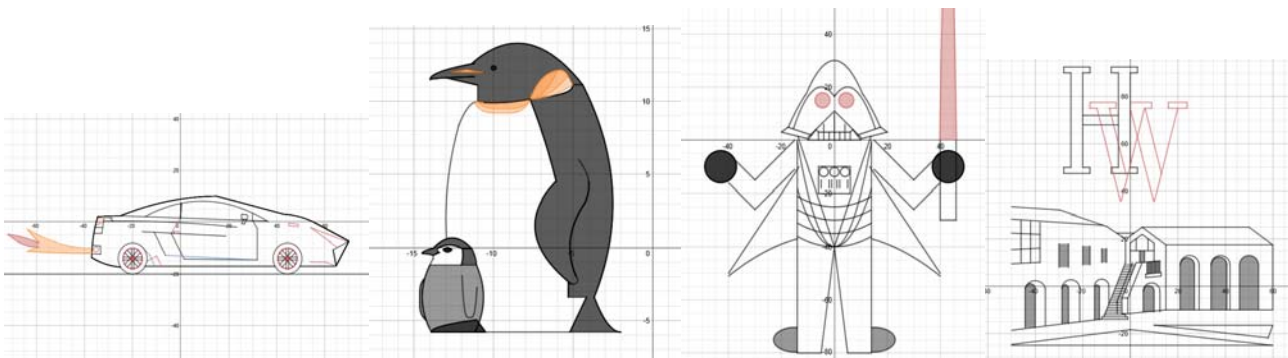


The Algebra Artist: Drawing With Desmos

9:30 AM - 10:30 AM, Saturday, April 18

Location: 159 (BCEC), Session #666

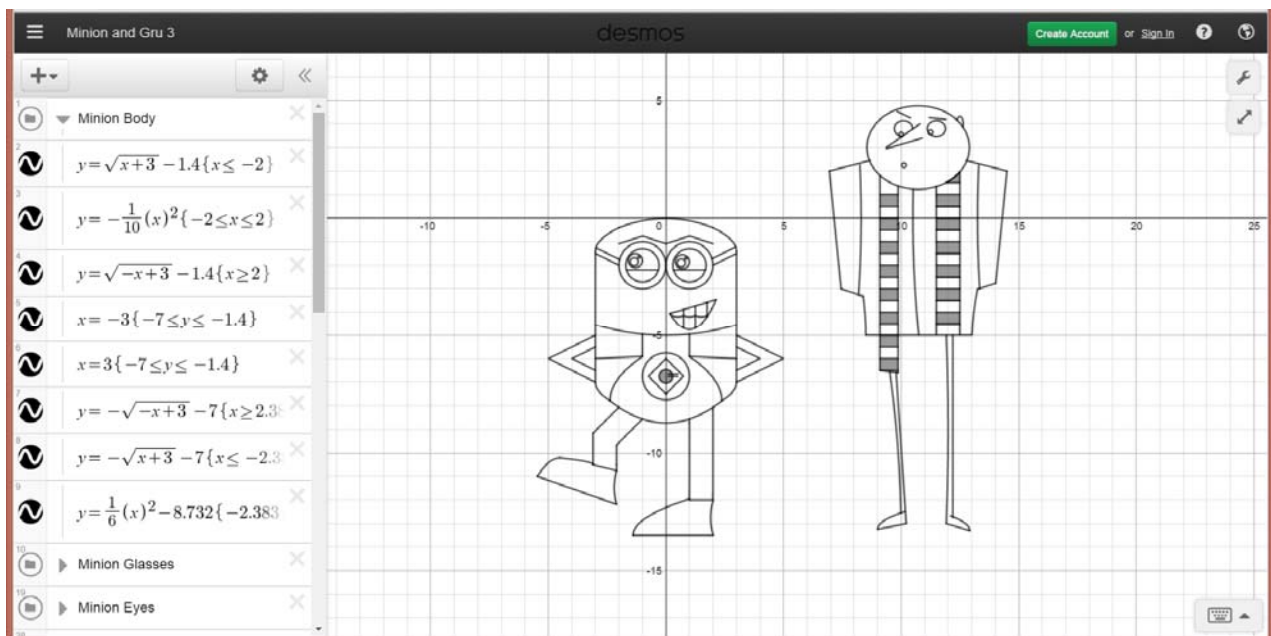
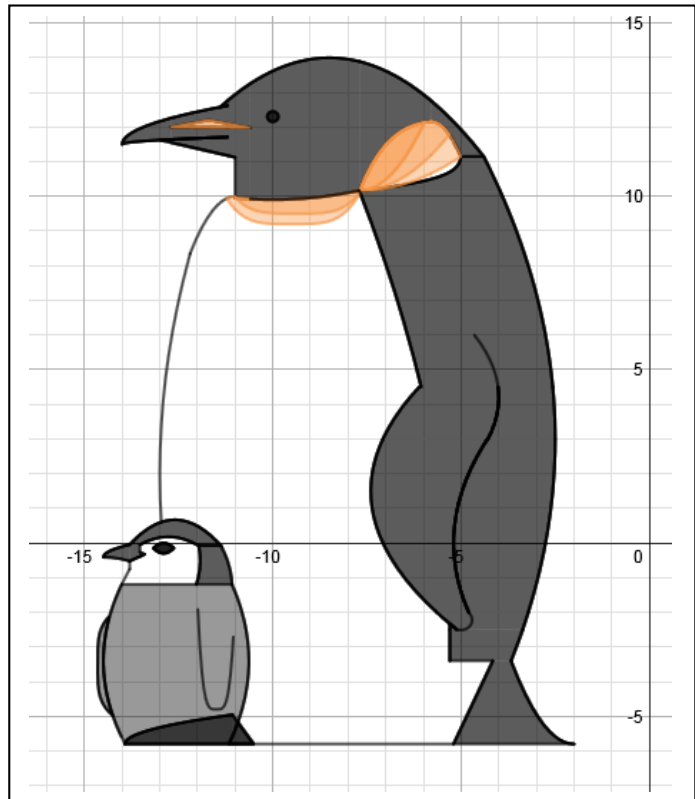
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Desmos free online graphing software (<https://www.desmos.com/>) is ideally suited for having students create Algebra Drawings.

