Title: "Wing Aspect Ratio and Morphological Measurement Analysis relating to Bird Flight and Natural History"

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Abstract:
This activity simulates analysis and identification of bird specimens based on the relationship of the natural history of bird species with the morphographic measurements and ratios compared to graphs of the same types of measurements and ratios for known examples of species for which the natural histories are given.

Subject, Grade, Level:
Integrated Science, Grade Level: 6, 7, 8

Learning Objectives:

1. Students will recognize that morphology of birds reflects their needs to survive within their ecological niche because morphology determines flying characteristics and success in predation and escaping predation by other organisms.
2. Students will make accurate measurements, compute ratios correctly and successfully construct graphs of measurement and ratio data for known and unknown bird specimens.
3. Students will find trends in measurement and ratio graphs that appear correlated to bird morphology, flying characteristics, feeding behavior and vulnerability to predation for known bird specimens that affect survival of each species as a result of evolution of bird species.
4. Students will first work independently and then in small groups to make hypotheses about the identity of unknown specimens that are not the same species as the known specimens based on morphological measurements, ratios and graphs when they are given a selection of possible identity species along with flying characteristics and other natural history information for those species.
5. Students will know the characteristics of birds (class aves) and recognize the characteristics of the bird families, genuses and species in this activity that make them different from other orders, families, genuses and species.
6. Students will understand that they have conducted an observational study.

Science Standards:

SC.6.L.14.1	Describe and identify patterns in the hierarchical organization of organisms from atoms to molecules and cells to tissues to organs to organ systems to organisms.

SC.6.L.14.5	Identify and investigate the general functions of the major systems of the human body (digestive, respiratory, circulatory, reproductive, excretory, immune, nervous, and musculoskeletal) and describe ways these systems interact with each other to maintain homeostasis.
SC.6.L.15.1	Analyze and describe how and why organisms are classified according to shared characteristics with emphasis on the Linnaean system combined with the concept of Domains.
SC.6.N.1.1	Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
SC.6.N.1.2	Explain why scientific investigations should be replicable.
SC.6.N.1.3	Explain the difference between an experiment and other types of scientific investigation, and explain the relative benefits and limitations of each.
SC.6.N.1.4	Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.
SC.6.N.1.5	Recognize that science involves creativity, not just in designing experiments, but also in creating explanations that fit evidence.
SC.7.L.15.1	Recognize that fossil evidence is consistent with the scientific theory of evolution that living things evolved from earlier species.
SC.7.L.15.2	Explore the scientific theory of evolution by recognizing and explaining ways in which genetic variation and environmental factors contribute to evolution by natural selection and diversity of organisms.
SC.7.L.15.3	Explore the scientific theory of evolution by relating how the inability of a species to adapt within a changing environment may contribute to the extinction of that species.

Timeframe:
Three 45 minute class periods following a prior lesson that introduces the general characteristics and variation in species of the class of birds (aves) and the role of birds in Darwin's development of the Theory of Evolution.

List of Materials:

- MorphoSource image files with measurement meta data.
- Class set of Macbook computers, iPads or Chromebooks
- Bird Field Guides

- Online resources including online ornithology notes - http://people.eku.edu/ritchisong/554notes2.html
- Google Education Suite
- Possible 3-D wing bone printed sets to reduced relative scale (1 for each specimen that can be examined at stations)
- Possible 3-D ulna for each specimen that is printed actual size at the stations

Procedure and General Instructions (for instructors):

Day 1

- Introduction to MorphoSource image sets and measurement tools
- Introduction to Bird Field Guides and online resources
- Practice calculating wing aspect ratio, ratio of body weight to wing area (loading), spreadsheet
- graphing of aspect ratio and wing loading and correlation to flying characteristics, prey and predation.
- Possible calculation of ratio of volume to length of ulna from bird wings if volume meta data is provided in MorphoSource.

Day 2

- Working individually
- Measure, compute aspect ratio and wing loading for each known and unknown specimens, then graph and identify correlations between the graphs and flying characteristics and other natural history data.

