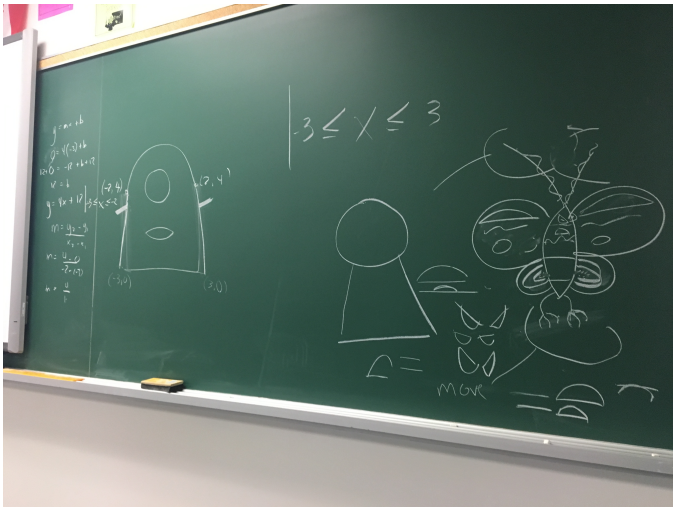
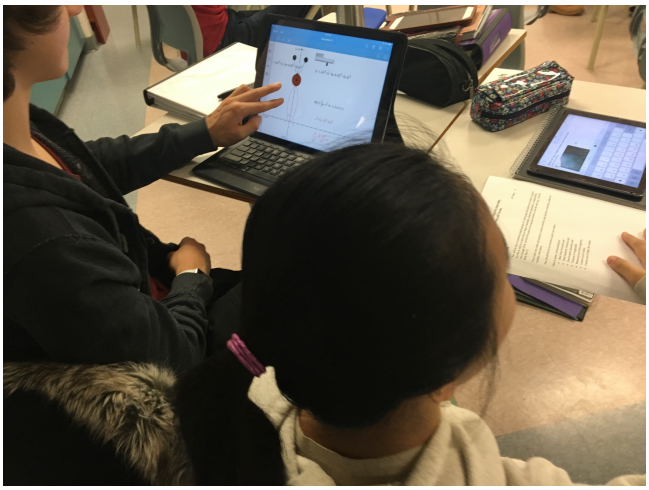
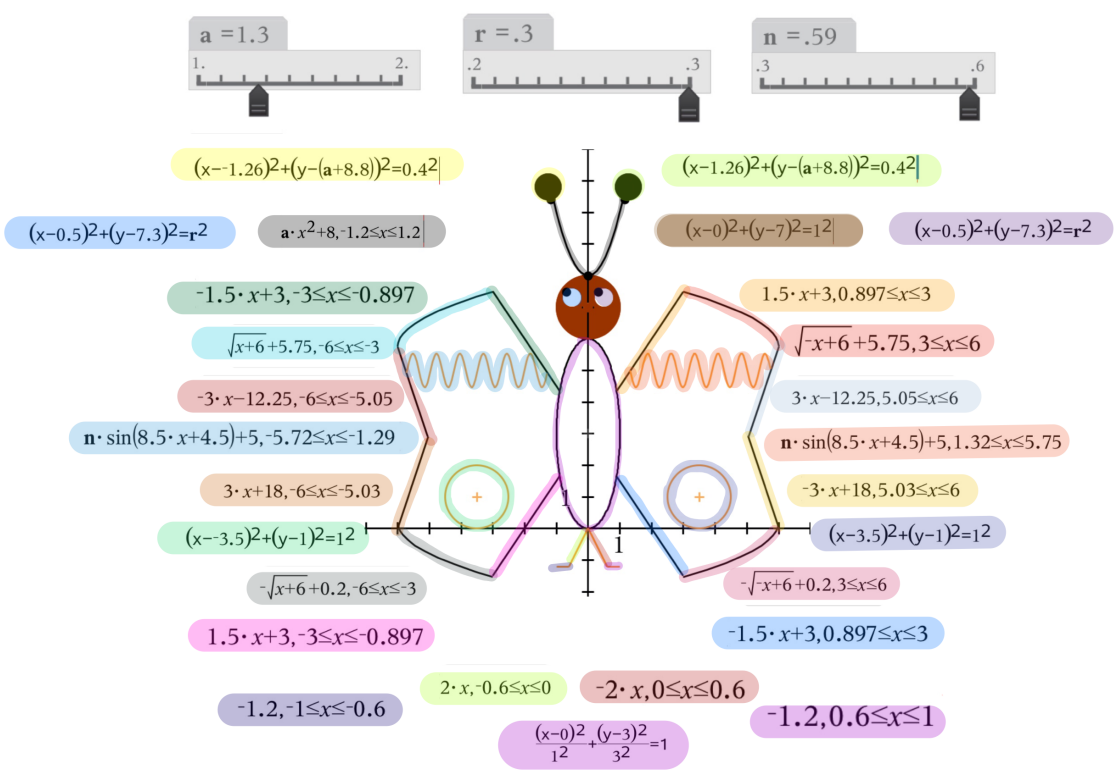


