Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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Three Dimensional Art of Vertebrates and Invertebrates

Curriculum Unit 85.07.07
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This unit will be written in two parts: the anatomy of the human skeleton and the anatomy of a shell. After the study of the anatomy of both the shell and the human skeleton, the students should be able to draw and paint with more intelligence and understanding of form and function of the two major biological groups—vertebrates and invertebrates.

In order to give the students a firmer foundation it will be necessary for the students to learn the basic human skeleton if they wish to draw the human figure. The lessons are presented as art lessons. The precise names and scientific background for bones in the human skeleton is secondary, but should serve necessary to assure recognition.of forms.

The unit's objectives are:

(1) To teach basic anatomy through life sketches of human skeleton and hells.
(2) To teach the fundamentals of line (sphere, cylinder, cone and cube) using the human figure and shells.
(3) To be able to observe life around you and to convey, through sketches or drawings, what you see. The twelve week unit is basically studied from an art point of view but it also introduces basic science and math into the curriculum. Teachers and students will find that academics can be fun when learning through art.

I have written this unit for students in 9, 10, 11, and 12th grades. Lessons may be used for students in Art I, II, or III increasing the intensity of the lesson according to their previous knowledge. This is a 12 week unit: 8 weeks on human skeleton and 4 weeks on shell anatomy.

In the first section, I give the basic vocabulary for the important parts of the skeleton that will enable the students to draw any man or woman. There are differences in the male and female body parts which can be shown in the form of lines drawn. There are six parts to this section that will lead up in sequence to the full figure drawings:

(1) The front and profile head. Using spheres and a basic cross section through the circle, the students will be able to learn the relationship of the skull to them.
(2) The neck and head. The study of the movement of the head and neck will show the limitations in drawing them in certain positions. Indeed, the thickness of the lines will play an important part in drawing a male or female head and neck.
(3) The arm. Using a skeleton model, students will enjoy sketching several bones from the shoulder to the elbow, to the wrist, and including the fingers. The importance of understanding this section will enable each student to draw the arm in any position that will increase their understanding of proportion.
(4) The hand. I will ask the students to study their own hand in use. I will ask them to make simple sketches of them to create a design. The hand is one of the most difficult to draw.
(5) The leg bones including the foot (the femur, the patella, the tibia and fibula). In drawing this section of the skeleton, the students will see that the knee cap helps protect the knee and it is necessary to divide the leg into three sections (thigh, leg, foot) to draw the anatomy of the leg.
(6) Simplified figure drawings. I will allow the students to study pictures from magazines and photographs. They can trace over the drawings to make studies of them. The final project in this section will be to draw from a live model which will enable them to apply the basic anatomy learned in the previous weeks.

Once the students have completed the six part lesson on skeletal anatomy, they will be able to make a final analysis of the human skeleton. I hope that the students will be able to see that the bones articulate by way of the joints fitting into other bones. This articulation will allow the young artist to draw the bending system and joints in each section of the human body.

The second part of this unit will look into exo-skeletons: univalve and bivalve shell. This will tie into what they have learned about the human skeleton and how to draw it. Humans wear their skeletons on the inside and shells wear their skeleton on the outside. Snails and mollusks live in-side their shells and use them for safety. As invertebrates grow they must increase their shell. There are many types of mollusks: snails, clams, oysters and scallops. Through observation of this range of shell structures students will be able to understand how layers of Calcium Carbonate ($CaCO_3$), form on the edge of the shell to make the shell larger. Also they will be able to see how color becomes part of the shell.

Two kinds of shells will be studied. The first are shells called Gastropods or Univalves. They will be able to measure the height and length or width and length of a variety of shells. As the invertebrate grows the whirls also get larger. Many pencil, chalk and charcoal sketches will be made of the animals with one shell. The students will be able to correctly identify each shell and draw them in three dimensions to show their symmetrical shapes.

The second shell type the student will study is the Bivalves or the animals that have two shells, usually of equal size and shape, hinged together. The studies of these shells will become much more interesting because

the shell will be drawn in an open or partially opened as well as a closed position.

A vocabulary unit will be presented for both the human anatomy and the shell anatomy. The terms will include scientific names as well as art terms.

The students will be able to experiment with the media of watercolors when adding color to their shell drawings. Line will play an important part in drawing the shells. Each student will use line to give a three-dimensional analysis of the growth of the shell. The projects will be enhanced by adding color to some and doing others in black and white.