Day 3

- Working in cooperative groups
- Discuss in small groups, where the aspect ratios and wing loading of the unknown specimens fit into the graphs of known specimens and look at the flying characteristics and natural histories of nearby species in order to make hypotheses about which unknown specimens fit with the possible species identities that have been provided for the unknowns.
- When the correct identities are revealed by the teacher, identify the key pieces of information that led to correct and incorrect identification of the unknown specimens.
- Each student write a short paragraph for each unknown specimen that explains how the measurement data for the specimen led their group to either the correct or incorrect identification.
- Discuss as a group the correct flying characteristics and natural histories provided for that species to identify key morphology that has allowed each species to survive because of appropriate flying characteristics that allowed the species to feed and escape predation. Each student record the group conclusions as part of their work product.

Name _____ Class Period _____ Date _____ Due _____

Teacher

Wing Aspect Ratio and Morphological Measurement

Rubric

_____ Computation - You correctly calculated and graphed required values.

_____ Analysis - You found patterns in graphical representations of data and computed values and identified correlations with flying characteristics and natural history of bird species in order to develop hypotheses.

_____ Communication - You summarized your methods and explained your logical conclusions clearly and employed correct word choice, sentence structure, spelling and grammar.

Instructions

Day 1

Use the links and example scans from bird guides on your google classroom to follow and participate as an oral reader and by responding to questions during the teacher led discussion in class or on your own if you have missed class.

Use the link on Google Classroom to go on the MorphoSource website to see the 3-d images and make measurements for the set of bird specimens while following along with what the teacher is demonstrating on the projector to collect data for each example specimens. If you miss class or can't remember what to do, watch the screen recording video posted on Google Classroom. Along with the teacher, practice using the data to do the simple calculations and make graphs of the measurements and computed values using Google Sheets. You must submit your spreadsheet to the Google Classroom assignment for this activity and submit the assignment when you have attached all of your work. Do not submit the assignment until all of your documents are finished.

You will be given time to use rulers and calipers to make some measurements of the 3-D printed bone sets. The complete sets have a smaller scale than the actual size ulna bone provided with each set. Verify that the scale is the same for each set by dividing the length of the small ulna from the set by length of the full sized ulna. The resulting ratio is the scale.

Are the scales for each set nearly the same value? _____ What is the biggest difference? _____

What scale did your calculate? (round to 2 decimal places) _____

Day 2

1. Following the methods covered yesterday, make a table in a google document that has a row for each specimen and a column for the specimen number, the name when it is known or hypothesized, the measurements of the length and chord of the wing mount image associated with each specimen, the computed aspect ratio, the average weight of the known or hypothesized bird specimens from a field guide or web page, the computed total wing area of both wings and the computed wing loading.

2. Compute the ratio of the volume of the ulna to its length if the volume data is available in MorphoSource.

3. Make a column chart for each computed quantity so that the ratios can be compared between specimens for aspect ratio, wing loading and ratio of ulna volume to length for the known specimens and when the unknown specimen identities have been hypothesized.

4. Look at the description of the flying characteristics, prey, predators and natural history for each of the known specimens and try to identify correlations between the graphed values and the descriptions of the characteristics of the known bird specimen species. Record the correlations that you identify using notes typed into a Google Document that your create for notes and attach your notes to the assignment in the Google Classroom.

Day 3

In your group of 3 or 4 students,

Discuss the correlations that each of you have identified that link the value of the aspect ratio, the wing loading and the ratio of volume to length of the ulna to the flight characteristics and natural history of the know specimen species. Create your own Google Document to submit for this assignment and write a short paragraph that summarizes your group's consensus about correlations that the group has identified.

As a group, reach a consensus on a hypothesis for the identity of each of the unknown specimens and in your own Google Document, summarize why the values for the three ratios led your group to choose that specimen identity based on its flight characteristics and natural history.

After the teacher reveals the actual identities of the unknown specimens, discuss with your group what values for the computed quantities led your group to correctly or incorrectly identify each of the unknown specimens.
In a paragraph for each of the unknown specimens, record a summary of your group's analysis of how they correctly or incorrectly identified the specimen.

Write a short paragraph that explains why this activity is an observational study rather than an experiment based on the procedure that your group used.

Write a final paragraph that gives some good examples of characteristics from 2 or three species from this activity made them evolutionary successes that have escaped extinction of their species.