A fantastic reflection. The layout and mathematical communication is EXCELLENT. She is incorrect for the discussion on whether all triangles within another triangle will always be similar. The answer is YES, they will. However, her attempt, reasoning, diagrams, communication is above or well-above standard.

Fractal Triangles

Fractals:

A fractal is an infinite pattern of a geometric shape, which remains self-similar across all scales. In other words, it's a shape or object which reproduces patterns or structures that look roughly the same across any scale. A good example of a fractal would be a snowflake, it is an object which consists' of a particular pattern which repeats its self over and over again, across all scales of magnification. If you look at a snowflake under magnification, it has different representations of the same snowflake except smaller, but it still remains similar.

Sierpinski triangle:

The Sierpinski triangle or Sierpinski gasket is a well-known fractal. The Sierpinski triangle is a fractal because it has an infinite pattern of equilateral triangles which are all self-similar across different scales. In other words, it's an equilateral triangle with a never-ending number of the same equilateral triangle inside it, but across different scales. The triangle was named after a Polish mathematician, whose name was Waclaw Sierpinksi, but there is evidence that the pattern was used many centuries before Waclaw's work.

Fractals in nature:

- **Leaves** – A plant has many leaves which are made up of the same pattern but are across different scales, this is because plants share the same DNA so they are bound to be self-similar.
- **Sea Shells** - Sea shells keep adding sections to its shell, every new section is bigger and bit more rotated than the other, but each section remains self-similar and the pattern is reoccurring.
- **Trees** – Fractals occur in trees because when a tree is growing it has a trunk or sprout which splits into branches, which split into new branches and so on. All the branches are proportional but are across different scales.
- **Snowflakes** – Snowflakes have smaller self-similar patterns of snowflakes within them, which are repetitive and are the same proportion no matter what scale.

- **Flowers** – Flowers have self-replicating patterns, of either the petals or other parts of the flower, which are never-ending and reproduce the same pattern across different scales.
- **Growth spirals** – Growth spirals are fractals because when they grow each section or row repeats the same pattern as the one before, but gradually getting bigger.
- **Vegetables** – There are many fractals in vegetables but there is a particular vegetable called the Romanesco broccoli, which has a unique pattern which is self-similar all around the vegetable across different scales as well.
- **River deltas** – River deltas are fractals because they have a branching out pattern, which repeats itself over and over again, across different scales.
- **Crystals** – After a hot crystal cools down, the dislocations form a random pattern which is self-similar inside the crystal.
- **DNA** – In DNA there are dimensions and patterns which are self-similar that repeat itself over and over again, across different scales.
- **Lightning bolts** – Lightning bolts itself are a fractal because when the electrically charged bolts flash in the sky, they actually split into self-similar lines, which are of the same proportion but across different scales.

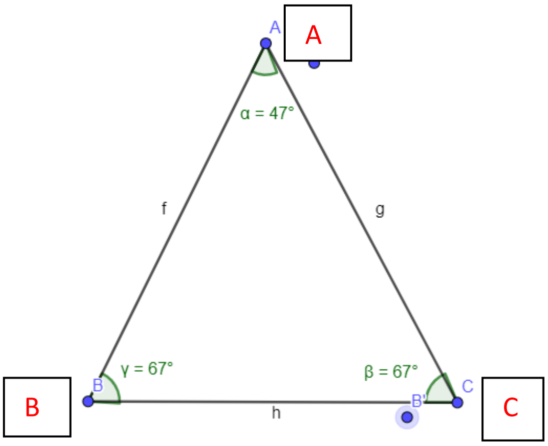
Human activity:

Humans have copied the idea of fractals, for many different practical reasons, an example of this would be biology. In biology fractals help predict and analyse the growth of bacteria, patterns of dendrites and other biological relations. This knowledge of fractals in biology help with the advancement in medicine. Humans also use fractals in art to create unique and eye-appealing artwork. Fractals are also used in digital animation; they help form shapes in animation by repeating themselves. Humans have also used fractals in infrastructure, by designing houses and landscapes that use fractals, to look visually appealing. Fractals are also used in astronomy, for discovering whether the stars and galaxies are all just fractals. Aside from fractals being used in movie animation, they are also used in computer science, this is to enlarge or decrease the size of something, while it still remains the same for example, a document or Pdf.

