Using Pseudozoids to Teach Classification and Phylogeny to Middle School Students

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Abstract

This research compared the outcomes of teaching middle school students two different methods of classification and phylogeny. Two classes were randomly selected and taught using traditional methods of instruction. Three classes were taught using the "Pseudozoid" approach, where students learned to classify, develop and read dichotomous keys, and make evolutionary diagrams using artificial organisms. Here, the pseudozoids are twenty-six different artificial organisms that have body shapes representing the twenty-six letters of the alphabet. For each method, students were divided into small cooperative learning groups based on my estimation of student ability to learn and work cooperatively (i.e. high learner, medium learner, and low learner). A pre-test and test were administered to all classes. The data was used to measure the amount of learning associated with the traditional method or Pseudozoid method. A survey was given to all students after the unit on classification and phylogeny was completed to measure student satisfaction. No significant differences in test results, learning, or student satisfaction were found between the types of teaching method used. That no significant differences were seen could be due in part to the similarity in the teaching methods or to test questions that were unable to detect slight differences in student learning.

Introduction

The scientific practice of taxonomy, to classify organisms into distinct species, has existed for over 275 years (Blackwelder, 1977). The evolutionary origin of the taxonomic groups was first described by Charles Darwin in *The Origin of Species* (1859). In 1940, *The New Systematics* revisited Darwin's ideas on evolutionary origin of taxonomic groups, applying slightly more modern methods based on advances in evolutionary theory and genetics (Blackwelder, 1977). Although computer technology has allowed for more rapid, comparative investigation of phylogenies, the idea of taxonomy has remained virtually unchanged.

In contrast, science educators have experienced numerous changes in the National Science Standards for education over the past decade. These changes have affected the New York State Standards. In turn, State Standards have affected district policies and school science curricula. These changes in curricula have motivated many science educators to evaluate the effectiveness of their traditional teaching methods, and to find new methods or strategies that increase student learning.

Teaching middle school biology students concepts like classification and phylogeny is a challenge for teachers. Some of the ideas behind these concepts may seem very abstract to a student. The challenge for a teacher is to develop lessons and activities that are both interesting and educationally sound. A recent science department meeting at my school revealed a concern shared by our middle school science teachers. We find it difficult for our students to understand concepts like dichotomy, classification, and phylogeny. Edward Clinch, Science Department

Chair at Benjamin Franklin Middle School (Kenmore, NY) states, “My students have such a problem naming organisms using dichotomous keys. They can’t grasp the full concept and understanding that goes along with classification. We need to develop a better method for teaching our kids these tough concepts” (Edward Clinch, personal communication).

The purpose of this study is to compare student satisfaction and student achievement for two different teaching methods (traditional and Pseudozoids) that teach classification and phylogeny. A new method of teaching classification and phylogeny using a set of artificial organisms, called Pseudozoids, was used to teach different aspects of classification and phylogeny. Gendron (2000) showed the advantages of teaching classification to students using artificial organisms, because it eliminates bias due to the students’ prior knowledge about an organism and this forces the student to focus on observed similarities and differences. In contrast, when students use objects they are familiar with to construct dichotomous keys, they are more capable of learning through their own knowledge (Burns, 1998). My traditional method of teaching classification and phylogeny was to use a combination of independent individual activities. These activities were not linked in any way to each other. In order to make classification and phylogeny more integrated and accessible to students, the Pseudozoid method was used as a common factor for numerous learning activities.

We chose to use cooperative learning groups when teaching both the traditional and Pseudozoid methods because educational research has indicated the benefits of using cooperative learning in the science classroom. When small teams of students are put together to solve problems, they understand the information better and retain the information for a longer period of time (Lord, 2001). Cooperative learning groups go beyond short-term memorization of facts from books and tap into a student’s creative ability to learn (Franklin, 2001). Cooperative learning groups also have a positive effect on student learning and student satisfaction; students enjoy class more and have more fun.

The goal of my research was to determine if the Pseudozoid method of teaching classification and phylogeny would result in higher student test grades and greater learning. I also wanted to analyze specific parts of the test to determine if students who learned classification and phylogeny using the Pseudozoid method understood certain scientific concepts better. Lastly, We sought to determine through student surveys if students preferred learning classification and phylogeny by means of the Pseudozoid method or the traditional method.

Materials and Methods

This study focuses on the Kenmore-Tonawanda Union Free Schools Middle Level Science Curriculum 8th grade process skills based on New York State Standard 4, the physical setting. Biology topics that address these skills include classification and phylogeny. The specific process skills that students are expected to know include (KenTon Middle Level Science Curriculum Handbook, 2000, section grade 8):

General Skills:

- recognizing patterns and trends
- classifying objects according to an established scheme and student generated scheme developing and using a dichotomous key

• sequencing events

Living Environment Skills:
• classifying things according to a student generated scheme and an established scheme
• identifying structure and function relationships in organisms

The instructional method was randomly assigned. Three science classes were taught using the Pseudozoid method and two science classes were taught using the traditional method. Both methods followed a six-day lesson plan (Table I). The lesson plans contained similar and different activities (Table 2). During the first two days of instruction all five classes were taught the same material in the same way (Table 1).

On day one, students in all five classes were divided into cooperative learning groups of three to four students based on past achievement levels (low achiever, middle achiever, and high achiever) observed over a seven month period. I (RF) started by placing the highest achievers into separate groups. I (RF) then assigned the lowest achievers among these groups. The middle achievers were then placed into the existing groups based on the assumption that the particular set of students would work well together. These work groups stayed the same throughout the six-day lesson. A pre-test with twenty questions was given to all students (Appendix I).

On day two, classification was introduced to all five classes. Vocabulary terms (binomial nomenclature, Carolus Linnaeus, classification, levels of classification,) species diversity, and taxonomy) were covered and explained. Student groups were given a bag of common assorted objects (Appendix 2). This mixed group of objects was separated, and classified, into smaller groups based on similarities and differences in shape, size, function, and color (Appendix 3). The dichotomous key activity used, was developed by Devore (1994). A classification homework assignment was given that reviewed the topics covered on day two (Appendix 4).

Traditional Teaching Method
On day three, the traditional method classes worked with a classified paper activity (Appendix 5). Student groups were given a set of paper objects with varying shapes and symbols. Following a structured procedure, student groups classified these objects based on observed similarities and differences. Students then assigned appropriate taxonomic (Kingdom, Phylum, Class, Genus and Species) names to their objects.

On day four, the traditional method classes were given a dichotomous key for ten common mammals in the Eastern United States (Appendix 6c). Students were shown the correct way to use a dichotomous key to identify an unknown mammal. Student groups then identified two mammals (longtail weasel and woodchuck) using this dichotomous key. The student groups also employed a shoe classification activity (Appendix 7). Each student removed one shoe. A group of students studied the differences in theft shoes. Each student group developed a dichotomous key, and assigned scientific names to their shoes. A homework assignment was given to these students giving them an opportunity to develop theft own dichotomous key for hypothetical alien life-forms (Appendix 8b).