The final test will be given to the students to see if the knowledge of the skeletons in shells and humans was achieved. Students will know that a Vertebrate is an internal skeleton and an Invertebrate is an external skeleton. Both have an architecture all their own.

Part I: The Human Anatomy—Three-Dimensional Proportions

Introduction —

Drawing the human anatomy is probably one of the most fascinating areas of study to any student. Most students looking at a completed drawing will readily state that they could never draw like that. I intend to reinstate their confidence and convince most that they will be able to complete an anatomy drawing to suit their satisfaction.

Objectives —

(1) Students will be able to draw parts of the human body by using basic cylinder and sphere shapes.
(2) Students will gain knowledge of the human skeleton figure.
(3) Students will be able to make simple full-figure action drawings.
(4) Students will be able to draw in detail the hand, skull (head) and foot to create their own anatomical design.

Motivation —

(1) I will show the students several charts. Chart 1 the skeletal figure and chart 2 the basic proportions of the human figure.
(2) Show examples of figure drawings done by other students or masters. Goya and Rembrandt.
(3) The unit of study will be done in six sections that will gradually lead up to a full figure drawing.

Materials
Medium-Drawing (Pencil)

12 x 18 newsprint

Compass

12 x 18 white drawing paper

Erasers

Pencils

Colored Pencils, crayons

***Procedure*- (Six Part Lesson)**

A. The Bone Structure: Basic Background

1. Distribute Vocabulary Handout #1 to each student. Go over all vocabulary terms. Students are expected to memorize these terms.
2. Using an adult skeleton model (borrow from the science department) introduce the students to a basic science background of the internal skeleton known as *Vertebrates.*
    a. Facts: (Refer to *The Vertebrate Body* by Romer)
        (1) There are over 200 bones in the human body.
        (2) The human body is divided on Morphology. Morphology depends on (a) genetics, (b) Mechanics and (c) Metabolism: good nutrition——Heavier bones.
        (3) Vertebrate = animals with backbone. The Axial skeleton.
        (4) Limbs are *long bones* called *Appendicular* Skeleton. Inside the *femur* (thigh bone) there is a bone marrow cavity. Most bones have bone marrow. Young people, have a large amount of bone marrow. As one becomes an adult, there will be a lesser amount of marrow and fluid (fats and lipid) will fill the cavity.
        (5) There are two ways bones may be joined. (refer to vocabulary handout #1)
            (a) *Articulation* —it is the joint where one bone fits into another bone.
            (b) *Sutures* can also join bones. They may be seen as a fine line———or a wavy line ~~~~~.
        (6) *Ossification* is the cellular process in which bone tissues are created—cells secrete matrix. Matrix then has mineral within it. Matrix is organic material mainly protein, collagen, which becomes mineralized. “Hard” white = mineral that are used to create the bones and teeth.
        (7) Bone would not be bone without mineral.
        (8) Calcium is an essential element in the process of making bone mineral: (Ca5 (PO4)3 (OH) = Apatite)
        (9) *Bone* tissue is the store house for other elements used in metabolism, a composite that forms the structures called bones.
    3. Test—(Test Ditto #1) This is a duplicate of the vocabulary handout. Have the students label the skeletal forms as studied in the basic bone structure.

B. Project #1 Drawing: The Skull.

1. Handout Practice Sheets #1 and #2 to each student.
2. Handout 12 x 18 newsprint paper, pencil, compass, ruler and eraser to each student.
3. To develop a good framework for drawing the skull have the students follow the step by step drawing on practice sheet #1.

(a) notice that it is important in step 1 to make a full circle using a compass. Using the ruler equally divide the sphere into four quarters.

(b) Step 2, working the upper left quarter, place in lines 1—3. Follow lines 4—7 into the lower left quarter. Lines 8—10 will be drawn next in the lower right quarters. The quarters allow the students to develop the correct proportions in drawing the skull.

(c) Once again, break down the remaining lines 12-16, according to the quarter in which they fall.

(d) In steps 4, 5 and 6 line is used to create the three-dimensional image to complete the skull.

4. Students should practice drawing the side profile until they feel they can make a final drawing on a large sheet of white drawing paper.
5. Repeat the process for the front view of the skull using Practice handout #2.
6. Have the students display their work on a bulletin board in the classroom.
7. This should take approximately 5 class periods (1 week).

