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Russian Nesting Dolls, otherwise known as Matryoshka dolls, are little wooden forms that decrease in size exponentially so that they fit inside each other to reveal more and more dolls as you open the last one. Taxonomic rank, otherwise known as Taxonomy, is the hierarchy of animals based on a common ancestor/common attributes/characteristics they share. I decided to combine these two concepts to create a new method of teaching this hierarchy- Taxonomic Nesting Dolls. (2)

I started off with the desire to create an easier way for children to understand taxonomic rank. As a child when learning this topic in science class, I saw the same triangular diagram over and over again, and I thought putting a hand-held, interactive twist on this subject might make it more helpful and enjoyable to learn. I started off with basic sketches of the organisms I wanted to include on my dolls; hand sketches turned to digital sketches where I set my simplistic style and my pastel color palette. I then acquired plain wooden nesting dolls, and sketched my organisms onto the dolls, followed by about 20 hours of acrylic painting and a spray of sealant. I painted the sides of the dolls with the organisms, the tops with the hierarchy that doll represented, and the bottoms of the dolls with what all these organisms have in common to belong to that grouping. (13)

Taxonomy stems from a larger topic- evolution. Taxonomic classification is basically what the name states it is- a classification system. The actual concept behind the system is that these organisms are classified/put into these certain groupings because they all share a common ancestor. This means that the similar attributes they have in common all come from sharing a relationship to one same organism, no matter how distantly related. For instance, the reason that a dog is more closely related to a cat than it is to a cow is because a dog and a cat share a relatedness to a common carnivorous mammalian ancestor. This little carnivorous mammal species was walking around on the Earth, and at some point in time, through adaptation to the environment or because of a genetic mutation that changed their phenotype (their physical attributes), the species changed. Changed enough that the species could no longer be considered the same species anymore. By change, I mean that that mutation or adaptation caused the mutated organism(s) to be better adapted to their environment, and survived more so than the organisms that didn't have their new mutation. Eventually, these changes made the organisms so different they had to be classified into more specific groups, in this case, felines and canines. They are different than their original carnivorous ancestor, and also different from each other, however both of the two new families of animals originated from the same common ancestor. If we wanted to bring the cow back into the situation, we would have to go even further back, and consider the common mammalian ancestor between the cow and the cat. The more closely related organisms are within the species, the next closest related organisms are in the genus, going up to the list of classifications until you hit domain, where the organism are the least directly related. Regardless of how closely related, there is still a common ancestor between all

the organisms in the domain they are in. Taxonomy basically is how we organize evolutionary organisms. (11) (12)

It is difficult to pinpoint exactly what these common ancestors were because obviously, no humans were there over the millions of years that life evolved to witness all the organisms involved. We do however use the fossil record to view evolution. The fossil record is incomplete, as the conditions to fossilize organisms has to be specific (organism had to have died by water, in mud heavy enough to make an impression and quickly be covered in multiple layers of sediment to become mineralized and preserved in their sediment layers), and then discovered by us humans to then piece together what we found and what we know from observing the organisms that currently exist and the information we have from past research. This is why I will not be providing exact common ancestors for each doll, however I will be providing a generalization of what the common ancestor of each doll would have been/what characteristics it had. (14)

Each doll is specific to the hierarchy they represent, as well as on each doll there is a common ancestor that relates all of the organisms on it. The smaller and smaller the dolls get, and the less organisms on the doll, the more closely related the organism on the doll are, meaning the more recent the common ancestor they share. We start off with all of the organisms included in this project on the first and largest doll (crocus plant, eastern tiger swallowtail, peacock, bottle-nose dolphin, lion, grey wolf, red fox, fennec fox), (1). All of these organisms are related because they are all part of the domain Eukaryote- meaning they are all organisms that have a nucleus and other organelles enclosed in a membrane. (10) The common ancestor on this doll is an organism called a LECA, or Last Eukaryotic Common Ancestor, who had these attributes as well. The reason that these organisms on the doll are related to this ancestor/each other is because they all originally were this organism until it mutated or adapted to its environment and through time and multiple generations of mutation/change it became the organisms represented on the dolls. The next doll inside that one consists of all the previously listed organisms except the crocus, bringing us to the Kingdom Animalia. All of these organisms are related because they are multicellular, heterotrophic, mobile organisms, stemming from a common simpler animal, that was that moved and looked for its food. (9) The crocus flower can make its own food and is stationary, which is why it is not included in this kingdom, stemming from the common ancestor among plants, a mutation off the Eukaryotic ancestor that stayed stationary and autotrophic.