On day five, the traditional method classes were introduced to evolutionary branching diagrams. Student groups observed a branching diagram comparing four mammals: brown bear, house cat, lion, and platypus (Appendix 6a). The class was then given the evolution of shapes activity (Appendix 9a). Students cut and pasted different shapes and symbols into theft correct evolutionary position on a branching diagram. The evolutionary branching diagram homework was assigned to arrange baboons, chimpanzees, humans, and lemurs (Appendix 8a). A test review assignment was also given that reviewed the major concepts studied on the previous four days (Appendix 9b).

On day six, a test was administered (Appendix 1). This test was the same as the pretest given five days earlier. A questionnaire was also completed by each student (Table 3). The questionnaire focused on student satisfaction and their evaluation of the teaching methods and activities experienced. Student questionnaire responses were assigned the following values: Strongly Agree = 5, Agree = 4, Not Sure = 3, Disagree = 2, and Strongly Disagree = 1. The average response was calculated for each survey item.

Pseudozoid Teaching Method

On day three, the Pseudozoid method classes began with a discussion of evolutionary branching diagrams and dichotomous keys. Student groups reviewed a branching diagram comparing four mammals: brown bear, house cat, lion, and platypus (Appendix 6a). Student groups then made their own branching diagram with a frog, kangaroo, rabbit, and snake (Appendix 6b). A dichotomous key to ten common mammals in the Eastern United States was introduced to the class (Appendix 6c). Students were shown the correct way to use a dichotomous key when attempting to identify an unknown mammal. Student groups then identified two mammals (longtail weasel and woodchuck) using this dichotomous key. The evolutionary branching diagram homework was assigned to arrange baboons, chimpanzees, humans, and lemurs (Appendix 8a). Also, a homework assignment was given to these students giving them an opportunity to develop their own dichotomous key for hypothetical alien life-forms (Appendix 8b).

On day four, the Pseudozoid method classes began their phylogeny activity. Student groups were randomly assigned one of the five sets of organisms (Figures 1, 2, 3, 4, or 5). Using the assigned set of organisms, each student group completed a corresponding table that outlined shared traits (Tables 4, 5,6, 7, and 8). Each student group then cut and pasted their organisms onto an evolutionary branching diagram in order from most simple to most complex (Figure 6). A written statement was then developed by each group to explain the reasons why the organisms were placed in this branching order.

On day five, the Pseudozoid method classes continued working on their phylogeny. Student groups assigned genus and species names, and developed a dichotomous key to help them identify the different organisms in their set. Test review homework was given that went over the major concepts studied on the previous four days (Appendix 9b).

On day six, a test was administered (Appendix 1). This test was identical to the pretest given five days earlier. A student questionnaire was also completed by each student (Table 3). The questionnaire focused on student satisfaction and their evaluation of the teaching methods and activities used. Student questionnaire responses were assigned the following values: Strongly Agree = 5, Agree = 4, Not Sure = 3, Disagree = 2, and Strongly Disagree = 1. The average response was calculated for each survey item.

Statistical Methods

Comparative statistical analyses were performed using the StatView software package. Analysis of variance (ANOVA) was used to determine if the average value for given sets of data differed from one another (StatView, 1999, p73). The null hypothesis is that there are no differences in test performance or student satisfaction due to the different teaching methods. ANOVA was used to compare test results between teaching methods, improvement from pre-test to test, student survey scores, and student performance on groups of test questions. Questions 11-13 were grouped together and analyzed because these involved using a dichotomous key to name a mammal. Questions 14-18 were grouped together and analyzed because these involved arranging organisms into a branching diagram based on most ancestral to most derived organism.

Results

Student test performance resulted in averages of 69% and 71% for the traditional method and the Pseudozoid method, respectively (Table 9). ANOVA indicated that there was no significant difference in learning or retaining of information based on the teaching method experienced by the students (Table 10). Further analysis of specific groups of questions was performed in order to determine if student learning was significantly different on groups of related questions. ANOVA of teaching method and cat questions #11-13 showed that there was no significant difference in learning how to identify cats using a dichotomous key based on the teaching method experienced by the students (Table 10). ANOVA of teaching method and improvement in cat questions #11-13 determined that there was no significant difference in student improvement on learning how to identify cats using a dichotomous key based on the teaching method experienced by the students (Table 10). ANOVA of teaching method and phylogeny questions #14-18 demonstrated that there was no significant difference in learning how to arrange ancestral organisms to derived organisms based on the teaching method experienced by the students. ANOVA of teaching method and improvement in phylogeny questions #14-18 indicated that there was no significant difference in student improvement on learning how to sequence ancestral organisms to derived organisms based on the teaching method experienced by the students (Table 10). On the whole, there was no significant difference between the teaching method used and how well students performed on their tests (Table 10).

A student survey was conducted to determine if there was any difference in student satisfaction based on the method of instruction. Table 11 shows the average of student responses for each method and question. There was no evident difference in student satisfaction associated with students who learned via the traditional method or the Pseudozoid method.

Discussion

Although science curricula in districts across the state continue to change with changing national and state standards, it is possible that sometimes changing the way that you teach may not have a substantial affect on student learning or student satisfaction. My results lead me to conclude that there was no significant difference in academic effectiveness or student satisfaction associated with the novel, Pseudozoid method of teaching classification and phylogeny. Although it is difficult to describe these results, there are reasonable explanations. It is likely that the two methods of teaching may not have differed enough to cause a significant effect. There was substantial overlap in the activities that students' performed (Table 2). Another reason for not finding a significant difference in student performance relative to teaching method may be due to the wide range of student learning styles and abilities. Some students may in fact learn better through one method than the other, but balance is seen when many mixed sets of students are grouped together. Lastly, it is also possible that the questions used to test student knowledge and learning were inappropriate. The questions may not have been able to detect slight differences between student learning and the teaching method used.

Because students were experiencing two different methods of teaching, we were concerned that one group might have received more or less exposure to certain topics. This in turn could have affected any differences seen in the test results. A comparison of the two methods (Table 2) showed that each method covered the same material, but in different ways.

Although there were no significant differences in student learning or student satisfaction when comparing the two methods, I (RF) gained much from this study. The additional comments written on the student questionnaire provided me with wonderful suggestions for future lessons and activities. The experience of comparing and testing new teaching methods to benefit student learning and teaching effectiveness has, in itself, been very rewarding. It equipped me with the tools and ideas needed to test new teaching methods.

A change to this new method of teaching classification and phylogeny would involve asking each student group to present and explain their Pseudozoid phylogeny to their classmates. Each group would be asked to describe and support their reasoning for the way they laid out their phylogeny. Having students explain to their peers what they did and why they did it should lead to a better understanding of the material. Consequently, a better understanding might lead to better test performance. Similarly, having each student group answer open-ended questions that focus on specific aspects of taxonomy and phylogeny would allow students to be intellectually involved. I (RF) have used similar activities in the past, and students have displayed a better understanding of the scientific aspects of what they are working on and learning.

