Lesson Title: The Fractal Geometry of Nature
Length of Lesson: 10 days
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Subject : Algebra II, Advanced Algebra
Grade Level : 10-12
State Standards: Geometry 2a, Algebra II 1e
DOK Level : 2

DOK Application:
Identify math patterns present in biological life forms, relate abstract math structures to real life biological geometric structures, and summarize the geometry of nature.

National Standards:
Draw reasonable conclusions about a situation being modeled.

Graduate Research Element: None

Student Learning Goal:
The student will connect the math properties of sequences and series to the fractal geometry of nature. The student will observe the fractal geometry of nature and discover that many biological structures have math definitions.

Materials Needed (supplies, hand-outs, resources):
Presentation, the Fractal Geometry of Nature, paper, mid-point ruler, pencil, dry-erase board, dry-erase marker, paper towel, web-connection.

Lesson Performance Task/Assessment:
The students as a group will build the Serpinski Triangle and the Koch Snowflake. See presentation for additional instructions. The student will observe sequences and series expressions that map out biological life.

Lesson Relevance to Performance Task and Students:
Most students are unaware of how completely math invades all aspects of biological life. The student's task will teach basic fractal principles so that the students can understand and observe the mathematical characteristics of nature; to the point, nature has a fractal geometry and can be defined by sequences and series. The lesson is a discovery activity.

Anticipatory Set/Capture Interest:
Is there any math in nature? Can biological life be described in terms of math equations?

Guided Practice:
Students will be directed to make the Koch Snowflake. As a second example of fractal generation, students will mimic generating the Serpinski Triangle. See the following link for Serpinski Triangle

http://math.bu.edu/DYSYS/arcadia/sect2.html

The link below is a simulation that constructs the Serpinski Triangle.

http://www.shodor.org/MASTER/fractal/software/Sierpinski.html

The teacher will lead an inquiry based series of slides from the presentation (Sequences and Series in Nature).

Independent Practice:
The student will execute the Koch Snowflake generating process and will mimic the Serpinski generation process.

Remediation and/or Enrichment:
Guided seat work and one-on-one assistance will be available. Individual IEP's will be supported. Partner help may be allowed on a case by case basis.

As an enrichment activity, ask students to bring in samples from nature (leaves, banches, etc.) that exhibit a fractal geometry.

Check(s) for Understanding: Inquiry questions.

Closure:
summarize fractal geometry; watch the PBS episode "Hunting the Hidden Dimension." See link below.

http://www.pbs.org/wgbh/nova/fractals/

Possible Alternate Subject Integrations: Biology

Teacher Notes: When you get to the slide that says "activity: building the Koch Snowflake," direct the students to draw a large triangle on a dry erase board. Next, direct them to construct the Koch Snowflake on the board using the iterative techniques as described at the web link. Using paper and the half-distance rulers, teach students how to complete the iterations which produce the Serpinski Triangle. Both of these activities should be completed in a timely fashion to tie into the presentation.