Mar 27th, 10:00 AM - 10:45 AM

Bend It Like Bloom!

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Bend it Like Bloom

By “Ludy” Ludwika Goodson (Indiana University–Purdue University Fort Wayne),
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Attachments to this file: Handouts A, B, C, D, E, F, G, and C Answers, D Answers.
This was an interactive session. Handouts were A, B, C, D, E, F, and G. The answers, for C and D were
provided verbally during the session. Handouts were pre-arranged in a separate packet for each person
in our session. Handout C was a worksheet with a preloaded statement of an objective, organized so
that individuals received different objectives and so that all levels of learning were represented.
Handout D was a set of test items and participants identified the levels to which they belong, using
Handout E for reference, after which they were provided the answers.

Session Description
Bend it like Bloom! (About SoTL)
This presentation will re-vision “Bloom’s Taxonomy” as a measurement and curricular alignment tool.
When re-visioned, it becomes a model of current standards for constructing "domain-referenced"
assessments. From this vision, we will broaden the view, with Anderson and Krathwohl, and Webb,
who in their research and proposed levels of learning, affirm and deepen the application of a learning
taxonomy to improve curriculum alignment with educational objectives and assessments. To begin, we
will bend back the lens toward creation of the original Taxonomy of Educational Objectives.
Measurement specialists wanted a framework for U.S. universities to share test items for building test
tanks from which to create annual comprehensive exams. Because each test bank had to assess the
same objective, they created categories, sub-categories, and descriptions of educational objectives, thus
defining the domain of measurement. They then added sample assessment items and explanations of
how they measured the objectives, further describing each category. Within this presentation, we will
compare objectives to categories and sub-categories in the Bloom’s taxonomy. The expectation is for
re-visioning to show how assessments can become more precisely aligned with objectives and that this
will enhance interpretation of the full Bloom’s taxonomy.

Introductory Notes
The title of this session “Bend it Like Bloom” is a takeoff on the movie called “Bend It Like
Beckham.” In that story, the young girl Jess Bharma wants to be a soccer player, and she eventually
succeeds. She begins with an ideal, Beckham, yet success depends not only on her abilities, but a
balancing of Indian and English traditions. Like Jess, we too have ideals; in this case our ideal is Bloom,
and we have other scholars to whom we look for standards in our discipline. Bloom and his colleagues
also had to balance two traditions—those of assessment and education. And, for another parallel, the
“Bend It Like Beckham” story was culturally diverse with social insights, and I hope you will see how
diverse perspectives that come to the table in scholarly deliberations lead to insights in our education
practices.

Among these scholarly deliberations are the principles of SoTL practice offered by Peter Felton,
principles that we may adapt as we consider the quality of a taxonomy. Peter acknowledged that we
have a tent of SoTL that houses many frameworks, and we can choose the one that fits. And, he raised
the question of what model you want to choose. As a metaphor, he showed us the French Poodle and
the American mutt. If you were to ask my mom, she would show you the German Shepherd - my mom raised them as show dogs and was always pointing out the best characteristics such a dog must possess to represent the ideal model of a German shepherd. The SoTL framework that we choose will vary with our needs as we seek the best fit. The same applies to the selection of a taxonomy.

Before going further, let’s answer a few questions. What is a learning taxonomy? And, why do we want to use one? Why do YOU use one? [planning objectives, generating test items and other assessments, aligning activities with assessments and objectives]

Next, I am wondering what are the parallels or adaptations of what Peter Felton identified as the five principles of SoTL practice to evaluating the scholarship of a learning taxonomy. Perhaps the following will work for reflection:

- 1st: classifications are clearly focused on learning outcomes, the development of a taxonomy begins with the inquiry of what are the types or levels of learning, and using a taxonomy could be the springboard for inquiry about how to articulate those outcomes;
- 2nd: we would expect a taxonomy to be grounded in the context of scholarly literature, of what has come before, and one's own context for its application;
- 3rd: the taxonomy and its use should be methodologically sound, we would expect the taxonomy's development to spring from systematic methods of learning analysis by experts, but is this enough to make it methodologically sound?
- 4th: while we cannot say that a learning taxonomy is developed in partnership with students, we can expect the taxonomy to facilitate our communication of clear expectations to students;
- 5th: the taxonomy and its use should be made appropriately public, and I think we can agree that what we call “Bloom's taxonomy” has met this principle of practice, yet I hope we can give closer scrutiny to how well these principles were met, particularly the quality of the methodology.

