Learning Outcomes for my 100 Level Courses:

In a recent letter from the Dean, College of Liberal Arts and Sciences, faculty were told:

"Almost two years ago the AU Student Learning Assessment Committee reminded us that all of our syllabi need to have learning outcomes stated on them and I have reminded chairs and faculty of this from time to time. At our January 2011 Retreat lead by the General Education Taskforce, colleagues on GET walked us through what a learning outcome is and how to write one. I have attached their handout on learning outcomes from that meeting, which is also on our CLAS Blackboard site. [*see below*] Please remember that our accreditation body, the Middle States Commission on Higher Education, also reminded us in its last review that we need to state our learning outcomes more clearly. With the next Middle States review already on the horizon, we should be at a point where learning outcomes are consistently and clearly stated on each syllabus within the College."

HOW TO WRITE STUDENT LEARNING OUTCOMES

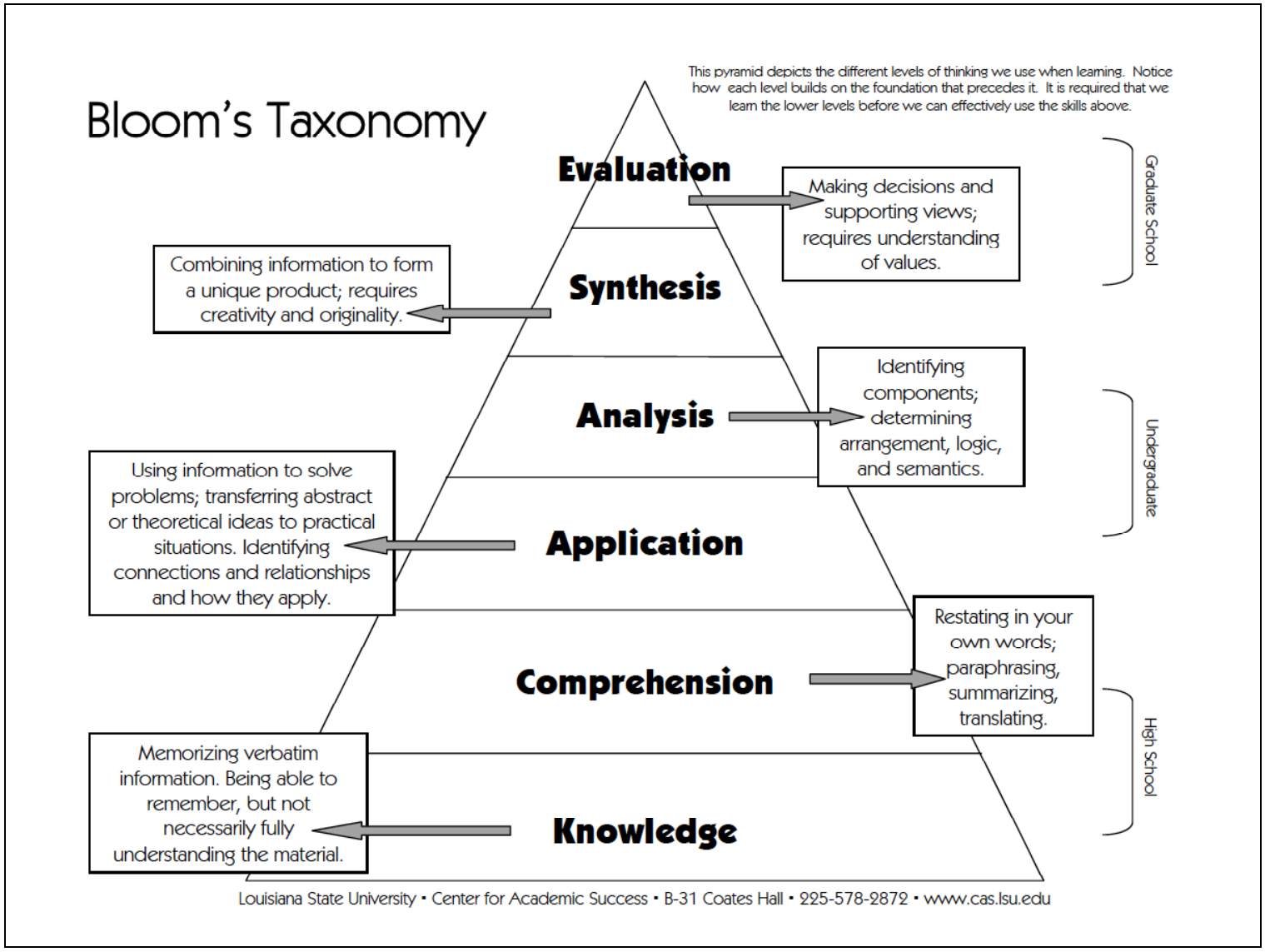
Action Verb List – Suggested Verbs to Use in Each Level of Thinking Skills

Below are terms (verbs) that can be used when creating student learning outcomes for a course or degree program.

Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Count	Associate	Add	Analyze	Categorize	Appraise
Define	Compute	Apply	Arrange	Combine	Assess
Describe	Convert	Calculate	Breakdown	Compile	Compare
Draw	Defend	Change	Combine	Compose	Conclude
Identify	Discuss	Classify	Design	Create	Contrast
Labels	Distinguish	Complete	Detect	Drive	Criticize
List	Estimate	Compute	Develop	Design	Critique
Match	Explain	Demonstrate	Diagram	Devise	Determine
Name	Extend	Discover	Differentiate	Explain	Grade
Outlines	Extrapolate	Divide	Discriminate	Generate	Interpret
Point	Generalize	Examine	Illustrate	Group	Judge
Quote	Give examples	Graph	Infer	Integrate	Justify
Read	Infer	Interpolate	Outline	Modify	Measure
Recall	Paraphrase	Manipulate	Point out	Order	Rank
Recite	Predict	Modify	Relate	Organize	Rate
Recognize	Rewrite	Operate	Select	Plan	Support
Record	Summarize	Prepare	Separate	Prescribe	Test
Repeat		Produce	Subdivide	Propose	
Reproduces		Show	Utilize	Rearrange	
Selects		Solve		Reconstruct	
State		Subtract		Related	
Write		Translate		Reorganize	
		Use		Revise	
				Rewrite	
				Summarize	
				Transform	
				Specify	

It may be useful to explore the likely origins of this table. In 1956 Bloom suggested the six levels seen across the top, and these have generally come to be known as "Bloom's Taxonomy." In the 1990's it became fashionable to restate nouns as verbs and a number of papers were written extolling the virtues of using "Identitfy" rather than "Identification" to refer to what is effectively the same skill.

Bloom's Taxonomy is often referred to as a "Pyramid" and represented by a triangle, bringing into question the ability of those doing so to identify some basic geometric shapes. But anyway, here is one from Louisiana State University:



Of particular interest is that the first two columns on the table, "Knowledge" and "Comprehension" represent verbs which should be used for Learning Outcomes in High School.

It is my custom to begin class with some questions covering material discussed in the previous class as well as the reading for that day. I have usually recorded grades for these, using the grades to come up with the Class Participation component for a course. With the new emphasis on Bloom's Taxonomy, I intend to revise this procedure by asking, of one student, a series of questions moving up the triangle from "Knowledge" to "Analysis."

1. Answering the initial questions asked during class will permit a student to demonstrate an ability to **define, describe, draw, identify, list, name, recall, recognize, reproduce** and **state** material covered in the reading and in earlier class discussions. Success will earn one point, and the opportunity to answer another set of questions.

2. The next questions will permit a student to **discuss** the issues brought up in the reading or in former class discussions, **explain** them, **generalize** and **extrapolate** from the examples given, **paraphrase** what was said, **predict** results other than those given in the examples, **give additional examples**, **summarize** what is most significant and to **defend** all of this. Success will earn two points, and the opportunity to answer another set of questions.

3. The third set of questions will permit a student to show an ability to **solve** problems, **calculating** results by **computing** answers **using** arithmetic (**adding**, **subtracting**, multiplying and dividing) and algebra; to **examine** the concepts presented, **interpolating** from known results to projected ones, while **demonstrating** the ability to **apply** those concepts covered earlier, **changing** and **modifying** them, or **manipulating** them in some other way, so as to **discover** new insights. Success will earn three points, and the opportunity to answer another set of questions.

4. The fourth set of questions will give a student the ability to **demonstrate** how a concept can be **analyzed** or **broken down** by **separating** it into components and then **differentiating** or **discriminating** between those which are essential and those which are not; and how this can be **illustrated** with a **diagram** designed to **point out related** aspects by **developing** or **designing** a model from which it is possible to **infer** additional new insights. Success will earn four points.