Acknowledgements

I (RF) would like to offer special thanks to the following people: Dr. Martin Kelly for his statistical analysis, knowledge of evolutionary biology, and continuous suggestions that helped guide me through this project. Members of my project committee, Dr. Randal Snyder and Dr. Joseph Zawicki, for their suggestions that focused on specific aspects of this study. My 2002-2003 eighth grade science class at Benjamin Franklin Middle School for their willingness to learn classification and phylogeny through a new and unfamiliar approach.

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Table 1. Comparing Traditional and Pseudozoid activities by day.

Day	Traditional	Pseudozoid
1	Assign groups Give pre-test	Assign groups Give pre-test
2	Intro to classification Assorted objects activity Classification homework	Intro to classification Assorted objects activity Classification homework
3	A classified paper activity	Evolutionary branching diagram (compare 4 animals) Construct a diagram (4 more mammals) Dichotomous key activity Dichotomy homework (alien shapes) Evolutionary diagram homework
4	Dichotomous key activity Shoe classification activity Dichotomy homework (alien shapes)	Phylogeny activity with Pseudozoids (classifying organisms)
5	Evolutionary branching diagram (compare 4 mammals) Construct a diagram (4 more mammals) Evolutionary branching diagram (cut and paste shapes) Evolutionary diagram homework Test review	Phylogeny activity with Pseudozoids (forming evolutionary branching diagrams) Developing dichotomous key and naming Pseudozoids Test review
6	Post-test Student survey	Post-test Student survey

Table 2. Comparing traditional and Pseudozoid method tasks: the tasks that are italicized represent different approaches to teaching that concept.

Traditional Teaching Method	**Pseudozoid Teaching Method**
Assign groups	Assign groups
Give pre-test	Give pre-test
Intro to classification	Intro to classification
Assorted objects activity	Assorted objects activity
Classification homework	Classification homework
A classified paper activity (guided grouping questions)	*Phylogeny activity (guided data table completion)*
Clas4fring shoes activity	*Phylogeny activity (classifying organisms)*
Binomial nomenclature (naming shoes)	*Binomial nomenclature (naming organisms)*
Dichotomous key activity (10 common mammals)	Dichotomous key activity (10 common mammals)
Dichotomy (homework shapes in book)	Dichotomy (homework shapes book)
Evolutionary branching diagrams (compare 4 mammals)	Evolutionary branching diagrams (compare 4 mammals)
Evolutionary branching diagrams (draw using 4 different mammals)	Evolutionary branching diagrams (draw using 4 different mammals)
Evolutionary branching diagrams (cut and paste shapes)	*Evolutionary branching diagrams (cut and paste shapes)*
Homework review for post-test	Homework review for post-test
Post-test	Post-test
Student survey	Student survey

Table 3. Student survey questions.

Question	Responses				
1. I enjoyed learning taxonomy.	SA	A	NS	D	SD
2. Taxonomy is an interesting topic to learn.	SA	A	NS	D	SD
3. I liked that the teacher chose my group for me.	SA	A	NS	D	SD
4. The class activities and group work were confusing to me.	SA	A	NS	D	SD
5. Working with other students helped me to understand this unit.	SA	A	NS	D	SD
6. I prefer to work by myself when performing the class activities.	SA	A	NS	D	SD
7. Every student in my group put an equal effort into group work.	SA	A	NS	D	SD
8. There were students in my group that did not put as much effort into group work as I did.	SA	A	NS	D	SD
9. The teacher did a good job explaining the group activities and unit.	SA	A	NS	D	SD
10. l understand what binomial nomenclature is.	SA	A	NS	D	SD
11. 1 am confident that I could identify an unknown organism by using a dichotomous key.	SA	A	NS	D	SD
12. I am confident that l know the seven levels of classification, from most general to most specific.	SA	A	NS	D	SD
13. I am confident that l can read and understand an evolutionary branching diagram.	SA	A	NS	D	SD
14. I am confident that I could develop my own dichotomous key when given a group of organisms or objects.	SA	A	NS	D	SD
15. I am confident that I can classify organisms or objects into groups based on similarities and differences.	SA	A	145	D	SD

Table 4. Data table and guided questions for cladistic analysis of Pseudozoid Group 1.

GROUP 1	Does it have 3 arms?	Are all arms straight?	Are all arms the same length?	Are all arms equally spaced?
A				
B				
C				
D				
TOTAL				

Directions

1). Write yes or no in the box for each question.
2). Add the total number of yes answers and write that number in the total row.
3). The column(s) that has the fewest number of yes answers probably represents the most simple trait, which should lead you to the most simple Pseudozoid(s). 4). Using this information, and ideas similar to this, construct your phylogeny (fill in your evolutionary branching tree diagram) based on the assumption that the ancestor Pseudozoid provided has evolved into the rest of these Pseudozoids (most simple to most complex).
5). Provide a written statement that explains why each Pseudozoid is placed where it is in your phylogeny diagram.
6). Developing a dichotomous key: assign a genus and species name to each of your Pseudozoids. Using physical characteristics (observable traits) develop a dichotomous key that will help me to identify your organism.

Table 5. Data table and guided questions for cladistic analysis of Pseudozoid Group 2.

GROUP 2	Is the tip of the arm the same width as the base?	Are all arms straight?	Are all arms the same length?	Are all arms equally spaced?
A				
B				
C				
D				
TOTAL				

Directions

1). Write yes or no in the box for each question.
2). Add the total number of yes answers and write that number in the total row.
3). The column(s) that has the fewest number of yes answers probably represents the most simple trait, which should lead you to the most simple Pseudozoid(s). 4). Using this information, and ideas similar to this, construct your phylogeny (fill in your evolutionary branching tree diagram) based on the assumption that the ancestor Pseudozoid provided has evolved into the rest of these Pseudozoids (most simple to most complex).
5). Provide a written statement that explains why each Pseudozoid is placed where it is in your phylogeny diagram.
6). Developing a dichotomous key: assign a genus and species name to each of your Pseudozoids. Using physical characteristics (observable traits) develop a dichotomous key that will help me to identify your organism.

Table 6. Data table and guided questions for cladistic analysis of Pseudozoid Group 3.

GROUP 3	Does it have two arms of the central body?	If one arm is present, does it have only one projection?	If two arms are present, do they bend only one time?	Is the arm(s) bent more than 90 degrees (obtuse)?
A				
B				
C				
D				
E				
TOTAL				

Directions

1). Write yes or no in the box for each question.

2). Add the total number of yes answers and write that number in the total row.

3). The column(s) that has the fewest number of yes answers probably represents the most simple trait, which should lead you to the most simple Pseudozoid(s). 4). Using this information, and ideas similar to this, construct your phylogeny (fill in your evolutionary branching tree diagram) based on the assumption that the ancestor Pseudozoid provided has evolved into the rest of these Pseudozoids (most simple to most complex).

5). Provide a written statement that explains why each Pseudozoid is placed where it is in your phylogeny diagram.