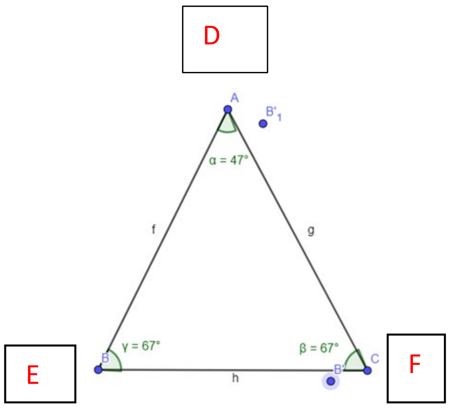
Calculations:

Iteration	Number of Right up triangles	Index number	Side 1	Side 2	Side 3	Angle 1	Angle 2	Angle 3
0	1	3^0	28.2	28.2	22	47°	67°	67°
1	3	3^1	14.1	14.1	11	47°	68°	68°
2	9	3^2	7.1	7.1	5.5	47°	67°	67°
3	27	3^3	3.5	3.5	2.8	47 °	68 °	68 °
4	81	3^4	1.7	1.7	1.4	47°	65°	65 °
5	243	3^5	0.9	0.9	0.6	47 °	67 °	67°

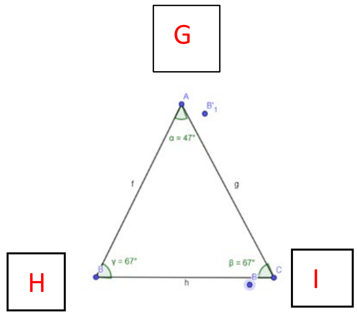
Triangle 0



Triangle 2



Triangle 5



Triangle proofs:

Triangle 0 & 5 -

∟BAC= ∟GHI = 47° (A)

∟ACB= ∟GIH = 67° (A)

∟CBA= ∟IHG = 67° (A)

Triangle 0&2 -

$\frac{BA}{ED} = \frac{28.2}{7.1} = 3.99$ (S)

$\frac{BC}{EF} = \frac{22}{5.5} = 4$ (S)

$\frac{CA}{FD} = \frac{28.2}{7.1} = 3.99$ (S)

*The numbers are one decimal apart, due to inaccuracy. *

Triangle 2&5

$\frac{EF}{HI} = \frac{5.5}{0.6} = 9.12$ (S)

∟EDF= ∟HGI = 47º (A)

$\frac{ED}{HG} = \frac{7.1}{0.9} = 7.9$ (S)

*The numbers for both the ‘sides’ are meant to be equal and would have been equal if they weren’t inaccurate. *

Therefore, triangle ABC (Triangle 0) is similar to triangle DFE (triangle 2) and triangle GIH (triangle 5).

The index numbers are associated with the Sierapinski triangle because they show the number of right-up triangles within the triangle. If you multiply the base and the index together, you get the number of right-up triangles, for example, $3^4 = 81$. The sierapinski triangle divides itself by 3 and the power means how many times it has divided by itself. In this case, the triangle has divided itself 3 times, 4 times in a row and 3x3x3x3= 81. That is how Sierapinksi triangles are involved, they show the number of times a triangle has divided by itself and the number it has divided by.

I think our class has made roughly about 7000 individual triangles. This is because the number of right up-triangles in an iteration of 5 is 243, if we add about a 100 more for the triangles facing down, we have a total of 343. I’m assuming most people in the class would have done a literation of 4 or 5. The total number of triangles including the triangles facing down, in a literation of 4, would be 181. To get a rough amount of the average triangle per person I averaged the two numbers 343 and 181 and got the answer 262. I then multiplied 262 by 26 for every student in our class and got 6812. The number 6812 rounded to the nearest thousand is 7000, I rounded the number up because it’s always good to aim above then below.