The software has 3 essential advantages for Algebra Drawings:

1. It provides a straightforward way to add restrictions, allowing students to join pieces of graphs to create drawings.
2. Regions can be conveniently shaded with different colors through inequalities.
3. An effectively unlimited number of graphs can be easily added (e.g., copy and paste, easy edits).



After a brief introduction to basic features of the Desmos software as it relates to making Algebra Drawings, the talk focuses primarily on curricular and pedagogical issues associated with having students create Algebra Drawings. A theme-based discussion of Algebra Art is presented, with plenty of student creations as examples. The 6 major discussion themes are:

1. Thinking holistically

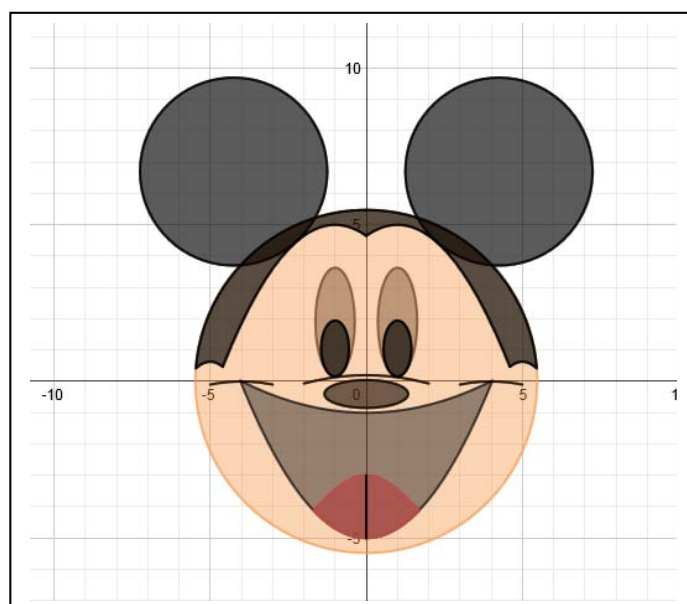
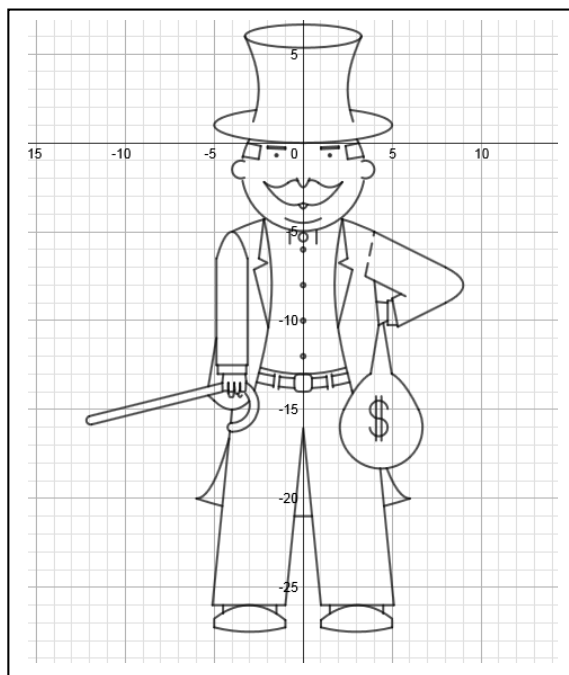
- The artistic goal of creating an image requires that students think of individual graphs as pieces of a much larger picture.
- Students use their entire arsenal of graph types, manipulating and combining various graph types to create a whole image.