6). Developing a dichotomous key: assign a genus and species name to each of your Pseudozoids. Using physical characteristics (observable traits) develop a dichotomous key that will help me to identify your organism.

Table 7. Data table and guided questions for cladistic analysis of Pseudozoid Group 4.

GROUP 4	Does it have more than one arm off the central body?	Does it have more than two arms off the central body?	Are there any projections off the main arm?	Are all arms equally spaced?	Does the arm form a complete outer circle?
A					
B					
C					
D					
E					
F					
G					
TOTAL					

Directions

1). Write yes or no in the box for each question.
2). Add the total number of yes answers and write that number in the total row.
3). The column(s) that has the fewest number of yes answers probably represents the most simple trait, which should lead you to the most simple Pseudozoid(s). 4). Using this information, and ideas similar to this, construct your phylogeny (fill in your evolutionary branching tree diagram) based on the assumption that the ancestor Pseudozoid provided has evolved into the rest of these Pseudozoids (most simple to most complex).
5). Provide a written statement that explains why each Pseudozoid is placed where it is in your phylogeny diagram.
6). Developing a dichotomous key: assign a genus and species name to each of your Pseudozoids. Using physical characteristics (observable traits) develop a dichotomous key that will help me to identify your organism.

Table 8. Data table and guided questions for cladistic analysis of Pseudozoid Group 5.

GROUP 5	Does it have one arm?	Is the tip of the arm the same width as the base of the arm?	Are there any projections off the main arm?	Is there a "bridge" between two arms?	Are there two or more long arms attached to the central body?
A					
B					
C					
D					
E					
TOTAL					

Directions

1). Write yes or no in the box for each question.

2). Add the total number of yes answers and write that number in the total row.

3). The column(s) that has the fewest number of yes answers probably represents the most simple trait, which should lead you to the most simple Pseudozoid(s). 4). Using this information, and ideas similar to this, construct your phylogeny (fill in your evolutionary branching tree diagram) based on the assumption that the ancestor Pseudozoid provided has evolved into the rest of these Pseudozoids (most simple to most complex).

5). Provide a written statement that explains why each Pseudozoid is placed where it is in your phylogeny diagram.

6). Developing a dichotomous key: assign a genus and species name to each of your Pseudozoids. Using physical characteristics (observable traits) develop a dichotomous key that will help me to identify your organism.

Table 9. The number of students taught each method of phylogenetic analysis and the overall average number of correct responses and its corresponding percentage.

Method	Students	Number Correct per 20 Questions	Item Difficulty
Traditional	41	13.8	69
Pseudozoid	53	14.2	71

Table 10. ANOVA table showing variables, F-value, and P-value.

Variable	F-value	P-value
Teaching method and post-test average	0.482	0.489
Teaching method and cat questions #11-13	0.236	0.627
Teaching method and improvement in cat questions #11-13	0.966	0.326
Teaching method and phylogeny questions #14-18	1.291	0.256
Teaching method and phylogeny questions #14-18	0.202	0.653

Table 11. Student survey averages: the question number is shown and the average response for each question from students in each method.

Question	Traditional Method	Pseudozoid Method
1. I enjoyed learning taxonomy	3.4	3.5
2. Taxonomy is an interesting topic to learn.	3.4	3.4
3. 1 liked that the teacher chose my group for me.	2.8	2.5
4. The class activities and group work were confusing to me.	1.9	2.2
5. Working with other students helped me to understand this unit.	3.7	3.7
6. I prefer to work by myself when performing the class activities.	2.2	1.9
7. Every student in my group put an equal effort into group work.	3.2	3.2
8. There were students in my group that did not put as much effort into group work as I did.	3.1	3.1
9. The teacher did a good job explaining the group activities and unit.	4.1	4.1
10. I understand what binomial nomenclature is.	3.9	4.2
11. 1 am confident that I could identify an unknown organism by using a dichotomous key.	4.2	4.1
12. I am confident that I know the seven levels of classification, from most general to most specific.	4.1	3.7
13. 1 am confident that I can read and understand an evolutionary branching	4.4	4.0

diagram.		
14. I am confident that I could develop my own dichotomous key when given a group of organisms or objects.	4.2	3.8
15. 1 am confident that I can classify organisms or objects into groups based on similarities and differences.	4.4	4.2

Figure 1. Pseudozoid group 1.

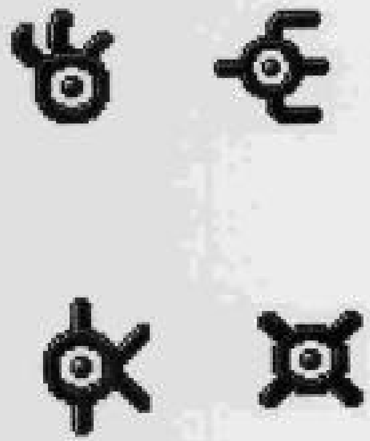
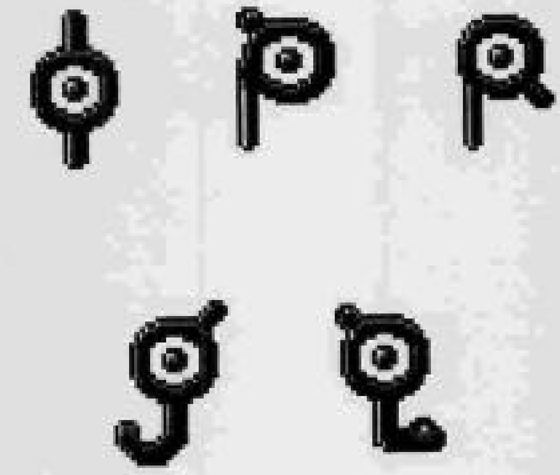


Figure 2. Pseudozoid group 2.



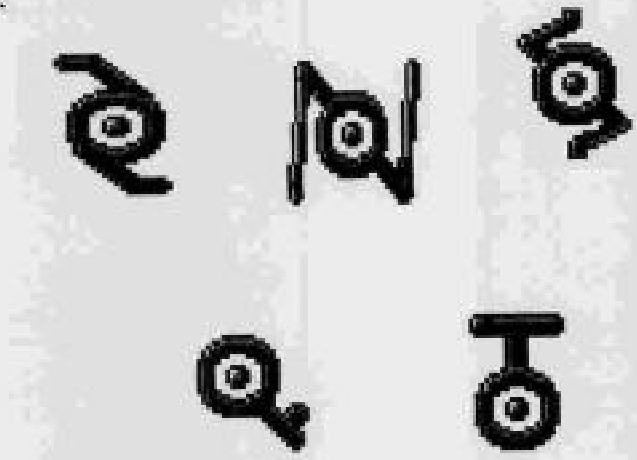


Figure 3. Pseudozoid group 3.

Figure 4. Pseudozoid group 4.