Day 1:
Our first day was spent brainstorming creative monsters to create on our TiNspire Apps, taking into account which functions we would use for certain parts of our creation. Our final decision was to make a butterfly. As seen on the left, we had many ideas for possible functions that we would include. Our finished product is much neater than our concept art.



Day 2:
The first part of our second day was used for experimenting with different functions we could use for our animal. After learning that hyperbolas (which were to be used for our butterfly's wings) were impossible to restrict, we struggled with finding an alternative function for them. At this point, we only had the head, antennas, and body. This was the day that we worked on making the parts of the antenna move in unison. We also decided to experiment with equations such as y=sin(x) and y=√x, both of which we ended up using. We did not, however, use y=|x| although this was considered for the antennas.



We first constructed the body and head. The body is an ellipse shape in which we used the relation for a circle, then decided we wanted to stretch it vertically so we divided $(y-3)^2$ by 3^2 and only divided $(x-0)^2$ by 1 such that the circle is stretched vertically and not horizontally.

The head is circular, so we used the relation $(x-0)^2+(y-7)^2=1^2$ so that the radius would be 1, and the head would be centred 7 above the point of origin, and on the y-axis.

To build the legs, we used 2 line segments which both had y-intercepts of 0, using opposite slopes of 2 and -2. $2\cdot x, -0.6\le x\le 0$ $-2\cdot x, 0\le x\le 0.6$

For the feet, we used 2 simple linear line segments $-1.2, 0.6\le x\le 1$ $-1.2, -1\le x\le -0.6$ with y-intercepts of -1.2 to create horizontal lines. Both feet were then restricted such that they cut off at exactly one unit from the y-axis.

The eyes were made with circles, so we used the relations $(x-0.5)^2+(y-7.3)^2=r^2$ and $(x-0.5)^2+(y-7.3)^2=r^2$ which were both placed the same distance away from the y-axis to be symmetrical. We needed them to be higher then 7 units above the point of origin so after some experimentation, we decided that 7.3 was the most appropriate distance. The radius we chose for both eyes needed to be proportionate to the radius of the head, so we used 0.2–0.3 to make them neither too large, nor too small.

The wings are made with both linear, and not linear functions. Firstly, there are 4 line segments between the two wings that had slopes of either 1.5 or -1.5 such as $1.5\cdot x+3, -3\le x\le -0.897$ or $1.5\cdot x+3, 0.897\le x\le 3$. These linear slopes allowed us to make direct extensions from the body of our butterfly to start the wings. During experimentation, we discovered the function y=√x which we used for the outer edges of the wings. This curve was perfect because it was not a full 90 degree turn, and it was gradual. Using negatives inside and outside the square root bracket, we were able to position these functions to suit our needs on all 4 corners of the wings.

$\sqrt{x+6}+5.75, -6\le x\le -3$ $-\sqrt{-x+6}+0.2, 3\le x\le 6$

To complete the wings, we joined two more linear segments using opposite slopes, but the challenge was that they needed to be individually restricted using trial and error such that they perfectly fit together, and extend from the previous function.

The designs on the wings were made with circles and waves. The circles were relatively simple; we decided on a radius, and position, and by this point we were pretty adept at positioning our figures. The waves were constructed with the y=sin(x) function. We tried the y=cos(x) and y=tan(x) functions but the y=sin(x) was definitely the right choice for us. We animated this function using **n** as our variable which we placed before sine and allowing the vertical stretch to range between 0.3 and 0.6. The difficult part was figuring out how to move and restrict the function. Although similar to quadratic functions, there are more components such as numbers that multiply x but can be inside **or** outside of the influence of sine. $n\cdot \sin(8.5\cdot x+4.5)+5, -5.72\le x\le -1.29$