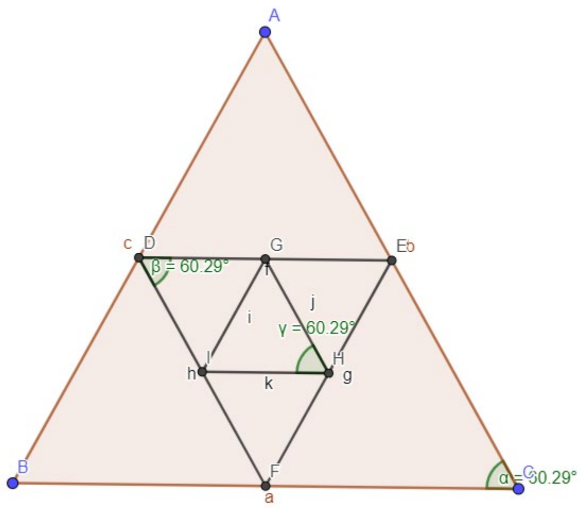
Discussion:

The index numbers represent what’s happening to the triangles as they divide. The index numbers calculate the number of right-up triangles within the sierapinski triangle. They show how many times a triangle has been divided and the number it's been divided by. For example, 3^2, the base 3 shows the number it's being divided by and the index 2 shows the amount of times it's been divide by the number 3. The sierapinski triangle has been divide by 3, two times, which means there would be a total of 9 right-up triangles. To get the answer 9, you have to multiply 3 by itself, since the Sierapinski triangle been divided by 3 triangles, two times. The index number shows the change in the variable, the variable in this case would be the number of triangles. The index numbers measure the number of right-up triangles in a sierapinski triangle.

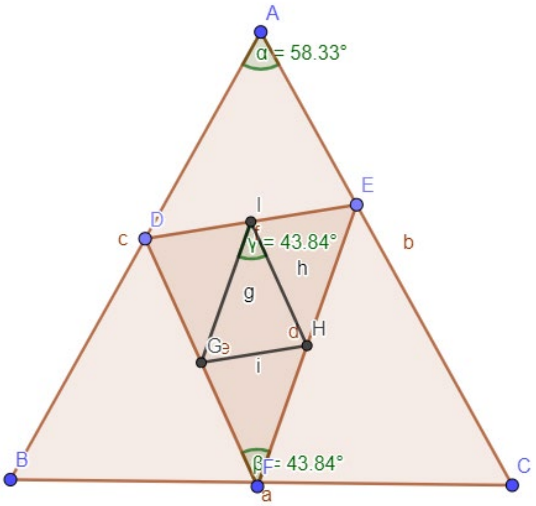
When drawing a Sierapinski triangle there are a couple of ways to draw the triangles faster, but these methods only work if all the triangles were accurate from the beginning. When drawing a triangle instead of measuring the middle of the bottom line and drawing a dot on it. A different approach would be placing your ruler on the tip of your triangle to the bottom line, while holding the ruler in place, draw the dot on the bottom line, while it's in line with tip. This way you get the exact midpoint of the triangle with out having to measure it. Another shortcut would be drawing a line horizontally, while skipping the upside-down triangles. Once you have a line going horizontally for one triangle, place your ruler (horizontally) along that line and draw straight across, while skipping the upside-down triangles. The last shortcut is drawing diagonally, place a ruler across a triangle side (diagonally) and draw a straight line, skipping the triangles that were not the right way up. These three shortcuts work only if all your triangles were accurate to begin with, if they were even the slightest bit off measurement, nothing will line up properly.
These shortcuts exist because all the triangles are similar and proportionate. The triangles are just dividing into smaller pieces of themselves, which means they will all be in line with each other. The triangles will be in line with one another because we divided the triangles into equal parts.

A couple of limitations faced with the accuracy of the artwork, would be pencils, calculations, lines and the measuring equipment. The thickness of the lead in a pencil, affected how accurately we drew, because sometimes when the lead is too thick, it increases the number of millimetres. It was also difficult to get the exact calculations down on paper, because sometimes the numbers would go into decimals places and the ruler cannot measure that accurately. Lines on the triangles also affected the accuracy of our work, because depending on whether you drew inside or outside the black lines would change the outcome of your work and you would have to remain consistent in everything you did. The protractors and measuring equipment also altered the accuracy of the drawing, because each brand of measuring equipment vary from one another.