C. Project #2— The Neck and The Head—Draw with Pencil and crayon

1. Distribute Practice Sheets #3 and #4. It is important at this point to indicate that muscles generally fill the space between the bone and the outer skin. In this exercise the students will have the ability to add main muscles, to a step by step drawing instruction, that will shape up the skull and neck to resemble that of a human head.
2. Distribute: newsprint paper, pencil, crayon, ruler, eraser, compass to each student.
3. Refer to practice sheet #3. Begin with step 1 and follow through to step #6. Remember to use the quarters to keep proportions in line. There is no need to repeat the sphere six times, duplicating what is on the practice sheet. Work from the same circle and complete all 6 steps in that sphere.

4. Repeat the process for practice sheet #4. Make sure in both, line is being used to indicate the flow of the different muscles.
5. Take a large sheet of white paper and draw a front and side view of the head, neck and face showing muscle. This will be the students finished drawing.
6. Allotted time: one week.

D. Project #3—Humerus to Phalanges—Pencil Sketching

1. Refer to vocabulary handout #1. Students should be made aware of the three basic sections of the armbone. To draw them in proportion to one another, notice the proportions (illustrate with body bend). The humerus is slightly longer than the ulna and radius bones. It would be wise for the student to measure these two distances an mark them with a dash or a short horizontal line. The length of the wrist and hand is only 3/4 of the length of the ulna and radius. This should also be marked.
2. Pass out a piece of newsprint for practice.
3. Students should begin at the top of the humerus and sketch down. Shading, using the side of the pencil or by using small variable lines, can be applied to give the three-dimensional effect of the bones.
4. The Ulna and radius bones should articulate from the Elbow, the bottom part of the humerus bone.
5. When drawing the finger bones; the phalanges, note that each finger has three sections where they bend. The thumb has only two sections. Have the students look at one of their hands. At this time, make note of keeping the fingers in proportion as they are sketching. The bends in each finger will aid in drawing them.
6. Final copy: white paper 12 x 18, using pencil, colored pencils, crayons and eraser.
7. Critique—Class discussion. Have the students display all their drawings on the bulletin. Allow them to discuss their feelings about drawing this section of the anatomy.

E. Project #4— The Arm and Hand—Pencil with Pen and waterproof drawing ink

Motivation -

1. Introduce the fourth part of anatomy by having the students look at their own arm and hand. Indicate that the bone structure drawn in the previous lesson can now be applied to drawing the arm and hand as we see it.
2. Have the students form a circle around you and demonstrate drawing the hand.

Procedure -

1. Distribute a large sheet of newsprint paper. Allow the students to sketch one of their own arms and hand.
2. Make sure they are marking the distances between the humerus, the ulna and radius and the metacarpals and phalanges. (Math input—use real measurements)
3. Students may wish to place a piece of paper over the bone sketches from the previous lesson to draw in the exterior lines. Handout practice sheet #5 to each student. Refer to the different sketches of the hands.
4. When the student is ready to start drawing the final copy, distribute 12 x 18 white drawing paper, pencil, eraser, pen and waterproof drawing ink. The student will make a series of anatomical sketches to create a simple design.
5. The finished drawing should be outlines by using a pen and waterproof drawing ink (assorted colors).
6. Drawings will be displayed in the classroom.
7. Time allotted: one week.

F. Project #5—The Femur (Thigh Bone) and Foot—Pencil Sketches

***Motivation* —Drawing the femur and foot bones are much like drawing the arm-bone. In comparison to the arm bones, the leg also has joints to allow for bending and movement. There is also three divided sections and should be marked as done for in project #3.**

Procedure —

1. Refer to the drawing on Vocabulary handout #1.
2. Distribute pencil, erasers, rulers and newsprint paper.

3. Loosely sketch the shape of the femur, patella (knee bone) and fibula and tibula.
4. If necessary refer to the skeleton in class to see which way the bones would face if drawn front view.
5. After a few sketches begin to draw on white drawing paper.
6. Place in the horizontal guide lines that will indicate the length of each section (as done in the arm-bone drawings).
7. Begin to draw. Use small uneven lines or the side of a pencil to shade. This will provide a three-dimensional drawing on a flat surface.
8. The project should take 1 week.

G. Simplified Anatomical Figure Drawing Pencil/Crayon

Motivation —
Students will be allowed to draw anatomical drawings by using a simple blocking or abstract lines to create their own skeletal sketches. Allow the students to trace over photographs, drawings and magazine pictures to simplify the study of a full figure drawing.