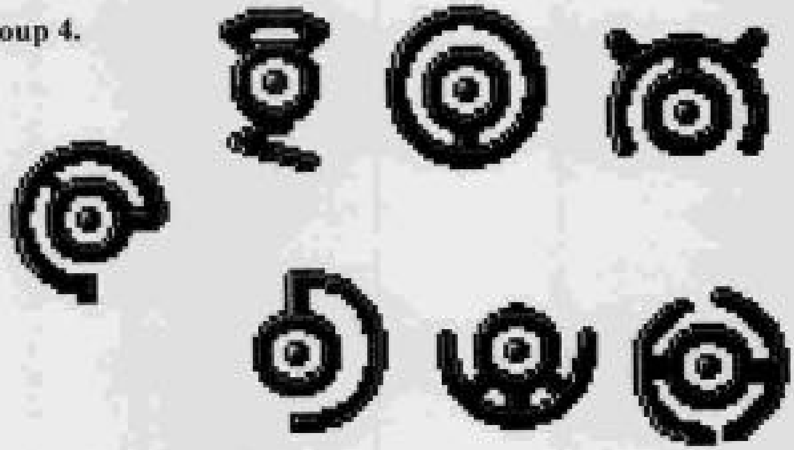


Figure 5. Pseudozoid group 5.

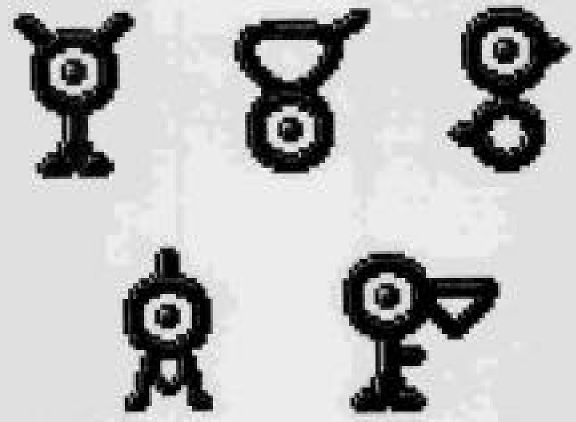
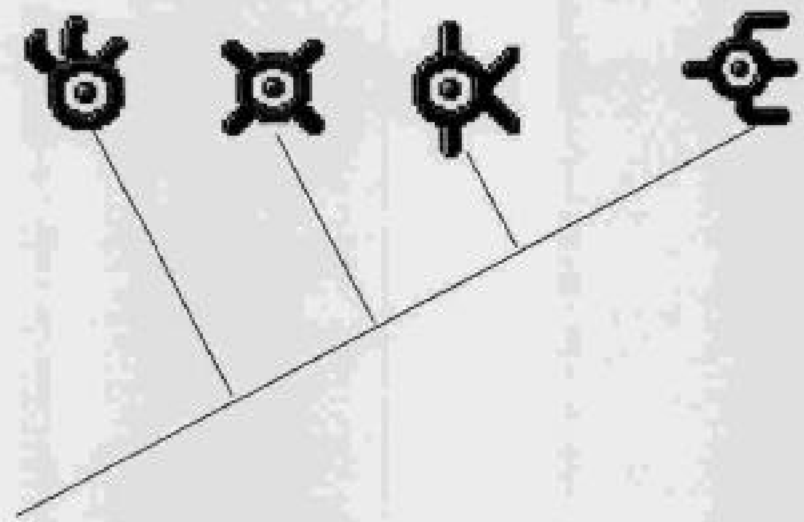


Figure 6. Example of the evolutionary branching diagram students used to construct their phylogeny for their given group of Pseudozoids.

Group 1 Phylogeny:



Appendix 1. Pre test and test given to all students.

Part A. Matching. Match the terms to the correct phrase.

a. binomial nomenclature b. classify c. dichotomous key d. genus e. phylogeny
01. to put similar organisms into groups
02. a group of similar species
03. system of naming organisms with two names
04. evolutionary history of organisms
05. tool for identifying organisms

Part B. Multiple Choice.

06. The science of classification is called
a. biology b. taxonomy c. chemistry d. ecology

07. Use the following cartoon statement to answer the question. In the cartoon, *Canis nipponicus* refers to a proposed scientific name for an imaginary organism. This proposed scientific name indicates the
a. kingdom and phylum b. phylum and genus c. genus and species d. kingdom and species

08. Which of the following is in the correct order from most general to most specific?
a. genus, species, family, phylum, order, kingdom, class
b. kingdom, class, family, order, genus, species, phylum
c. species, family, kingdom, phylum, order, class, genus
d. kingdom, phylum, class, order, family, genus, species

09. The great variety of plants, animals, and other organisms found in an area make up
a. the animal kingdom b. species diversity c. binomial nomenclature d. taxonomy

10. Binomial nomenclature was developed by
a. Carolus Linnaeus b. Charles Darwin c. Gregor Mendel d. Jean LaMarck

Part C. Key to native cats of North America. Use the key provided on the overhead to name the following cats.

#11

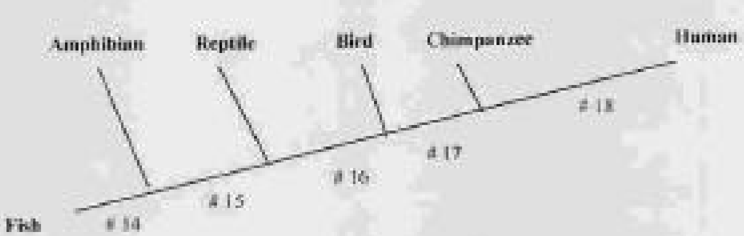

#12


#13


Key to Native Cats of North America
1a if the cat has a short tail, go to step 2
1b if the cat has a long tail, go to step 3.
2a if the cat is distinctly mottled with long ear tufts tipped with black, and no cheek ruff, it is a lynx, *Felis lynx*.
2b if the cat has indistinct spots, short ear tufts, and a broad cheek ruff, it is a bobcat, *Felis rufus*.
3a if the cat has a plainly colored body, go to step 4.
3b if the cat has a patterned body, go to step 5.
4a if the cat is yellowish to tan above with white to buff below, it is a mountain lion, *Felis concolor*.
4b if the cat is either brown or black all over its body, it is a jaguarondi, *Felis yagouaroundi*
5a if the cat has a patterned body with tan and black, go to step 6
5b if the cat has black-bordered brown spots, tending to form lines on the body, it is an ocelot, *Felis pardalis*
6a if the cat is large, spotted with black rosettes or rings in horizontal rows, it is a jaguar, (Felis onca.
6b if the cat is small, with irregularly shaped spots and four dark-brownish stripes on the back and one on the neck, it is a margay, *Felis wiedii*

11. Cat A.____________________________
12. Cat B.____________________________
13. Cat C.____________________________

Part D. Branching Diagram. Plug the following phrases into the branching diagram on the overhead (#14-18).
a. bipedal b. warm blooded c. take care of young d. binocular vision e. ability to survive on land



Part E. Short Answer. Answer the following two questions in complete sentences.