Notes for Handout A: Knowledge & Skill Hierarchies: A Sampling

For a few moments, let’s bend the lens back further and take a mega view of the development of taxonomies. While most of you have indicated that you use the “Bloom’s Taxonomy,” to prepare for a chapter I completed recently for the Encyclopedia of Educational Technology, I did some extra historical review of the development of knowledge and skill hierarchies. While I cannot share the chapter with you, you can see a sampling of taxonomies I found in “Page A” in your packet, and that the earliest formal taxonomy I found was a tree of knowledge with three main trunks: MEMORY/History, REASON/Philosophy, and IMAGINATION/Poetry. 1751. This taxonomy of knowledge, with its main domains that still show up in current thinking, was inspired by Francis Bacon’s “The Advancement of Learning.” Before looking more at the 1900s listed on this handout, there is another part of the mega view to see, and that is the influence of mentors in our progression of taxonomy development. To begin, Benjamin Bloom had a mentor who influenced his approach to assessment. So, who was it? And what was the mentor’s influence? [Ralph Tyler] According to Lou Rubin, who reflected on Tyler’s contributions to policy, evaluation, and curriculum development, “Ralph Tyler had a remarkable aptitude for discovering and nurturing the talents of others.” While you may not be familiar with Ralph Tyler, unless you are a measurement specialist or are familiar with the
history of the National Assessment of Educational Progress, I am going to guess that you will recognize the name of one of his mentors, and that was John Dewey. He was considered a leader in progressive education in his time, and kept the focus of education as the purpose of contributing to society as a main goal. We could say that service learning has that same goal.  

Sometimes, mentors are not the source of guidance and inspiration, however. For M. David Merrill, who developed a very effective taxonomy of learning, often in training environments, and who has become a mentor to many other scholars, it was disappointment in the instruction he encountered in his Education studies. He had considered dropping that major, but one of his instructors suggested, yes, he could do so, or he could realize there is much to be done, and do something about it. Another event that Merrill said changed his direction and vision was the time when a student pointed out after one of B.F. Skinner's talks, that what Skinner had said seemed to contradict something he had written before. It was Skinner's reply that made all the difference. He said, “Hell”—“do you think I believe everything I ever wrote?” From this reply, Merrill came to see we must keep thinking, and there can be many different psychological systems, and each can be tested against reality to see how closely it fits. Some taxonomies are carefully constructed, and some are not. Even when constructed on the basis of careful observations and analysis, they may have gaps, which is what Merrill thought when he studied the 1965 edition of Gagné's “Conditions of Learning”—ten years later, I studied the 1975 edition—and Merrill began considering how he could build upon the work of Gagné. Merrill's contributions have been widely recognized and very successful, much of the applications in the context of training. [Information on Merrill comes from his reflection on his personal career.]

So, this is the mega view we want to keep in mind as we look further at the progression in the evolution of taxonomies from the 1900s forward. “Page A” shows you the names of significant contributors to taxonomies of learning in the 1900s and from 2001 forward. The “Bloom's Taxonomy” falls in the middle of the 1900's. Then from 2001 forward we have reviews of other taxonomies and a revision to the Bloom's taxonomy. On this handout, you also are given a list of several specialized taxonomies, including Norman Webb's for curriculum alignment, one with my name on it for evaluation of instructional materials, McREL's, and for these you can find evidence of validity and reliability, and I draw your attention to the taxonomies specialized for particular purposes where you can see names of some of the scholars associated with those specializations. Then last, on “Page A” you have the list of some major references.

NOTE: In the middle of the sampling of taxonomies on the front side of Page A, there is a note about NRT v. DRT. These abbreviations represent “norm referenced testing” and “domain referenced testing.” DRT sometimes is called “criterion referenced testing” or CRT. In NRT, the purpose of assessment is to compare one student to all the others. In DRT, the purpose of assessment is to compare one student to progress in reaching a goal. Under the influence of Tyler, Bloom advocated that it was more important in education to help students reach goals, and the examples of assessments in the taxonomy focus on how well the test item assesses the intended objective, not on trying to create test items that will produce a “bell curve.”
Notes for Handout B: Title, Copyright, Dedication, and Contributors to “Taxonomy of Educational Objectives”

On “Page B” you have a copy of the cover page, copyright page, and the statement about the dedication to Ralph Tyler, as well as the 1956 copyright and date renewed in 1984. You can see the four other co-authors with Bloom, and then the list of 34 individuals from multiple universities across the United States who contributed to development of the taxonomy from 1949 to 1953. The initial idea for the taxonomy began at an American Psychological Association meeting, when thinking about how to develop a larger pool of test items for university comprehensive examinations. The idea was to build the test bank with contributions from other universities. So that items would assess the kind of goal they were meant to measure, it would be necessary to carefully define the goals and provide sample test items that match. The introduction to this book includes this statement on developing the taxonomy: “...we began work by gathering a large list of educational objectives from our own institutions and the literature. We determined which part of the objective stated the behavior intended and which state the content or object of the behavior. We then attempted to find divisions or groups into which the behaviors could be placed...We proceeded to divide the cognitive objectives into subdivisions from the simplest behavior to the most complex. We then attempted to find ways of defining these subdivisions in such a way that all of us working with the material could communicate with each other about the specific objectives as well as the testing procedures to be included....We have not succeeded in finding a method of classification which would permit complete and sharp distinctions among behaviors.” (p. 15).7