The antenna were made with a parabola. So we used the equation , $a\cdot x^2+8, -1.2\le x\le 1.2$ using a step pattern (vertical stretch factor) of "**a**" because we created a slider for the antenna. The antenna moves from 1 - 2. We restricted the antenna from -1.2 to 1.2. Then we added 2 circles on the top. We used the equation $(x-{-1.26})^2+(y-(a+8.8))^2=0.4^2$ and $(x-1.26)^2+(y-(a+8.8))^2=0.4^2$ We did the right circle first, then we used the same equation but a negative x-coordinate for the circles on the left. The circle has the same variable as the antenna so they would move together. Then we used the circle shape then filled in the circle with black.
Things we found to be easy:

We would say first and foremost that the easiest functions/relations to implement were the circle relations. Since we already knew the formula for a circle, it was simply a matter or determining it's radius and centre. This was not difficult because we adjusted the radius based on whether or not we believed the circle was visually proportional to the rest of the body and wings. The head and eyes were specifically easy, because the radius for the head was 1, meaning that the centre would need to be one unit away from the top of the body and wings. Secondly, we knew that for the eyes, they needed to be smaller than the head, but not too small. We chose to animate their radius between 0.2 and 0.3, making 10 steps in between. This ensured that they would never get too small, thus becoming irrelevant, and never get too large, such as to overtake the head itself.

The body was our first relation, and we needed to do some research in order to find the ellipse relation. However, it made a lot of sense that the relation for an ellipse would be a modification of the circle relation, in which you decided whether you wanted a vertical or horizontal stretch or compression by dividing either the y or x portions of the circle equations by a number other that . We chose $\frac{(x-0)^2}{1^2}+\frac{(y-3)^2}{3^2}=1$ so that it would be vertically elongated but not horizontally stretched, giving our body an oblong shape, much like the thorax of a real butterfly. It also helped having the based of the body at the point of origin, and 6 units tall. This allowed us to better construct the wings of our butterfly because the center of the ellipse was at (0,3) meaning that the y-intercepts of some of our linear segments would not only intersect at this point, but also have y-intercepts here. The green, yellow, pink, and blue linear functions that extend from our creatures midsection have the same y-intercepts and have slopes of either 1.5 or -1.5 depending on which direction the line needed to face. This was simply another way of making our creature symmetrical and aesthetically pleasing.

Things we found to be challenging:

One thing we found to be challenging was deciding which functions should be used to make the wings of our creature. In our rough concepts, we envisioned a hyperbola, which proved to work extremely well at first. However, we were unable to restrict the hyperbola in the same way that you could restrict some other functions. In the end, this attempt at exploring a new function was interesting, but did not prove useful in our final draft. Instead, we decided that we could simply demonstrate our knowledge of linear functions, by using four linear segments to begin the outer shape of each wing, and then expand our knowledge by trying different combinations of the function, $y= \sqrt{x}$. This challenging at first, but we soon realized that the strategic positioning of positive and negative numbers inside or outside the square root bracket allowed us to control which direction the function would go in. We also learned that we can adjust where on the graph the point at which the line makes its primary bend by adding y and x coordinates at certain places in the formula, whether it be inside the square root our outside.

In addition, we also struggled to find a way to make the parabola that makes up the antennas of our butterfly, and the two circles at the top move in unison using the sliders. Originally, we spend a lot of trying trying to find a way to use one variable and one slider that would change such that as the parabola stretches vertically, the centre of the two circles moves up, making it appear as if the antennas are extending. This was very difficult because the parabola was not stretching at the same rate at which the circles were increasing their y-coordinates. Our solution to this was to fill the circles, so it is impossible to tell that they do not move in unison, since any overlap is covered by the shading, and when you play the animation, it looks very natural. This is a good example of a problem that would have taken a long time to solve if we hadn't found a shortcut, especially considering that if we had used two variables, and not just **a**, it would have been much more difficult to make two separate sliders move in unison.

Lastly, we had difficulty adding the y=sin(x) function in the wings. This was a new concept to us. We were able to identify ways in which we could position the function, but we had a difficult time changing the frequency of the wave without affecting the height from top to bottom of each wavelength. It was also difficult to restrict this function because we had to make sure that it intersected with the outline of the wing at the point where we restricted it, so we used the graph trace tool to determine which coordinates to restrict it to. Finally, we actually added the variable **n** before sin(x), to increase and decrease the vertical stretch of each wave when animated.