No, not all triangles within a sierapinski triangles will always be similar. Only equilateral triangles within a sierapinksi triangle can be similar. This is because a sierapinksi triangle is an equilateral triangle, and only equilateral triangles can fit inside another equilateral triangle. Since, the midpoint of a triangle determines whether it is similar or not. For example:

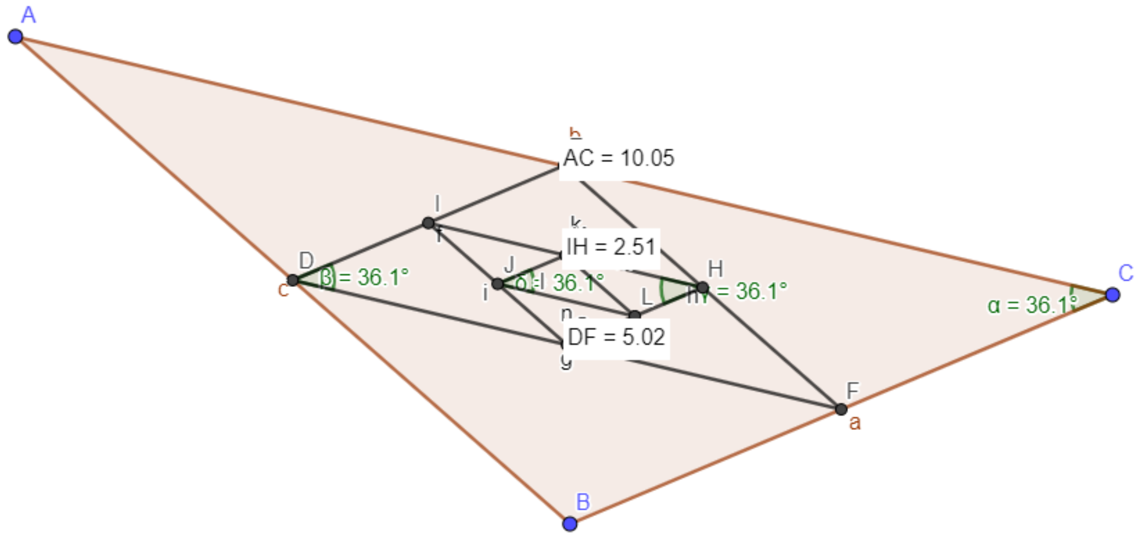


This triangle is similar because the midpoints divide the triangle into proportionate sections, turning them into fractals.



Notice how with this scalene triangle, when the midpoints are not in the middle the angles don’t turn out the same. Where as when it’s the scalene triangle within the scalene triangle it becomes similar.

The triangle down below shows an isosceles triangle, with similar isosceles triangles inside it. The reason they are all similar is because the midpoints are in the middle, creating the same shape but on a different scale.



All the triangles within a sierapinksi triangle will always be similar as long as they’re equilateral, because the midpoints of a triangle determine the next triangle. If the midpoints are in the middle, a replica of the shape will be made across a different scale. A sierapinksi triangle is an equilateral triangle, if a scalene or isosceles triangle is placed inside it, they will not be similar. Although scalene and isosceles triangles can be similar, but just not when inside a sierapinksi triangles.

Fractals reveal God’s creativity when making the world. Fractals show just how much time and care, God put into planning all the little details of the universe. They also reveal that everything he put into the universe has a purpose, no matter how big or small, everything is here for a reason. Fractals also reveal that there is mathematics behind the creation of the universe. It also goes to show just how careful, precise and intelligent our God is. He created something so small, that has great significance. Which also make you think, if god can create something so significant like fractals. How much more important would a human being be to God?

Conclusion:
Fractals are an infinite geometric shape, which are self-similar across different scale. A sierapinksi triangle has an infinite number of equilateral triangles within itself and the triangles are all different scales. Fractals

are found all over nature and are used in biology, medicine, art, movie animation and digital tech. The triangles within the sierapinski triangle are self-similar across different scales, this is proven by the three proofs (AAA, SAS, SSS). The index numbers represent the change in the variable and show the number of right-up triangles. There were three shortcuts in drawing a sierapinski triangle, drawing diagonally, horizontally and vertically. The accuracy of the artwork was affected by the pencil, measurement, lines and the measuring tools. In conclusion, all triangles within a Sierapinski triangle are similar, as long as they are equilateral. We know this, because as long as the midpoint of a triangle is right in the middle it will produce proportionate triangles but on a smaller scale. Scalene and isosceles triangles can be similar, but not when they are within a Sierapinski triangle.

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