Notes for Handout C: Learning Objective Worksheet

There have been some validation studies of a few taxonomies, and among them the “Bloom’s Taxonomy,” and results have not always been favorable. That is, when a number of individuals are given objectives and asked to identify the level of learning to which they belong, the individuals do not consistently agree; one person codes an objective as belonging to one level of learning, and another individual codes it as belonging to a different level of learning.8, 9

Recently a number of studies about knowledge surveys have included the process of coding objectives to identify the level of learning from “Bloom’s Taxonomy” and often there has been ambiguity in the coding. I suspect one reason may be that those who are asked to identify the level of learning for an objective are not given the full taxonomy.10, 11 We’ll look more closely at this concept later. For now, before we go to the next handout, let’s make a list of the major categories of learning outcomes.


The next handout is “Page C” and this is a worksheet for analyzing the learning objective listed on the worksheet. Below the learning objective is a space to describe the “Level of Learning” that you think matches up with this objective, and where you can make a note about why you chose that level of learning. I’ll give you a few minutes to do this, and then we’ll have some discussion. [Each worksheet has a different objective. [After time to write, we began the Pair and Share part of the activity. Answers were provided verbally for each objective and in this file are shown in “Handout C Answers,” taken
Notes for Handout D “Test exercises” and Handout E “The Taxonomy”

Handout D has 13 test items taken from the Bloom taxonomy handbook. Handout E shows the table of contents from the taxonomy handbook that lists subcategories for all of the major learning levels except the application level. There are three subcategories for the categories of knowledge, comprehension, analysis, and synthesis; there are two subcategories for the evaluation level. It may be that those studies that report problems in agreement about coding of the Bloom levels of learning for objectives do not provide this full taxonomy, but instead, only provide the major categories, as that seems to be the “norm” in many sites that describe these levels of learning. There is a presumption of a common understanding. Here is our chance to do our own validation study. Using Handout E for reference, you can look at each test item and decide what level of learning is being assessed by each test item. [This task takes longer than the first one and is an individual activity. As individuals look about ready, a few minutes after flipping over the page of the handout, they then were provided with the answers verbally, and shown in this file as “D Answers.” There was some modest discussion. No one is asked to reveal whether or not their answers match the handbook’s answers. If time had allowed, this would have been the opportunity to go back to the “Page C” to then create an assessment item for the objective on the worksheet, but in this session, timing was such that we had to move on. If the assessment item had been written, the initial discussion prompt would have been “What did you consider when writing your test item?”]

Notes for Handout F “The Taxonomy Table” and “Knowledge Dimension,” and Handout G “The Cognitive Processes”

Handout F provides an overview of the 2001 revision to “Bloom’s Taxonomy.” The knowledge categories are listed in the left column; the cognitive processes are listed across at the top. So, for example, this revised layout suggests that one might not only remember factual knowledge, but could apply or analyze it as well. The challenge would be to take something that you teach and use this matrix to help in deciding what fits where. The flip side of this matrix has a description and examples of the knowledge categories, and then “Page G” has a description of each cognitive process level, also with examples. The challenge now is to examine the matrix shown on “Page F” and compare it to the worksheet shown on “Page C.” Which approach will work better for you in analyzing your objectives? Does the Anderson and Krathwohl 2001 revision of Bloom’s taxonomy work any better than the original “Bloom’s Taxonomy?” We don’t know. We do know that a team of authors, listed in the references in “Page A” did deliberate and reframed the taxonomy to integrate more recent educational research into the reflection process of the taxonomy. But is it any more effective? Is it any more valid? We don’t know, and it would be a good research project to test out how the 2001 edition performs compared to the 1956 edition in agreement about the levels of objectives and the signaling of both instructional strategies and assessment methods.