2. Restricting to Expand Possibilities

- Students quickly become comfortable making restrictions on graphs and joining different graphs to form an image.
- Creating a piecewise function, normally an abstract concept, becomes a routine maneuver in the context of algebra drawings.

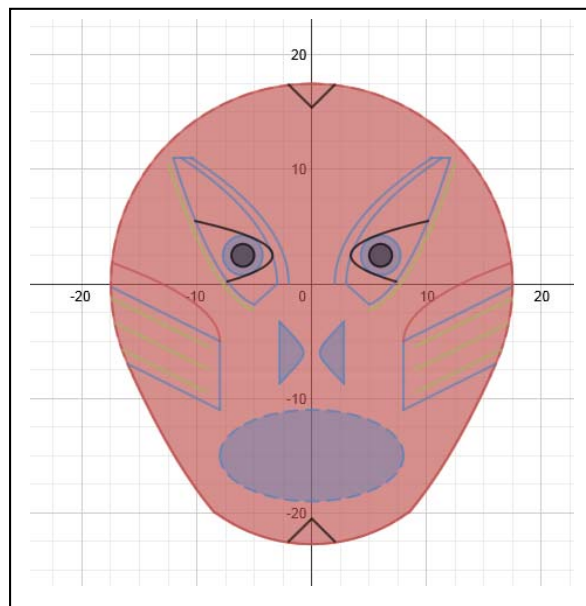
3. Inequalities in a New Light

- Inequalities generally garner less attention than equations, but algebra drawings provide a context in which inequalities can be valued as a flexible shading tool.



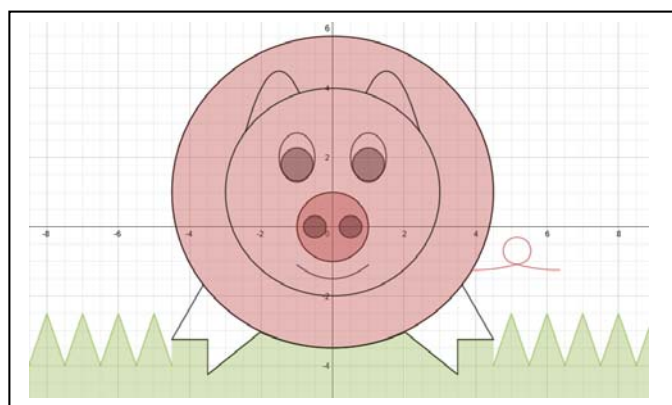
4. Translations and Dilations

- Algebra drawings naturally stimulate horizontal and vertical shifts of graphs.
- Algebra drawings also spur the use of dilations, which the Algebra 1 students think in terms of making nonlinear graphs thinner and wider.



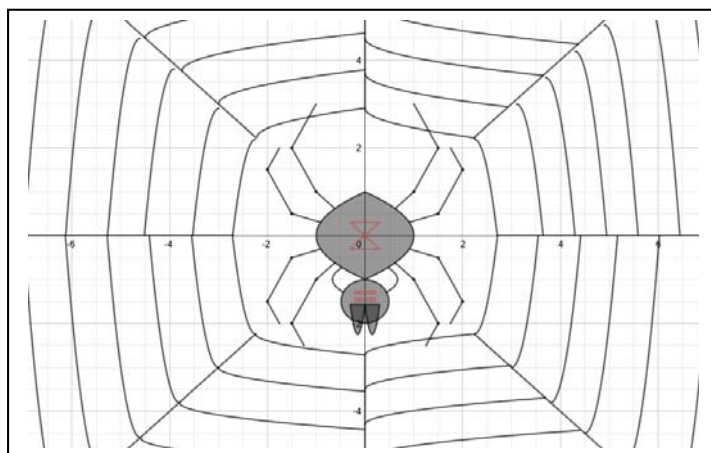
5. Reflections, Rotations, and Symmetry

- Topics such as reflections and symmetry were only informally introduced to the students, but these features emerged naturally and played prominent roles.
- Reflections were intimately connected with symmetry, and students gained some elementary perspective on reflections (e.g., changing the sign of the x-component of a vertex to reflect a parabola or absolute value graph).



6. Attending to Precision

- Perhaps the strongest indication of the value of the Algebra Art project is the students' commitment to detail and precision in their creations.



A summary of some of the lessons learned from the Algebra Drawing Project:

1. People who are attracted to STEM-related fields are drawn not by a desire to take math tests, but to create things.

2. The element of choice, and the personal nature of the artistic creation, motivates students and generates pride in workmanship.