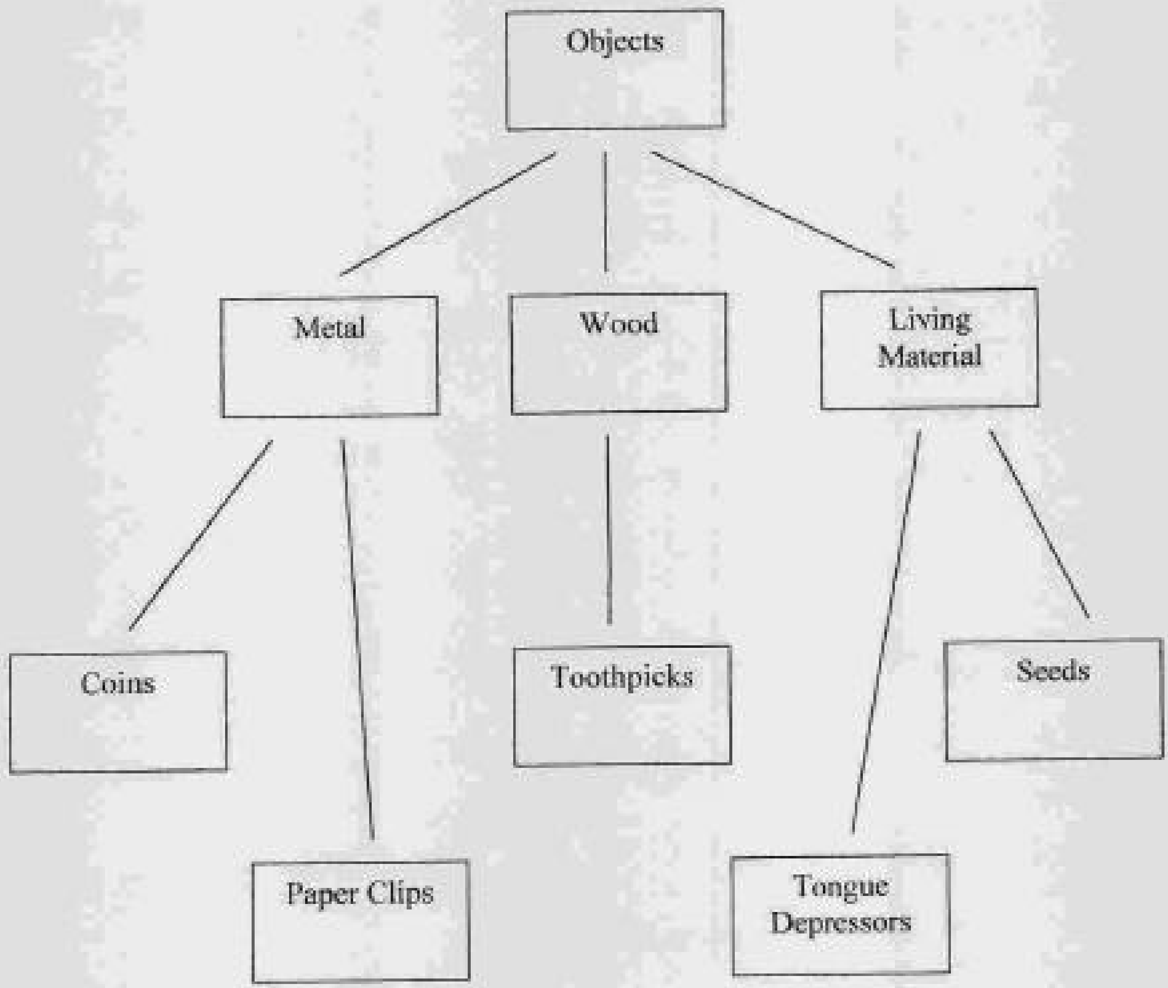
19. Compare the number and variety of organisms in a kingdom and a genus.

20. You observe an organism that you don't recognize. How would you go about determining its name?

Appendix 2. List of objects used in sorting activity.

- blue wooden stick
- green wooden stick
- purple wooden stick
- yellow wooden stick
- yellow toothpick
- brown toothpick
- large orange plastic chip
- large yellow plastic chip
- large red plastic chip
- small orange plastic chip
- small black plastic chip
- small blue plastic chip
- penny
- nickel
- quarter
- large gold paper clip
- large silver paper clip
- small silver paper clip
- bolt
- screw
- staple
- red thumbtack
- blue thumbtack
- yellow thumbtack
- pea seed
- corn seed
- kidney bean seed
- large black button
- small black button
- large white button
- small white button
- small clear button

Appendix 3. Example of sorting activity, using objects in Appendix 2.



Appendix 4. Classification homework given to all students.

Classification Homework

Name______________________________ **Group**______

01. Define the following terms:
    - a. Classification-
    - b. Binomial Nomenclature-
    - c. Species Diversity-
    - d. Taxonomy-

02. List the seven levels of classification from most general to most specific 3 x's.

______________	______________	______________
______________	______________	______________
______________	______________	______________
______________	______________	______________
______________	______________	______________
______________	______________	______________
______________	______________	______________

03. Who was Carolus Linnaeus and what is his contribution to science?

Extra Credit: Provide me with the complete classification of the humans.

Ex). Kingdom Animalia, etc, etc.

Appendix 5. A classified paper activity.

Name________________________________ Group____

A Classified Paper

If you were asked to classify objects, you would probably group together those objects which have some certain things in common. A scientist does the same thing when grouping or classifying living things. Living things are grouped according to certain likenesses or similar characteristics. Each group may then be divided into subgroups. Each subgroup is given a name to help identify the scientist's work.

- You will classify paper objects.
- You will use the words Kingdom, Phylum, and Class in your classifying system.
- You will determine what characteristics you are using to make your classification.

Procedure

- Cut out the 13 objects. By following the instructions, you will be able to classify these objects into Kingdom groups, Phylum groups, and Class groups.

Kingdom Groups

- Classify your objects into two Kingdom groups by placing objects 3,4,6,7,9,10, and 11 into the first group and 1,2,5,8,12, and 13 into the second group. What characteristics do all members of the first group have that make them different from the second group?
- If you had to use a name that describes the characteristic that is common to the first Kingdom, what would be a suitable name?
- What name could describe the second Kingdom?