Materials —

Newsprint 12 x 18	crayon
White drawing paper	colored pencils
pencil	ruler
eraser	

Procedure —

1. Sketch on the blackboard stick figures in different positions . Use the basic farms in line ta draw these sketches.
Ex.

(figure available in print form)

examples:

(figure available in print form)

(all sketches are copied from *Anatomy* by Walter T. Foster)
2. Handout Practice Sheet #6 (Basic Drawing Proportions). Students should be made aware that an adult is approximately 8 heads high. Using circle and cylinder shapes the proportions can be drawn quickly and accurately.
3. Have students take turns being a model. Have one 40 minute class period of quick 5 minute sketches of different students in the roam, Begin with a simple standing pose and gradually work into a more difficult position.
4, Distribute Vocabulary handout #2 to each student. Up until this point, it was not necessary ta fill in the facial features. Students should practice drawing the shape of the head, dividing it into sections and practicing the eyes, nose and lip examples on the handout. The handout should be explained in class before allowing the students to draw.
5. By applying what was learned in project #1, the students should relate back to the skull. It should be easy to draw a face from a magazine ar photograph. Have the students do a few sketches to get use to working on facial features.
6. *Final Drawing.* Ask the students to bring in a picture of themselves. Each student will draw on white drawing paper, a self-portrait. The project should include a full skeletal figure that shows the human body parts drawn in proportion which will shaw the students' knowledge received regarding drawing the human anatomy.

Part II: The Anatomy of a Shell

Objectives —

1. Students will be able to identify a univalve and a bivalve.
2. Students will be able to successfully draw a three-dimensional shell on a flat surface.
3. Student will be able to identify and measure shells found in the area. (Shells are made of $CaCO_3$ and may dissolve or change over time if not cared for properly. See Nancy Wyskiel's unit).

Motivation —

Most students enjoy going to the beach and at one time or another they have experienced picking up pretty shells along the way. Shells often show many colors; red, orange, green and blue. Some shells may have pearly luster colors or some may have very little color, perhaps black with a little variation of white. We are going to study shells. We will be able to give their names and be able to identify them.

Show an example of a large pink counch, moon snail and other mollusks. (black mussel, white and grey oyster) Discuss the texture of the shells—roughness or smoothness of the shell.

***Procedure*— (This unit will be written in four parts.)**

A. Shells are Skeletons Too: Basic Background

1. Shells are *invertebrates* .
    a. Invertebrates are animals without (an internal) backbone.
    b. Invertebrates build an exo-skeleton shell of $CaCO_3$.
    c. An invertebrate shell is made up of calcium carbonate, $Ca\ CO_3$.
    d. The shell material is built up by the animal and forms an exoskeleton.
    e. As the animal grows—the shell is enlarged by forming layers.of shell. There is a layer, called the mantle, which is a layer of skin covering the mollusk's body. It is the interior part of the body of the animal. It secretes the shell or produces the minerals to make the shell layers.
    f. Shells vary depending on the amount of $Ca\ CO_3$ per unit area. Some shells are thick (alot of $Ca\ CO_3$) and are heavy. Others are paper thin and very light. (Show some examples)
    g. The animal (inside a bivalve shell) is called a *Mollusk* .
        (1) The name is a latin word (Mollis) which means soft.
        (2) The animal is soft-bodied although the shell is hard.
        (3) Two examples are clams and oysters.
        (4) The animals build their shells just as we unconsciously build our own skeletons.
        (5) Without these shells the animal cannot live.
2. *Univalves*— Are animals that live inside one shell. Snails (land dwelling mollusks) and periwinkles (ocean dwelling mollusks) are classified as univalves.
3. *Bivalves*— Are animals that have two shells, hinged together (clams, oyster). The muscle keeps the shell closed. Refer to Vocabulary Handout #3.
4. *Shell Growth*— As the shelled animal gets older they grow a bigger shell. There may be ridges on the shell showing growth increments of the annual cycle. Once the animal's mantle stops building it's shell, the animal inside cannot grow any larger.
5. *Reproduction* —(Refer to Shells Are Skeletons, Joan Berg Victor)
    a. Most mollusks hatch from very tiny eggs.
    b. Oysters produce millions of eggs—only a few survive.
    c. Snails hatch eggs in a protective capsule.
    d. Most snails and bivalve eggs develop into a minute organisms called Larvae. They swim around until they land on a hard object. Then they begin to develop and grow their shell. Some snails hatch into minute snails.
6. There are six classes of Mollusks:
    a. bivalves: clams, mussels

b. gastropods: (univalves) limpets, snails, slugs.
c. scaphopods: the elephant tusk shells
d. chitons: the roll up snail
e. cephalopods: octopuses, cuttlefish and squid
f. segmented mollusks: monoplacophora or gastroverms