Thus each student called upon in class can earn up to ten points. Assessment is straightforward as the score recorded will indicate the level attained by a student on a given day and summary statistics can be easily derived. Students will be selected using the Otto Lotto method:

Rules for Otto Lotto

Before class, a column of random numbers between 0 and 10 will be generated, one number for each person in the class. Each random number will be multiplied by each student's average Class Participation Score at that time, resulting in a Rank Number. A list will then be constructed of the names of the students in the class according to that rank number. During the class, students will be called on in that order, starting with the lowest and proceeding to the highest Rank Number. After every student has been called on, a second list, constructed from the same Class Participation Scores, but different random numbers, will be used, etc. Students with low Class Participation Scores will be more likely to get called on than those with high scores, but there is always a chance that someone with the highest Class Participation Score will end up with the lowest Rank Number, and be called on first.

An example follows, based on some of the reading for the first chapter in the textbook for GEOL 101:

1. What was the Big Bang?

2. What was the universe like after the Big Bang, but before stars formed? How did the formation of stars change this? What about Supernovae?

3. What data were used to determine when the Big Bang occurred? On what physics was this based? What results were obtained? What limits does this place on the size of the observable universe?

4. How might the presence of Dark Matter / Energy affect these results? Could there be a universe beyond the edge of the observable universe? Do you think this matters? What are likely consequences of your answers to questions concerning the likelihood of intelligent life in the universe? What about our ability to communicate with it?

In addition to the questions during class, there will be one or two Graded Learning Opportunities taken during class time and a two hour Final Graded Learning Opportunity given during Finals week. These will consist of multiple-guess questions with five answers each. All questions will receive the same weight, although some will be testing only the lower levels of Bloom's Taxonomy, while others will ask students to employ those verbs used for the upper levels in order to obtain the correct answer. Some examples follow:

Many processes are affected by more than one variable. A question will often read:

1. Which will produce the greatest increase in Process X?
   A. Increase variable A while decreasing variable B
   B. Decrease variable A while decreasing variable B
   C. Increase variable A while increasing variable B
   D. Decrease variable A while increasing variable B
   E. Variables A and B cannot vary independently

This requires a student to **analyze, differentiate, discriminate, infer** and **relate**.

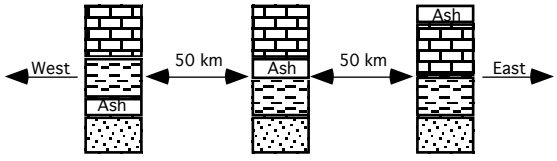
In Lunar Geology, GEOL 110, we consider the motions of the Moon and the Earth. A typical question might be:

2. Consider Planet X which has a moon orbiting it in a clockwise sense with a sidereal month of 10 of its days. Which of the following is true?
   A. If Planet X rotates in a clockwise sense, its Synodic month will be about 11 of its days.
   B. If Planet X rotates in a clockwise sense, its Synodic month will be about 28 of its days.
   C. If Planet X rotates in a clockwise sense, its Synodic month will be about 9 of its days.
   D. If Planet X rotates in a counter-clockwise sense, its Synodic month will be about 11 of its days.
   E. If Planet X rotates in a counter-clockwise sense, its Synodic month will be about 28 of its days.

This requires a student to know what Sidereal and Synodic months are. Does this means the student needs to **define, describe, identify, list, name, match, recall, recite, repeat** or **state?** It is not clear to me, but some of those verbs probably apply. After that, the student needs to **analyze** the situation, **relate** the two components of rotational motion in order to **differentiate** between the need to **add** or **subtract**, and then either **calculate, compute** or **solve** the problem in order to **select** the correct answer.

In This Dynamic Earth, GEOL 101, a favorite question is similar to:

3. Three outcrops, separated by 50 km, are shown in the figure to the right. All have the same three units, a sandstone beneath a shale which is beneath a limestone. But a volcanic ash unit lies just above the sandstone unit in the west, just above the shale in the middle, and just above the limestone in the east. What can best be said about how this situation occurred?



   A. Deposition was in a basin which got deeper towards the east, and gradually filled as sea level rose.
   B. Deposition was in a basin which got deeper towards the west, and gradually filled as sea level rose.
   C. Deposition was in a basin which got deeper towards the east, and gradually emptied as sea level fell.
   D. Deposition was in a basin which got deeper towards the west, and gradually emptied as sea level fell.
   E. The strata depicted require that the ash must have fallen at different times in the different locations.

This requires a student to **analyze** the situation, **examine** the diagram and **recognize** that some of the units transgress time, **distinguish** between those which do and those which do not**, relate** the lithologies of the units

to the environment at their location when the sediments were deposited, **solve** the problem and **select** the correct answer.