Phylum Groups

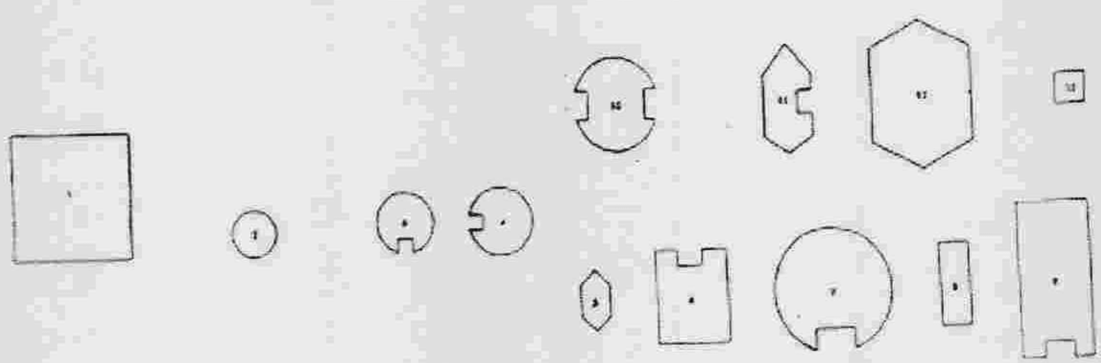
- Place objects 3,4,7 and 10 into one group. This will represent one phylum.
- Place objects 6 and 9 into another group. This will represent a second phylum.
- Place 11 by itself for a third phylum.
- What characteristic do objects 3,4,7,and 10 have that make them different from 6,9 and 11?
- Why are 6 and 9 different from 11?
- If you had to use a name that describes the characteristic that is common to the first phylum containing objects 3,4,7 and 10 what would be a suitable name?
- What name best describes the second phylum?
- What about the third phylum (object 11)?

Class Groups

- Use objects 3,4,7 and 10 and separate them into classes by placing 3,4 and 7 into the first class and placing 10 into the second class. What characteristics do objects 3,4 and 7 have to make them different from 10?
- What name would best describe the class for objects 3,4 and 7?
- What about 10?

Prove That You Understand This Activity

1. Prepare a classification system that will divide objects 1,2,5,8,12 and 13 into two phyla. List the numbers of the objects in your first phylum.
2. Your second phylum?
3. What characteristic was used to separate these figures into two phyla?
4. Are all of your classmates' systems of classification the same as yours?
5. What does a scientist look at to describe if living things are in the same Kingdom?



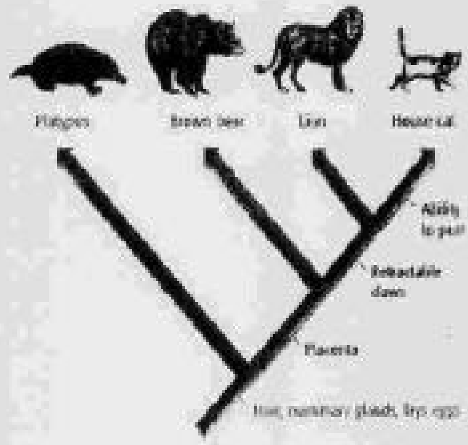
Appendix 6.

6a. Branching diagram (phylogeny) for four mammals (Allen and Berg, 2000, p162).

6b. Phylogeny practice activity (Allen and Berg, 2000, p163).

6c. Dichotomous key for 10 common mammals (Allen and Berg, 2000, p165).

6a.



6b. **QUICK LAB**

Evolutionary Diagrams

A branching evolutionary diagram can be used to show evolutionary relationships between different organisms. Construct a diagram similar to page 162 (Appendix 6a). Use a frog, a snake, a kangaroo, and a rabbit. What do you think is one major evolutionary change between one organism and the next? write them on your diagram.

6c.

1.	a. This mammal flies. Its hand is formed into a wing.	Little brown bat
	b. This mammal does not fly.	Go to step 2
2.	a. This mammal has a naked (no fur) tail.	Go to step 3
	b. This mammal doesn't have a naked tail.	Go to step 4
3.	a. This mammal has a short, naked tail.	Eastern mole
	b. This mammal has a long, naked tail.	Go to step 5
4.	a. This mammal has a black mask across its face.	Raccoon
	b. This mammal does not have a black mask across its face.	Go to step 6
5.	a. This mammal has a tail that is flattened and shaped like a paddle.	Beaver
	b. This mammal has a tail that is not flattened or shaped like a paddle.	Opossum
6.	a. This mammal is brown with a white underbelly.	Go to step 7
	b. This mammal is not brown with a white underbelly	Go to step 8
7.	a. This mammal has a long, furry tail that is black on the tip.	Longtail weasel
	b. This mammal has a long tail without much fur.	White-footed mouse
8.	a. This mammal is black with a narrow white stripe on its forehead and and broad white stripes on its back.	Striped skunk
	b. This mammal is not black with white stripes	Go to step 9
9.	a. This mammal has long ears and a short, cottony tail.	Eastern cottontail
	b. This mammal has short ears and a medium-length tail.	Woodchuck

Appendix 7. Classifying shoes activity (Allen and Berg, 2000, p159).

Name________________________________ Group_____

Classifying Shoes

1. Take off your right shoe.
2. Develop a common name and scientific name for each of your shoes.

Common Name	Scientific Name
a.	
b.	
c.	
d.	
e.	
f.	
g.	

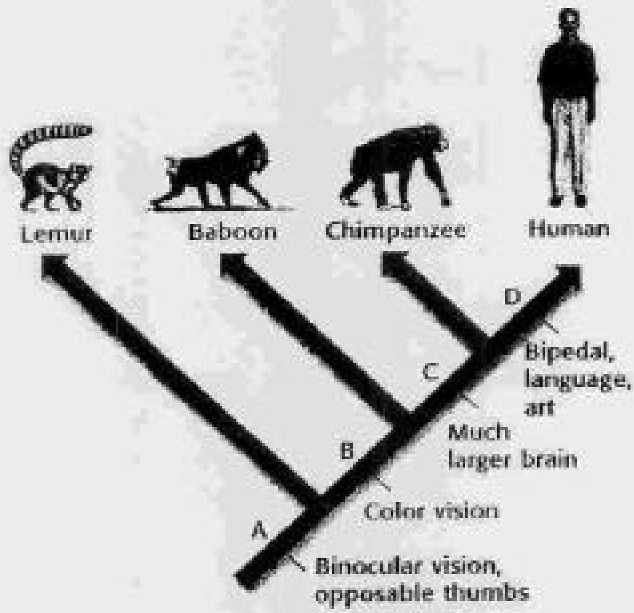
3. Develop a dichotomous key that will help someone to identify each shoe.

Dichotomous Key:

1a.
1b.
2a.
2b.
3a.
3b.
4a.
4b.
5a.
5b.
6a.
6b.
7a.
7b.

