Accessible Sketchpad - Math Images

# Background Information

The DIAGRAM Center strives to ensure that accessible educational material is created, published and available for all types of disabilities and learning styles. Accessible math is one area that we are very interested in improving. Doing math on the web is becoming more prevalent and having an accessible way to show your work including sketch's, diagrams, and notes in an accessible way is currently not available. Benetech Labs has created [Mathshare](https://mathshare.benetech.org/) (currently in beta) which is the first accessible solution that allows a student to answer a math question online and includes the steps the student took to show their work and send this back to the teacher. One of the features Mathshare has is a sketch pad to draw diagrams, but this is not fully accessible.

We would like to create a stand-alone widget that could be incorporated into Mathshare or other online solutions that allows the user to pick from a given set of diagrams provide the necessary parameters and generate an accessible SVG corresponding image, instead of hand drawing the image which would be not keyboard accessible for instance. We chose SVG as the output image format since it can be made accessible and allows a student with assistive technologies such as a screen reader the ability to explore the image to get more information about the sub components the image has. Also SVG images scale to any size without pixilation which will also help with low vision users.

To start we would like to limit the scope to geometry and have a preselect number of geometric shapes or concepts (ie. Pythagorean theorem, basic geometric shapes such as polygons where one can set the number of sides and lengths, ellipses where a circle can be selected with a specific radius, diameter, or circumference defined. Other options like color thickness of the lines may also be nice improvements.

Our original idea was to focus on the automatic creation and scaling of images based on defined attributes of the image. For example, for triangles, the measures of sides or angles. This would make it significantly more usable for students with physical disabilities or who use keyboard navigation, and could also potentially benefit students who use screen readers. See Figures 1 and 2 below on a possible solution.

We see that this tool could be expanded in the future to support other diagram types, for example simple charts and graphs.

Figure 1: Polygons

Sketch Pad Area:
Triangle labelled ABC with side AB=1, BC=2, CA=3, and angle B=90 degrees.

Below sketch Pad is a post-it note with 3 tabs Polygons, ellipses, and free hand.

Polygons are selected 
# sides = 3
Length AB = 1
Length BC = 2
Legth CA = 3
Angle A: (blank)
Angle B: (blank)
Angle C: (blank)

Figure 2: Ellipses

Sketch Pad Area:
Triangle labelled ABC with side AB=1, BC=2, CA=3, and angle B=90 degrees.

Post-it Note:  Ellipses selected (Polygons and Freehand tabs not selected)

Dropdown: (Circle) selected
radius = (blank)

# Design Requirements

* This accessible Image widget needs to be fully accessible, in both the input as well as the output. (I.E. WCAG-AA 2.1 Compliant). Benetech will be present and can help with this.
  + Input all dropdowns, form fields are accessible and have appropriate labels
  + Output overall image should have an accessible description known as its "Alt Text", we may even consider extended image descriptions if warranted. Individual pieces of the SVG should also have their own textual description (i.e. labels and values within the diagram)
* HTML5, CSS and JavaScript should be the only required technology needed, and hopefully the output accessible SVG image will only contain HTML and CSS styling.

# Useful Links and Additional Information

* **Scalable Vector Graphics (SVG) 2** W3C Candidate Recommendation *04 October 2018:* [*https://www.w3.org/TR/2018/CR-SVG2-20181004/*](https://www.w3.org/TR/2018/CR-SVG2-20181004/)
* Mathshare: <https://mathshare.benetech.org/>
* Accessible Data Visualizations (containing both an accessible Heat Map Table and an Assessible SVG Bar Chart.): <http://diagramcenter.org/diagram-reports/diagram-report-2019/datavizualization.html>
* Fizz Studio (Accessible Data Visualizations): <https://fizz.studio>
* **Web Content Accessibility Guidelines (WCAG) 2.1** W3C Recommendation 05 June 2018: <https://www.w3.org/TR/WCAG21/>
* **Accessible Rich Internet Applications (WAI-ARIA) 1.1** W3C Recommendation 14 December 2017: <https://www.w3.org/TR/wai-aria-1.1/>