers are displayed. Locate integers, and add and subtract by moving "right" and "left" along the number line. Multiply and divide with integers as well, although this is not so visually clear. The entire activity can be performed in 1 or 2 class periods and will serve as the introduction to computation with integers, which will subsequently be performed numerically by students, but hopefully they will retain this visual reference.

State goal 7: Estimate, make, and use measurements of objects, quantities, and relationships and determine acceptable levels of accuracy.
C. Select and use appropriate technology, instruments and formulas to solve problems, interpret results and communicate findings.
7.C.3a Construct a simple scale drawing for a given situation.
7.C.3b Use concrete and graphic models and appropriate formulas to find perimeters, areas, surface areas and volumes of two- and three-dimensional regions.

Activity: Plot the vertices of simple polygons and use the grid to "count squares" to approximate area and perimeter. This can serve is a visual introduction to area and perimeter calculations, which will subsequently be carried out by students using more traditional methods.

State goal 8: Use algebraic and analytical methods to identify and describe patterns and relationships in data, solve problems, and predict results.
B. Interpret and describe numerical relationships using tables, graphs and symbols
8.B.3 Use graphing technology and algebraic methods to analyze and predict linear relationships and make generalizations from linear patterns

Activity: Plot a line and examine its properties such as slope and intercepts

State goal 9: Use geometric methods to analyze, categorize, and draw conclusions about points, lines, planes, and space
A. Demonstrate and apply geometric concepts involving points, lines, planes and space.
9.A.3a Draw or construct two- and three- dimensional geometric figures including prisms, pyramids, cylinders and cones.
9.A.3b Draw transformation images of figures, with and without the use of technology
B. Identify, describe, classify and compare relationships using points, lines, planes and solids
9.B.3 Identify, describe, classify and compare two- and three- dimensional geometric figures and models according to their properties

Activity: plot points, draw a line from 2 points, draw 2 intersecting lines, conceptualize the angle between them, draw a triangle and investigate its properties, draw closed
polygons with increasing numbers of sides until they approximate a circle, draw a circle and investigate its properties.

State goal 10: Collect, organize, and analyze data using statistical methods; predict results; and interpret uncertainty using concepts of probability.

A. Organize, describe and make predictions from existing data.
10.A.3a Construct, read and interpret tables, graphs (including circle graphs) and charts to organize and represent data
B. Formulate questions, design data collection methods, gather and analyze data and communicate findings
10.B.3 Formulate questions (e.g., relationships between car age and mileage, average incomes and years of schooling), devise and conduct experiments or simulations, gather data, draw conclusions and communicate results to an audience using traditional methods and contemporary technologies.

Activity: Take experimental data, preferably from a science experiment performed by the students in science class, and plot the data points. Construct a best-fit curve representing the data, draw conclusions from it and interpolate and extrapolate to predict data values which were not measured. Return to the experiment if possible and verify the accuracy of the predicted values.

1.2 NCTM Principles and Standards[2]

1.2.1 Principles

Technology Principle
"Students can learn more mathematics more deeply with the appropriate and responsible use of technology. They can make and test conjectures. They can work at higher levels of generalization or abstraction... Technology cannot replace the mathematics teacher, nor can it be used as a replacement for basic understandings and intuitions. The teacher must make prudent decisions about when and how to use technology and should ensure that the technology is enhancing students' mathematical thinking”

1.2.2 Standards

Standards for grades 6-8
"...students will learn significant amounts of algebra and geometry throughout grades 6, 7, and 8. Moreover, they will see algebra and geometry as interconnected with each other... They will have experience with both the geometric representation of algebraic ideas, such as visual models of algebraic identities, and the algebraic representation of geometric ideas, such as equations for lines represented on coordinate grids. They will see the value of interpreting both algebraically and geometrically such important mathematical ideas as the slope of a line and the Pythagorean relationship. They also will relate algebraic and geometric ideas to other topics—for example, ...when they represent an approximate line of fit for a scatterplot both geometrically and algebraically"

Algebra
• identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations.
• use graphs to analyze the nature of changes in quantities in linear relationships

Geometry
• precisely describe, classify, and understand relationships among types of two- and three-dimensional objects using their defining properties;
• understand relationships among the angles, side lengths, perimeters, areas, and volumes of similar objects;
• create and critique inductive and deductive arguments concerning geometric ideas and relationships, such as congruence, similarity, and the Pythagorean relationship.
• use coordinate geometry to represent and examine the properties of geometric shapes;
• use coordinate geometry to examine special geometric shapes, such as regular polygons or those with pairs of parallel or perpendicular sides.
• describe sizes, positions, and orientations of shapes under informal transformations such as flips, turns, slides, and scaling;
• examine the congruence, similarity, and line or rotational symmetry of objects using transformations.
• draw geometric objects with specified properties, such as side lengths or angle measures;
• use two-dimensional representations of three-dimensional objects to visualize and solve problems such as those involving surface area and volume;
• use visual tools such as networks to represent and solve problems;
• use geometric models to represent and explain numerical and algebraic relationships;

Representation
• create and use representations to organize, record, and communicate mathematical ideas;
• select, apply, and translate among mathematical representations to solve problems;
• use representations to model and interpret physical, social, and mathematical phenomena.

2. Hardware
• 4 projectors at +X, +Y, -X, -Y ceiling mounted, projecting onto the floor
• softens shadows
• registration
  • projector mounting with yaw, pitch, roll fine adjustment
  • trapezoidal software correction
• passive 3d possible with this projector configuration?

3. Demo
The following is a single projector mockup of the system
3. References