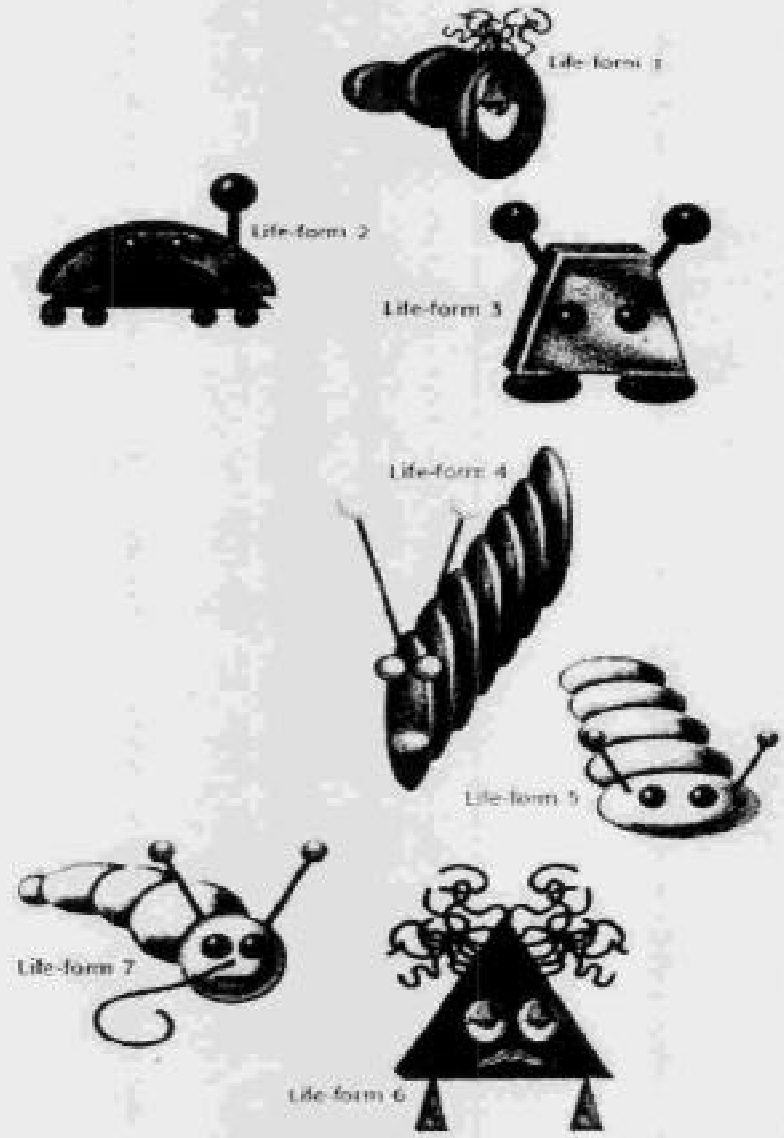
Appendix 8a. Phylogeny homework (Allen and Berg, 2000, p177).

The diagram below illustrates the evolutionary relationships among several primates.



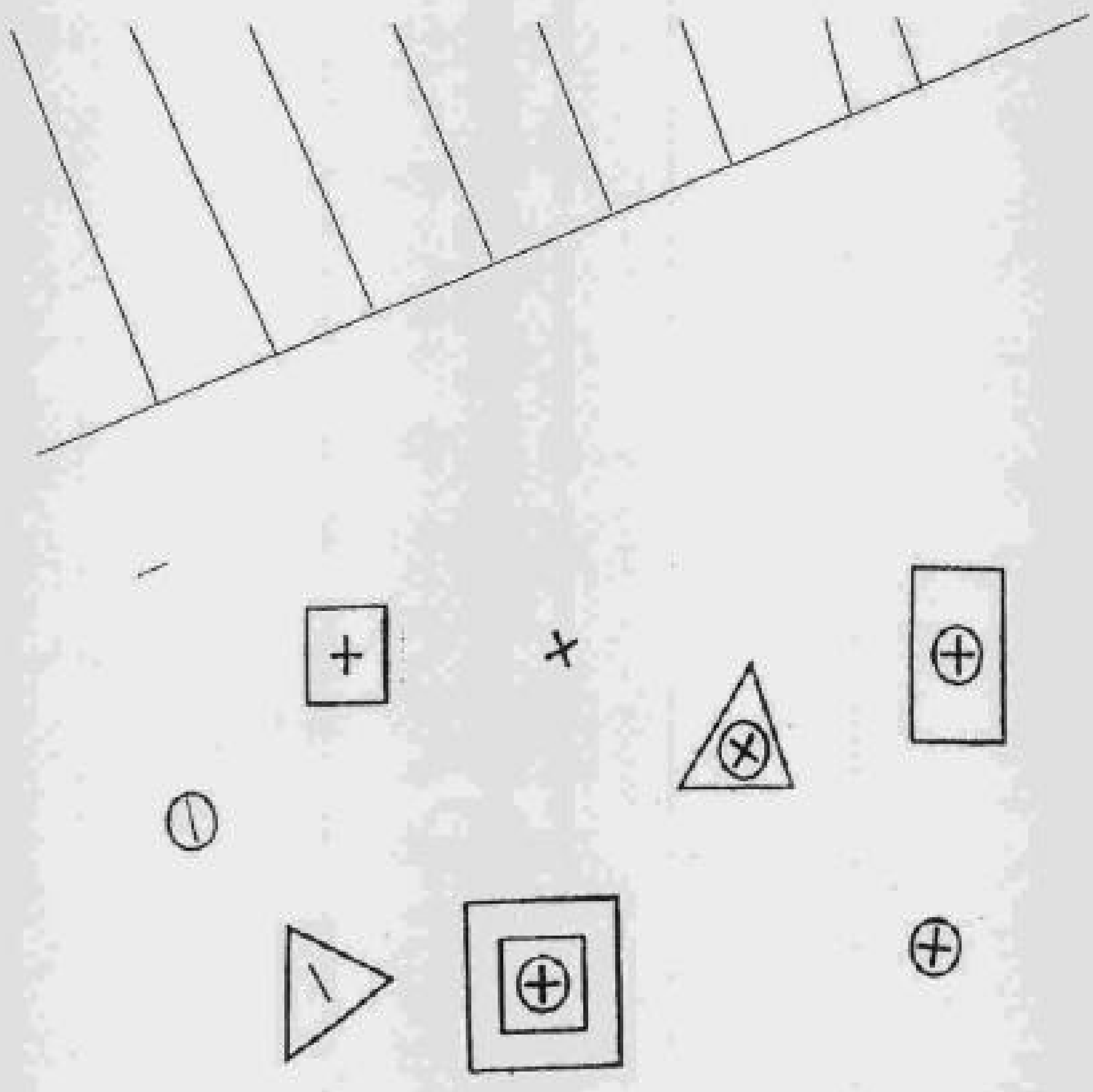
- Which primate is the closest relative to the common ancestor of all primates?
- Which primate shares the most traits with humans?
- Do lemurs share the characteristics listed at point D with humans? Explain your answer.
- What characteristic do baboons have that lemurs do not have? Explain your answer.

Appendix 8b. Alien life-form homework (Allen and Berg, 2000, p192).



Appendix 9.

9a. Cut and Paste phylogeny activity.



9b. Classification and Phylogeny Test Review

01. Define the following: binomial nomenclature, taxonomy, classify, species diversity.

02. How was Carolus Linnaeus important to the topic of classification.

03. List the seven levels of classification from most general to most specific.

04. This is an example of what? *Australopithecus afarensis*

05. Develop a dichotomous key for the following organisms: panda, rat, human, dog

06. Develop an evolutionary branching diagram for the following organisms: lake trout, leopard gecko, human, and fire belly salamander…pay special attention to the order you place them and the characteristics you write on the lines.