The next doll, omits the Eastern Tiger Swallowtail. This doll is for the Phylum of Chordata, which means all the animals on this doll have a notochord, a hollow dorsal nerve cord, and a post-anal tail for at least part of their lives, and are bilaterally symmetrical. (8) This doll shares a common ancestor that mutated off the animal common ancestor and eventually developed a vertebrae. Despite the butterfly being symmetrical, its body structure is different and it does not possess the rest of these traits. The next doll inside is shown sans peacock, as a peacock is a bird and not a mammal. The Class of Mammalia includes animals that have some form of body hair, three middle ear bones and perhaps the most significant for this class- mammary glands that produce milk in females to feed their young with, as well as they give birth to their young after carrying them in their uterus while they develop. (7) This class developed off of a common ancestor of a simpler mammal, which stemmed off of the common ancestor of the chordates, altering mutating/adapting and developing these traits. The peacock does not do these things, as

they lay eggs to create offspring, they do not have mammary glands, and they have feathers instead of hair.

As we leave the bottle-nose dolphin behind, we meet the order of Carnivora. These animals are meat-eating organisms, with adaptive teeth and claws that allow for an easier way to kill and consume their animal prey. (6) Bottle-nose dolphins do not fit into this category, as they are finned and do not have claws. They also do not share the same common ancestor, the carnivores came from an organism that stayed on land, whereas the dolphin's ancestor mutated and adapted to life in the water. On the next doll, we say goodbye to the lion, as we move to the Family of Canidae. These organisms' characteristics include having long muzzles with strong canine teeth, non-retractable claws and bushy tails. (5) The lion does not fit in this category because most felines have retractive claws, shorter muzzles, and are devout carnivores. The common ancestor as mentioned previously, was a carnivorous mammal, that over time mutated to eventually land us with different enough organisms because of these attributes to bring us to felines and canines. As we further specify, and leave the wolf on the last doll, we move to the Genus Vulpes. This genus brings us the actual foxes, foxes being smaller canidaes with flatter skulls and triangular markings between their eyes and nose, as well as a different colour on the tip of their tail than the rest of their body. (4) The reason the grey wolf does not fit this genus is because they are much larger canidae that have heavy large skulls, with a consistent colour of fur throughout their bodies. Although still closely related, the common ancestor of both eventually changed enough in size and physicality that the wolves and foxes became their own genuses. This doll of the two foxes is the most closely related doll between two species, as they are actually both stemming from an earlier fox form.

We arrive to our last and smallest doll of the set, with our species of Vulpes Zerda, otherwise known as the Fennec Fox. This little guy is the smallest species in the canidae family; they are normally a cream/tan colour, and mainly live in the North Sahara of Africa. Its main characteristic that separates it from other foxes is its unusually large ears; they span out about the length of half their body. (3) The reason the red fox is not this species is because they live in colder climates, North America and Eurasia usually, as well as they are larger and as the name implies- normally red. All of the organisms in this species have the same common ancestor because they are all the same organism, despite there still being able to be variation within a species.

All of the information about the traits that make these organisms related is condensed and included on my dolls, either representationally through the loss of a certain organism from doll to doll, or physically, on the bottom of the dolls in writing. I believe this set of dolls is a great way to teach children/beginners taxonomic rank in a more fun and hand-ons way, that is educational as well as colourful and creative.

View a video of my work here: https://www.youtube.com/watch?v=sSiEhgBc24U

Works Cited:

(1) “Classification - Vulpes Vulpes". *Bioweb.uwlax.edu*. N.p., 2007. Web. 26 Mar. 2017.
This website provided me with a more clear breakdown of the exact genus I chose to use for my dolls. I chose the Fennec Fox, and this article iterates the classification of the red fox (who I chose to represent my genus instead of my species.) However, all the other steps along the way were wonderfully broken down for me and gave me the information necessary to explain why that fox was included in these classifications. It provided me with traits that separated certain organisms and characteristics that made certain organisms alike. This website helped me determine which organisms I would choose to represent each level of hierarchy on my dolls.