Summary

In summary, we seem to all agree that the 1956 taxonomy operates well to signal instructional and assessment strategies. In using the principles of SoTL practice suggested by Peter Felton, we see that the Bloom’s taxonomy holds up well with mixed results on methodology in the area of valid coding of
levels of learning when using the categories, but this may be due to researchers who do not provide the complete taxonomy. We looked earlier at the example of Webb’s depth of knowledge, and there is data to support its effectiveness in matching learning levels to curriculum frameworks. However, that framework has only four levels and is supported by a training program before individuals begin to code the levels of learning. Similarly, the Goodson framework, used by the Florida Department of Education, has a full research report that evaluators of instructional materials receive along with companion training. McREL also provides training support. Such training does not typically accompany the use of what we call “Bloom’s Taxonomy,” and this also could be a factor in the variation of results in validity studies. Our challenge is to examine the scholarship of these taxonomies and we may find that one works well for one discipline and a different one works well for another, just as Merrill’s works superbly in training settings, and Webb’s for curricular alignment.

Reference notes – see Attachment A for primary reference sources about taxonomies:
1[The Film Education Study Guide for “Bend it Like Beckham” URL is http://www.filmeducation.org/pdf/film/Bend_It_Like_Beckham.pdf].
4[The URL for the quote by Lou Rubin is http://www.ascd.org/publications/educational-leadership/may94/vol51/num08/Ralph_-W._Tyler-Remembered.aspx, ¶3.]
5[A 2004 dissertation compares the theories and practices of Tyler and Dewey. The URL is https://getd.libs.uga.edu/pdfs/smith_karen_h_200305_edd.pdf.].
6[The URL for David Merrill’s reflection on his professional life is http://mdavidmerrill.com/Papers/Reflections.pdf].
7[A comparison of DRT/CRT to NRT can be found at http://www.edpsycinteractive.org/topics/measeval/crmref.html].
8[The quote on how the taxonomy was developed comes from the 1984 renewed copyright edition of the taxonomy, the reference for which is listed in Handout A.].
9[Validation studies for Bloom’s taxonomy and Gagné’s hierarchy are discussed beginning on page 64 of the book by Barbara Martin and Leslie Briggs listed in the references at the end of Handout Page A].
10[Also refer to AV Communication Review, 1974, Developing and Validating Learning Hierarchies by James Okey at http://www.jstor.org/stable/30217729.]
1751:
Jean le Rond d'Alembert and Denis Diderot's knowledge hierarchy domains: (a) MEMORY, History, Understanding; (b) REASON, Philosophy, Apprehension, Judgment, Analysis and Synthesis; (c) IMAGINATION, Creativity, Poetry.

1900s:
**Ivan Pavlov, Edward Thorndike, John Watson, B.F. Skinner:** S-R with reinforcement of behaviors.
George Mead, Edward Tolman, Jerome Bruner: learning can occur without reinforcement, mental processing supports learning (cognitive map, plan of action).
**J. Paul Guilford:** structure of intellect - (a) OPERATIONS (cognition, memory, divergent/convergent production, evaluation), (b) CONTENT (figural, symbolic, semantic, behavioral,) and (c) PRODUCT (units, classes, relations, systems, transformation, and implications).
**Reuven Feuerstein** -- more than 60 cognitive functions; attention and perception to problem-solving.
**Benjamin Bloom, Max Engelhart, Edward Furst, Walker Hill, David Krathwohl, et al.:** cognitive, affective, psychomotor; COGNITIVE: recall, comprehension, application, analysis, synthesis, evaluation
**David Krathwohl, Benjamin Bloom, Bertram Masia:** AFFECTIVE: receiving, responding, valuing, and organizing, all leading to acceptance of a value system.
**Robert Gagné, Leslie Briggs:** verbal information, intellectual skills (S-R, concepts, rules, problem solving, metacognitive); ATTITUDE: predisposition to behave in a certain way; MOTOR SKILLS.
Anita Harrow: PSYCHOMOTOR: reflex and basic movements, perceptual abilities, physical abilities, and skilled, expressive, and interpretive movement.
**Elizabeth Simpson:** PSYCHOMOTOR added establishing a mental set, performing with guidance, creating movement patterns, adapting patterns to new situations, and creating new movement patterns.
**Alexander Romiszowski:** PSYCHOMOTOR: acquiring procedural knowledge, executing actions and skills.

**NOTE:** Under the influence of Ralph Tyler, Benjamin Bloom advocated that it was more important in education to help students reach goals than to compare them to other students. Discuss NRT v. DRT.

2001 forward:
**David Merrill:** KNOWLEDGE: facts, concepts, procedures, principles; SKILLS: remember, use, find.
**David Mosely, team:** reviewed 35 hierarchies of productive thinking; 33 basic & 29 reflective
thinking; 27 knowledge recall; 19 self-engagement; 13 perception; FRAMEWORK: information gathering (experiencing, recognizing, recalling, comprehending information); understanding (developing, elaborating, representing meaning, working with rules & patterns, concepts, & organizing ideas); productive thinking (reasoning, understanding, relationships, inquiry, problem solving, creative thinking).