7. We will be drawing shells classified as gastropods (univalves) and bivalves.
8. *Measuring A Shell*

Bivalve

(figure available in print form)

Univalve

(figure available in print form)

9. Test—handout #2 (Shells) Have each student tested on their basic background knowledge learned in this lesson.

B. Project #1— A Univalve (Gastropod) —Pencil Sketch with Pen and water soluable ink

Materials— pencils, eraser, 12 x 18 newsprint, white drawing paper, pens, water soluable ink.

Motivation — Show sample cards of drawings done of shell. Place them around the room on bulletin boards. Bring in samples of univalves that the students will be drawing. Go over the shade and line forms of the shell—Identify.

Procedure —

1. Pass out pencil, eraser and one piece of newsprint paper to each student.
2. demonstrate in class how to begin drawing the shell. i.e. *moon shell* . . . described as a broadly round shell.
Fig. A

(figure available in print form)

Fig. B

(figure available in print form)
(figure available in print form)

The basic form should be a broad circle—loosely sketched (Fig. A). Working from right to left put in the shell spiral lines (Fig. B). Next put in the curving lines (growth lines) that follow the spiral shape of the shell, Then the detail will follow . . . curving lines will give shape and form the three-dimensional drawing.
3. Have the students pick out the univalve they wish to draw. Shells should be drawn at least two sizes larger.
4. Each student should practice drawing the shell on newsprint paper until they feel ready to place their finished drawing on white drawing paper.

5. Once the drawing is transferred on white paper, black ink may give color to their drawing. This may be used to show texture.

C. Project #2— A Bivalve— Pencil Sketch with watercolors and pen and water soluable ink.

Materials — watercolors, brushes, water tins, pencil, eraser, newsprint, watercolor paper, pen, water soluable ink.

Motivation — Do a quick sketch of a shell on watercolor paper.

Explain the procedure of using watercolors:
1. The more water applied to the brush, the lighter the color.
2. The lesser amount of water on the brush will give a fine line and also a darker color.
3. Once the pencil drawing is on the paper, you may dry-brush the watercolors by applying just the paint to a dry piece of paper.
4, You may choose to wet the entire paper with clear water and then apply the watercolors. This gives a looser, washy look to the painting.
5. After the paper drys, the students can outline the shell with pen and Black ink.

Procedure —

1. Hand out newsprint paper, pencil and eraser.
2. Have the students pick out the Bivalve they wish to draw.
3. They should begin to sketch their shell on paper. Sketches can be made of the shell in many positions.
4. Once the student has chosen his sketch for his final drawing, he may transfer the drawing to the watercolor paper.
5. Take a brush, watercolor tin, water tin and begin to apply color to the shell. Color can be set around the shell to represent the natural surroundings or applied directly to the shell.
6. Allow the painting to dry.
7. Get a pen and black ink. At random, outline sections of the pencil sketched shell.
8, Frame the finished painting and display. Have the class have a critique on the finished paintings.
9. Time allotted: one week.

D. Project #3— Sea Shell Still Life— Combined media

Motivation —Arrange a still life of univalves and bivalves.
Talk about placement of shells: make sure they form an interesting arrangement. Some may be drawn as an overlapping design that uses only one shell, but repeats the shell to create an interesting pattern. Demonstrate in class.

Procedure —

1. Handout newsprint for sketching pattern of design.

2. Have students set up the still life they will be drawing.

3. Transfer sketch to white drawing paper.

4. Apply color by using any media they wish.

5. Have each student write a short paragraph explaining

6. Display all finished work on the bulletin boards.

(figure available in print form)
Vocabulary Handout #1: Anatomy
(figure available in print form)
Profile Head—Practice Sheet #1
(figure available in print form)
Profile Head—Practice Sheet #2
(figure available in print form)
Practice Sheet #3
(figure available in print form)
Practice Sheet #4
(figure available in print form)
Anatomical Hand Sketches—Practice Sheet #5
(figure available in print form)
Basic Proportions—Practice Sheet #6
(figure available in print form)
Vocabulary Handout #2: Anatomy
(figure available in print form)
Vocabulary Handout #3: Shells
(figure available in print form)
Test #2: Shells

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