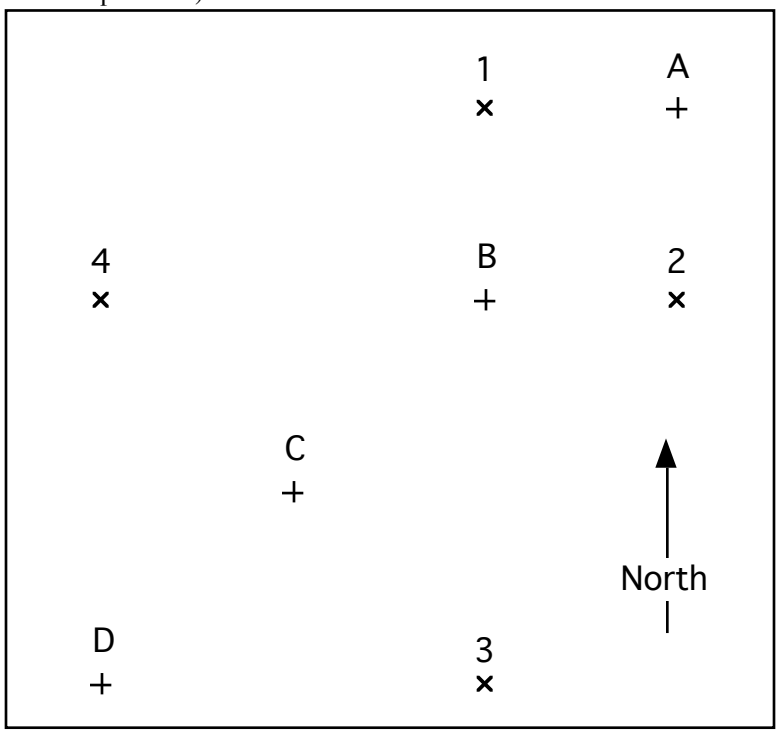
In Elementary Oceanography, GEOL 106, considerable emphasis is placed on global climate, currents, etc. A typical question might be:

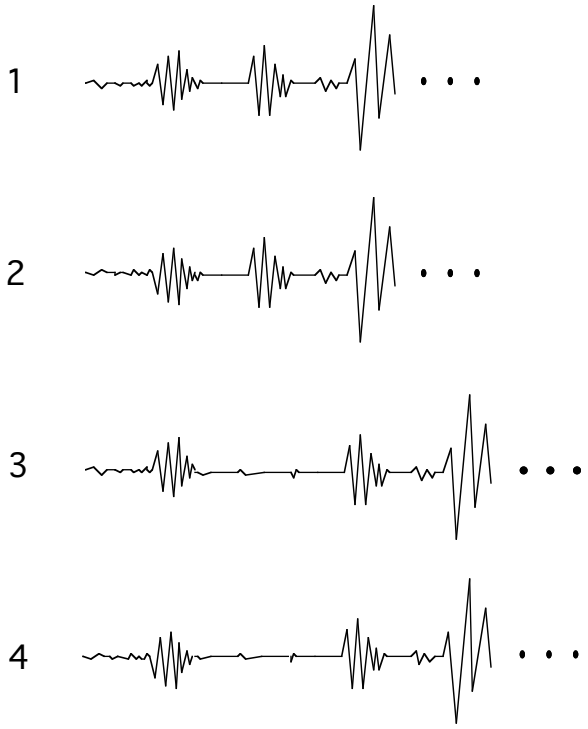
4. If the axis of the Earth were tilted 36° from being perpendicular to the plane of the ecliptic, how far North would you need to go to have a day with 24 hours of daylight?
   A. 23.5° N
   B. 36 N
   C. 45° N
   D. 54° N
   E. 66.5° N

This requires a student to **recognize** that the situation is similar to one done in class. By **reproducing** the diagram we constructed, but **modifying** it to incorporate different data, it can be used to **illustrate** the geometry correctly, permitting the student to **compute** or **calculate** the desired result by **adding** or **subtracting** the relevant values, and then **selecting** the correct answer.

In Earthquakes and Volcanoes, GEOL 103, we study how seismologists are able to locate the epicenters of earthquakes. A question on a Graded Learning Opportunity might be:

5. Shown below are four simplified seismograms recorded after the same earthquake, and a map showing where each was obtained. Select the letter on the map which is probably nearest to the epicenter of the earthquake (choose E if it cannot be done with the data provided)





This requires a student to **examine** the map and images, **select** the relevant parts of the seismograms to **analyze**, **recognize** how time is portrayed, **infer** the correct relationship between time and space, and then **solve** the problem by **arranging** the results spatially, in order to **select** the correct answer.

For what it's worth, I have used questions of this sort for the last 41 years, advising students in my syllabi that questions "...will try to probe your understanding and comprehension of the material." It is not at all clear to me that using verbs from an approved list improves matters much, but I am happy to play along.