Lorin Anderson, David Krathwohl, and colleagues: review of 19 hierarchies; revision to Bloom:

KNOWLEDGE: factual, conceptual, procedural, and metacognitive; SKILLS: remembering, understanding, applying, analyzing, evaluating, and creating

Brenda Sugrue: KNOWLEDGE: facts, concepts, procedures, principles; PROCEDURES skills: assemble, calculate, decide, and distinguish between multiple related procedures; FACTS, CONCEPTS skills: the usual; PROCESS skills: troubleshooting, predicting, or improving; PRINCIPLE skills: applying rules to problems/decisions or predicting events/outcomes.

Robert Marzano: information, mental procedures, physical procedures, self-efficacy.

Specialized frameworks, late 1900s forward:

Norman Webb: Depth of Knowledge (DOK) framework for curricular alignment: recall and reproduction, skills and concepts, short-term strategic thinking, and extended thinking.

Ludwika Goodson, integrated DOK, Bloom, Gagné, Gardner for evaluating instructional materials: LEVEL I, Recall and Reproduce—verbal information, concept definitions, procedural knowledge; LEVEL II, Apply Skill or Concept—cognitive learning strategies, multiple intelligences, attitude choices, concept applications, routine rules and principles, procedure applications, motor skills; LEVEL III, Strategic Thinking—metacognitive thinking, insight, critical thinking together with analysis, synthesis, and evaluation; LEVEL IV, Extended Thinking—scientific inquiry and research, problem solving, and complex rule using, and creativity., and described four skill levels, each with multiple subcategories.

Mid-continent Research for Education and Learning (McREL): dimensions of learning for critical, creative, and self-regulatory thinking: attitudes and perceptions, acquiring and integrating knowledge, extending and refining knowledge; using knowledge meaningfully, and productive habits of mind.

Specialized: (a) intellect (E. Jean Gubbins, Robert Sternberg, Howard Gardner), (b) critical thinking (Robert Glaser, Michael Scriven, Richard Paul, Diane Halpern, Debra McGregor, Robert Ennis, B.Z. Pressseisen), (c) problem solving (David Jonassen, B.Z. Pressseisen, John Sweller, Center for Problem Oriented Policing), (d) creativity (Frank Edwin Williams, Ellis Paul Torrence, Edward deBono), (e) inventive thinking (Genrich Altshuller), (f) integrative and reflective thinking (John Flavell, Scott Paris & Peter Winograd, Hope Hartman, , and (g) self-regulated learning (Paul Pintrich).

References:
Wesley, Longman, Inc.
New York: David McKay.
TAXONOMY OF EDUCATIONAL OBJECTIVES

Handbook 1: Cognitive Domain
95 Church Street, White Plains, New York 10601

Longman Inc., New York

Associated companies, branches, and representatives throughout the world.

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32 33 34 35/93 92 91 90 89

Library of Congress Catalog Card Number: 64-12369

Manufactured in the United States of America
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1.10 Knowledge of specifics

1.20 Knowledge of ways and means of dealing with specifics

1.30 Knowledge of the universals and abstractions in a field

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Appendix
A condensed version of the Taxonomy of Educational Objectives
<table>
<thead>
<tr>
<th>Learning Objective #18</th>
<th>Assessment</th>
<th>Rationale for Assessment</th>
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<tbody>
<tr>
<td>Examine the conclusions reached in a controversy and identify the logic used and missing elements in the logic.</td>
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</table>

**Level of Learning**

**NOTE:**
Each worksheet had a different objective numbered from 1 through 18. Extra sets were made of the higher level objectives, so a few people had the same objective, but we distributed the sets to avoid giving individuals next to each other the same objective. The 18 objectives used are listed in “Attachment C Answers.”
Test yourself on the classification of test exercises

The reader may now wish to try his hand at classifying additional test exercises. The following exercises have been selected from the book, *Measurement of Understanding*. The key to the classification of these exercises will be found on page 59.

In the following problem, assume that the student has studied tariffs in some detail.

1. Which has been a result of this country's policy of maintaining a high protective tariff? (1) Higher prices for domestic goods (2) lower prices for foreign goods (3) increased foreign trade (4) higher prices for farm products sold in foreign markets (p. 88)

Previous years also addressed measurement – I found as early as 1914. But this yearbook explains and provides test items to measure understanding in:


“...understanding is assumed to be evidenced by some kind or kinds of behavior” p. 325; the teacher has to determine what those behaviors will be that demonstrate understanding.