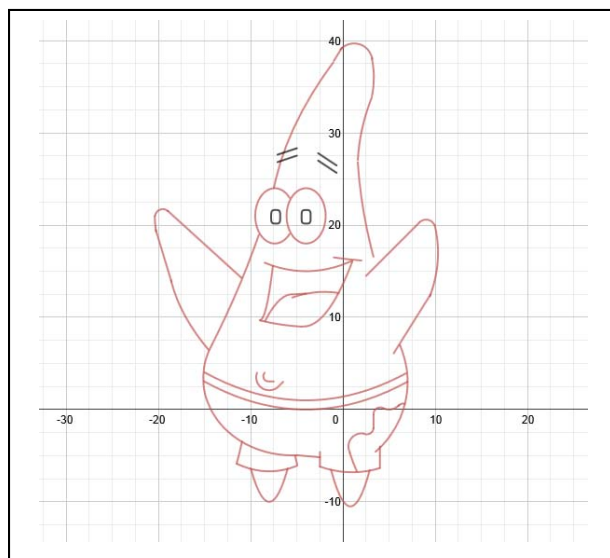
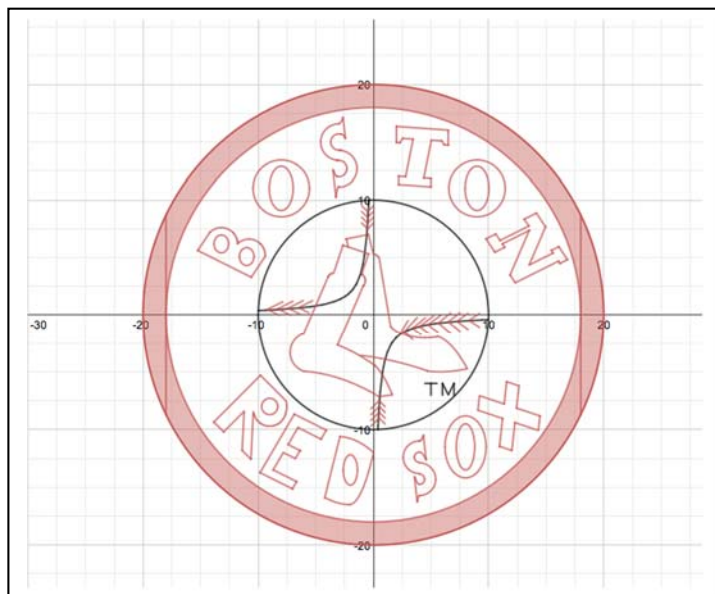
3. Hands-on work can lead to internalization ("Wax on, wax off" or "Jacket on, jacket off").

4. Motivated, informal, discovery-oriented learning can make very abstract concepts intuitive and concrete: restrictions and piecewise functions, translations and dilations, inequalities, reflections, symmetry, new graphs types, etc.

5. Sustained work can lead to far beyond typical results.

6. Set reasonable expectations.

7. Students bring to the project a youthful playfulness combined with newly formed powers of abstraction.



Selected References on Algebra Art, Green Globbs, and Fractal Art:

- [1] Darin Beigie. 2014. The Algebra Artist. *Mathematics Teacher* 108 (November): 258-265.
- [2] Darin Beigie. 2005. Exploring Graphs in a Target-Oriented Environment. *Micromath* 21(Spring): 24-29.
- [3] Darin Beigie. 2005. Computer-Generated Fractal Art. *Mathematics Teaching in the Middle School* 10 (February): 262-269.

Desmos: <https://www.desmos.com/>

Green Globbs: <http://www.greenglobs.net/>

Selected References on Problem Solving and Patterns:

- [1] Darin Beigie. 2015. *Math Analogies Level 4 (Grades 8-9)*. Seaside, CA: The Critical Thinking Company, 64 pages. Available Summer 2015.
- [2] Darin Beigie. 2014. *Mathematical Reasoning™ Middle School Supplement (Grades 7-9)*. Seaside, CA: The Critical Thinking Company, 320 pages.
- [3] Darin Beigie. 2014. *Pattern Explorer Level 1 (Grades 5-7)*. Seaside, CA: The Critical Thinking Company, 96 pages.
- [4] Darin Beigie. 2014. *Math Analogies Level 3 (Grades 6-7)*. Seaside, CA: The Critical Thinking Company, 64 pages.
- [5] Darin Beigie. 2012. Slow Cooker Problems in a Microwave World. *Mathematics Teaching in the Middle School* 18 (November): 76-79.
- [6] Darin Beigie. 2011. No Child Left Unchallenged. *Mathematics Teaching in the Middle School* 17 (November): 214-221.
- [7] Darin Beigie. 2011. The Leap from Patterns to Formulas. *Mathematics Teaching in the Middle School* 16 (February), 328-335.
- [8] Darin Beigie. 2008. Integrating Content to Create Problem Solving Opportunities. *Mathematics Teaching in the Middle School* 13 (February), 352-360.