(2) Cain, A.J. "Taxonomy | Biology". *Encyclopedia Britannica*. N.p., 2011. Web. 19 Feb. 2017
This website was used for a basic definition of taxonomy. I needed a very clear definition before I could continue forth and this dictionary website provided me with one.

(3) “Fennec Fox | National Geographic". *Nationalgeographic.com*. Web. 26 Mar. 2017.
(4) “Red Fox | National Geographic". *Nationalgeographic.com*. Web. 26 Mar. 2017.
(5) “African Lion | National Geographic". *Nationalgeographic.com*. Web. 26 Mar. 2017.
(6) “Gray Wolf | National Geographic". *Nationalgeographic.com*. Web. 26 Mar. 2017.
(7) “Common Bottlenose Dolphin | National Geographic". *Nationalgeographic.com*. Web. 26 Mar. 2017
(8) “Peacocks | National Geographic". *Nationalgeographic.com*. Web. 26 Mar. 2017.
(9) “Eastern Tiger Swallowtail Butterfly, Size, Colors, Life Span, Host Plants, Photographs". *Butterfliesathome.com*. N.p., 2017. Web. 26 Mar. 2017.
(10)“Crocus Vernus - Plant Finder". *Missouribotanicalgarden.org*. Web. 26 Mar. 2017.
I used all of these sources for information about all of these organisms. Since they are all so different and I didn’t know all of their characteristics before I started this project, and I wanted to be scientifically accurate, I wanted good sources. National Geographic provided me with tons of information on most of the organisms I selected, and from there I could actually determine what made each organism not continue onto the next and smaller level of hierarchy.

(11) Jensen, Christopher X J. "Evolution". 2017. Lecture.
I am citing this class because a lot of the information that is in this summary is the culmination of the semester’s worth of learning/lectures/homeworks, etc. I didn’t want to make it seem like the information was coming from nowhere, so I cited this to show that the information that I am using to explain my project is coming from my head from all that I’ve learned this semester.

(12)“On The Relationship Between Taxonomy And Evolution On JSTOR". *Jstor.org*. N.p., 1969. Web. 15 May 2017.
This excerpt from this book helped me to further articulate the relationship between taxonomy and evolution. It gave me the information I needed to then use what I learned in class into my paper, and tie together my whole project to this class.

(13) Society, National. "Animal Pictures - National Geographic". *National Geographic*. N.p., 2017. Web. 26 Mar. 2017.
This website provided me with accurate photographs of the animals/plants I included in project. Despite using a more cartoony style, I wanted the animals to be as accurate as they could be, form wise. While Google Images may have this information, I wanted an acclaimed website for reference of these animals in action/in their environment.

(14) Vargas, Pablo and Rafael Zardoya. *The Tree Of Life*. 1st ed. Sunderland, MA: Sinauer Associates, Inc., 2014. Print.
This book helped inform me of the definitions and specifics of each level of the hierarchy of taxonomy. It taught me about the difference between domain, kingdom, etc. and why they are separate categories, and why there are so many levels of hierarchy in this system. It taught me about why certain organisms with certain characteristics fit into certain domains, kingdoms etc. This book gave me a more clear understanding of how exactly taxonomy is broken down.


Domain
Kingdom
Phylum
Class
Order
Family
Genus
Species


Eukarya:
Organisms w/
cells that have a
nucleus & other
organelles en-
closed in a
membrane
Animalia:
multicellular,
heterotrophic,
capable of move-
ment, body plan
becomes fixed
as they develop.
Chordata:
possess a noto-
chord, a hollow
dorsal nerve cord,
& a post anal tail
Bilaterally
symmetrical
Mammalia:
possess hair, three middle
ear bone & mammary
glands
Carnivora
meat eating
organisms
w/ adaptive
teeth &
claws
Canidae
Feliforms
that live in
social groups
w/ muzzles
strong jaws
& bushy
tails