Assume that the student has learned something about meteorology, but that the particular relationships between the fact and the statements have not been studied in this form.

7. Tell whether each of the statements following the fact is (A) a cause of the fact, (B) a result of the fact, or (C) not related to the fact.

Fact: A flash of lightning occurs.

Statements

A roar of thunder can be heard. ______

Electricity passed between clouds and the earth. ______

It is dangerous to stand under a tree during a rainstorm. (p. 135) ______
Some additional test exercises drawn from the files of the cooperating examiners are presented below.

8. A brick can be pulled along a fairly smooth surface by means of a string; the string would break, however, if jerked sharply. Which of the following principles is most directly useful in explaining this fact?

   A- Force is equal to mass times acceleration.
   B- Friction exists between any two bodies in contact with each other.
   C- Conservation of momentum
   D- Conservation of energy
   E- None of these principles applies.

"For what men say is that, if I am really just and am not also thought just, profit there is none, but the pain and loss on the other hand are unmistakable. But if, though unjust, I acquire the reputation of justice, a heavenly life is promised to me. Since then appearance tyrannizes over truth and is lord of happiness, to appearance I must devote myself. I will describe around me a picture and shadow of virtue to be the vestibule and exterior of my house; behind I will trail the subtle and crafty fox."

9. Which one of the following best expresses the main topic of this selection?

   A- What is justice?
   B- How to attain eternal life
   C- How to be successful
   D- What is the nature of virtue?
   E- What is truth?

10. Which of the following might be most inclined to follow the policy recommended in the selection?

   A- An absolute ruler
   B- A politician
   C- A philosopher
   D- A statesman
   E- A religious leader

11. If some external force should shift the earth nearer the sun so that the mean radius of its orbit would be eighty million miles, the anticipated effect on the earth would cause the

   A- seasons to be longer.
   B- sidereal day to be longer.
   C- average yearly temperature to be lower.
   D- year to be shorter.
   E- None of these.

12. Which one of the following actions would probably be least effective in correcting the undesirable features of group political pressures?

   A- Overhaul the national patent system.
   B- Concentrate the economic power of the nation.
   C- Give the public more information about the origin and extent of political lobbying.
   D- Use congressional investigating committees.
   E- Encourage all groups to subordinate their interests to the national interest.

13. Set the following poem to music:

   (Copy furnished the student) ________ by ________

Write a simple melodic line.

Write a composition with a single tonal base.

Write a composition using two tonal levels.

Write a specific work in a larger form for any of the accepted mediums of expression such as a chamber group, orchestra, chorus, or piano. The composition should be at least ten minutes' duration and have received performance. Suggested designs are as follows: a string quartet, a trio, or a sonata for violin or violincello and piano, or a work for full orchestra, or a dramatic work or a cantata for solos, chorus, and orchestra of at least fifteen minutes' duration. (Thesis requirement for master's degree in music.)
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Educational significance of Synthesis objectives
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6.10 Judgments in terms of internal evidence
6.20 Judgments in terms of external criteria

Appendix
A condensed version of the Taxonomy of Educational Objectives
### 3.1 The Taxonomy Table

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<tbody>
<tr>
<td>A. Factual knowledge</td>
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<td>B. Conceptual knowledge</td>
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<tr>
<td>C. Procedural knowledge</td>
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<tr>
<td>D. Meta-cognitive knowledge</td>
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</tr>
</tbody>
</table>
### 4.1 The Knowledge Dimension

<table>
<thead>
<tr>
<th>Major Types and Subtypes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. FACTUAL KNOWLEDGE</strong>—The basic elements students must know to be acquainted with a discipline or solve problems in it</td>
<td></td>
</tr>
<tr>
<td><strong>Aa.</strong> Knowledge of terminology</td>
<td>Technical vocabulary, musical symbols</td>
</tr>
<tr>
<td><strong>Ab.</strong> Knowledge of specific details and elements</td>
<td>Major natural resources, reliable sources of information</td>
</tr>
<tr>
<td><strong>B. CONCEPTUAL KNOWLEDGE</strong>—The interrelationships among the basic elements within a larger structure that enable them to function together</td>
<td></td>
</tr>
<tr>
<td><strong>Ba.</strong> Knowledge of classifications and categories</td>
<td>Periods of geological time, forms of business ownership</td>
</tr>
<tr>
<td><strong>Bb.</strong> Knowledge of principles and generalizations</td>
<td>Pythagorean theorem, law of supply and demand</td>
</tr>
<tr>
<td><strong>Bc.</strong> Knowledge of theories, models, and structures</td>
<td>Theory of evolution, structure of Congress</td>
</tr>
<tr>
<td><strong>C. PROCEDURAL KNOWLEDGE</strong>—How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods</td>
<td></td>
</tr>
<tr>
<td><strong>Ca.</strong> Knowledge of subject-specific skills and algorithms</td>
<td>Skills used in painting with watercolors, whole-number division algorithm</td>
</tr>
<tr>
<td><strong>Cb.</strong> Knowledge of subject-specific techniques and methods</td>
<td>Interviewing techniques, scientific method</td>
</tr>
<tr>
<td><strong>Cc.</strong> Knowledge of criteria for determining when to use appropriate procedures</td>
<td>Criteria used to determine when to apply a procedure involving Newton’s second law, criteria used to judge the feasibility of using a particular method to estimate business costs</td>
</tr>
<tr>
<td><strong>D. METACOGNITIVE KNOWLEDGE</strong>—Knowledge of cognition in general as well as awareness and knowledge of one’s own cognition</td>
<td></td>
</tr>
<tr>
<td><strong>Da.</strong> Strategic knowledge</td>
<td>Knowledge of outlining as a means of capturing the structure of a unit of subject matter in a textbook, knowledge of the use of heuristics</td>
</tr>
<tr>
<td><strong>Db.</strong> Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge</td>
<td>Knowledge of the types of tests particular teachers administer, knowledge of the cognitive demands of different tasks</td>
</tr>
<tr>
<td><strong>Dc.</strong> Self-knowledge</td>
<td>Knowledge that critiquing essays is a personal strength, whereas writing essays is a personal weakness; awareness of one’s own knowledge level</td>
</tr>
</tbody>
</table>
## 5.1 THE COGNITIVE PROCESS DIMENSION

<table>
<thead>
<tr>
<th>Categories &amp; Cognitive Processes</th>
<th>Alternative Names</th>
<th>Definitions and Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. REMEMBER</strong>—Retrieve relevant knowledge from long-term memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.1 Recognizing</strong></td>
<td>Identifying</td>
<td>Locating knowledge in long-term memory that is consistent with presented material (e.g., Recognize the dates of important events in U.S. history)</td>
</tr>
<tr>
<td><strong>1.2 Recalling</strong></td>
<td>Retrieving</td>
<td>Retrieving relevant knowledge from long-term memory (e.g., Recall the dates of important events in U.S. history)</td>
</tr>
<tr>
<td><strong>2. UNDERSTAND</strong>—Construct meaning from instructional messages, including oral, written, and graphic communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.1 Interpreting</strong></td>
<td>Clarifying, paraphrasing, representing, translating</td>
<td>Changing from one form of representation (e.g., numerical) to another (e.g., verbal) (e.g., Paraphrase important speeches and documents)</td>
</tr>
<tr>
<td><strong>2.2 Exemplifying</strong></td>
<td>Illustrating, instantiating</td>
<td>Finding a specific example or illustration of a concept or principle (e.g., Give examples of various artistic painting styles)</td>
</tr>
<tr>
<td><strong>2.3 Classifying</strong></td>
<td>Categorizing, subsuming</td>
<td>Determining that something belongs to a category (e.g., concept or principle) (e.g., Classify observed or described cases of mental disorders)</td>
</tr>
<tr>
<td><strong>2.4 Summarizing</strong></td>
<td>Abstracting, generalizing</td>
<td>Abstracting a general theme or major point(s) (e.g., Write a short summary of the events portrayed on a videotape)</td>
</tr>
<tr>
<td><strong>2.5 Inferring</strong></td>
<td>Concluding, extrapolating, interpolating, predicting</td>
<td>Drawing a logical conclusion from presented information (e.g., In learning a foreign language, infer grammatical principles from examples)</td>
</tr>
<tr>
<td><strong>2.6 Comparing</strong></td>
<td>Contrasting, mapping, matching</td>
<td>Detecting correspondences between two ideas, objects, and the like (e.g., Compare historical events to contemporary situations)</td>
</tr>
<tr>
<td><strong>2.7 Explaining</strong></td>
<td>Constructing models</td>
<td>Constructing a cause-and-effect model of a system (e.g., Explain the causes of important 18th-century events in France)</td>
</tr>
<tr>
<td><strong>3. APPLY</strong>—Carry out or use a procedure in a given situation</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3.1 Executing</strong></td>
<td>Carrying out</td>
<td>Applying a procedure to a familiar task (e.g., Divide one whole number by another whole number, both with multiple digits)</td>
</tr>
<tr>
<td><strong>3.2 Implementing</strong></td>
<td>Using</td>
<td>Applying a procedure to an unfamiliar task (e.g., Use Newton's Second Law in situations in which it is appropriate)</td>
</tr>
</tbody>
</table>
### 5.1 The Cognitive Process Dimension (continued)

<table>
<thead>
<tr>
<th>Categories &amp; Cognitive Processes</th>
<th>Alternative Names</th>
<th>Definitions and Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4. Analyze</strong>—Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4.1 Differentiating</strong></td>
<td>Discriminating, distinguishing, focusing, selecting</td>
<td>Distinguishing relevant from irrelevant parts or important from unimportant parts of presented material (e.g., Distinguish between relevant and irrelevant numbers in a mathematical word problem)</td>
</tr>
<tr>
<td><strong>4.2 Organizing</strong></td>
<td>Finding coherence, integrating, outlining, parsing, structuring</td>
<td>Determining how elements fit or function within a structure (e.g., Structure evidence in a historical description into evidence for and against a particular historical explanation)</td>
</tr>
<tr>
<td><strong>4.3 Attributing</strong></td>
<td>Deconstructing</td>
<td>Determine a point of view, bias, values, or intent underlying presented material (e.g., Determine the point of view of the author of an essay in terms of his or her political perspective)</td>
</tr>
</tbody>
</table>

| **5. Evaluate**—Make judgments based on criteria and standards | | |
| **5.1 Checking** | Coordinating, detecting, monitoring, testing | Detecting inconsistencies or fallacies within a process or product; determining whether a process or product has internal consistency; detecting the effectiveness of a procedure as it is being implemented (e.g., Determine if a scientist's conclusions follow from observed data) |
| **5.2 Critiquing** | Judging | Detecting inconsistencies between a product and external criteria, determining whether a product has external consistency; detecting the appropriateness of a procedure for a given problem (e.g., Judge which of two methods is the best way to solve a given problem) |

| **6. Create**—Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure | | |
| **6.1 Generating** | Hypothesizing | Coming up with alternative hypotheses based on criteria (e.g., Generate hypotheses to account for an observed phenomenon) |
| **6.2 Planning** | Designing | Devising a procedure for accomplishing some task (e.g., Plan a research paper on a given historical topic) |
| **6.3 Producing** | Constructing | Inventing a product (e.g., Build habitats for a specific purpose) |
KNOWLEDGE 1-Know the meaning of the term “synapse.”
KNOWLEDGE 2-Know the strategies to help you solve a problem.
KNOWLEDGE 3-Know the notes on a musical staff.

COMPREHENSION 4-Correctly identify different geometric shapes.
COMPREHENSION 5-Create an example of alliteration that matches its technical definition.
COMPREHENSION 6-Match piano keys to the corresponding notes on a musical staff.

APPLICATION 7-Relate the principles of civil liberties to current events.
APPLICATION 8-Explain the physics of the ability to smell a scent even when it is not nearby.
APPLICATION 9-Given the size of some dimensions of a geometric area, determine the size of the other dimension.

ANALYSIS 10-In text from a research article, distinguish the facts from the hypotheses.
ANALYSIS 11-In an argument for or against an issue, identify the unstated assumptions.
ANALYSIS 12-From a set of data over a period of time, identify the trends and predict the next set of future data.

SYNTHESIS 13-Write a set of musical notes to express the words and meaning of a poem.
SYNTHESIS 14-Explain the reasons for a chemical reaction and the effect of introducing different elements.
SYNTHESIS 15-Given a set of data, identify the hypotheses that are reasonable and those that are untenable.

EVALUATION 16-Given a medical care scenario, use the nursing code of ethics to identify the unethical actions taken and the ethical actions that should have been taken.
EVALUATION 17-For a given poetry selection, identify and use the criteria appropriate for evaluating this type of poetry.
EVALUATION 18-Examine the conclusions reached in a controversy and identify the logic used and missing elements in the logic.
Test Exercise Answers, adapted from p. 59 of the Bloom, et al. cognitive taxonomy handbook referenced in Attachment A.

1=KNOWLEDGE, 1.22, ways and means of dealing with specifics

2=COMPREHENSION, 2.30, extrapolation

3=COMPREHENSION, 2.30, extrapolation

4=COMPREHENSION, 2.10, translation

5=COMPREHENSION, 2.30, extrapolation

6=COMPREHENSION, 2.10, translation

7=ANALYSIS, 4.20, analysis of relationships

8=KNOWLEDGE, 1.31, knowledge of an abstraction

9=COMPREHENSION, 2.20, interpretation

10=COMPREHENSION, 2.30, extrapolation

11=APPLICATION, 3.0

12=EVALUATION, 6.20, judgments in terms of external criteria

13=SYNTHESIS, 5.10, production of a unique communication