Evaluating the Degree of Student Learning

Mohamad H. Ahmadian
Eastern New Mexico University
Mohamad.ahmadian@enmu.edu

Abstract

Student learning is a goal of every teacher, department, and school administrator. One way of assuring student learning is through classroom assessment which provides faculty with a means to improve student learning. The features that are included in the Bloom's Taxonomy can assist teachers to raise students' critical thinking skills. Primary trait analysis is a means to guide the teachers in improving the desired skills in students. This article discusses Bloom's Taxonomy and the development of primary trait analysis for classroom assessment. Results from two classroom assessments are presented.

Introduction

Employers expect engineering technology graduates to be critical thinkers and have problem solving skills that involve higher order of thinking. Assessment monitors the competence of graduating students, not just in terms of disciplinary expertise but also with respect to the attainment of a general education. Much of assessment is embedded within the teaching function of the university and ideally occurs alongside each student's regular academic effort. [1], [2], [3]

According to Benjamin Bloom [4], asking students to think at higher levels, beyond simple recall, is an excellent way to stimulate students' thought processes. Different types of questions require us to use different kinds or levels of thinking. According to Bloom's Taxonomy, human thinking skills can be broken down into the following six categories.

1. Knowledge: remembering or recalling appropriate, previously learned information to draw out factual (usually right or wrong) answers. Skills demonstrated in this area include:
    - observation and recall of information
    - knowledge of dates, events, places
    - knowledge of major ideas
    - mastery of subject matter
    - *Question Cues:*
      list, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.

2. Comprehension: grasping or understanding the meaning of informational materials. Skills demonstrated in this area include:
    - understanding information
    - grasping meaning

- translating knowledge into new context
- interpreting facts, comparing, contrasting
- ordering, grouping, inferring causes
- predicting consequences
- *Question Cues:*
  summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend

3. Application: applying previously learned information (or knowledge) to new and unfamiliar situations. Skills demonstrated in this area include:
   - using information
   - using methods, concepts, theories in new situations
   - solving problems using required skills or knowledge
   - *Questions Cues:*
     apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover

4. Analysis**:** breaking down information into parts, or examining (and trying to understand the organizational structure of) information. Skills demonstrated in this area include:
   - seeing patterns
   - organization of parts
   - recognition of hidden meanings
   - identification of components
   - *Question Cues:*
     analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer

5. Synthesis: applying prior knowledge and skills to combine elements into a pattern not clearly there before. Skills demonstrated in this area include:
   - using old ideas to create new ones
   - generalizing from given facts
   - relating knowledge from several areas
   - predicting, drawing conclusions
   - *Question Cues:*
     combine, integrate, modify, rearrange, substitute, plan, create, design, invent, what if?, compose, formulate, prepare, generalize, rewrite

6. Evaluation: judging or deciding according to some set of criteria, without real right or wrong answers. Skills demonstrated in this area include:
   - comparing and discriminating between ideas
   - assessing value of theories, presentations
   - making choices based on reasoned argument
   - verifying value of evidence
   - recognizing subjectivity

- *Question Cues:*
  assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize

Each category of Bloom's Taxonomy directs to a higher order of thinking. In order for students to be successful at the higher end, they have to have mastered the knowledge and comprehension levels. For engineering technology students to be successful in their careers they must have necessary critical thinking skills. These skills are sharpened to a degree during the college years through various activities such as lectures, assignments, laboratory assignments, and effective grading techniques. However, critical thinking is the art of analyzing and evaluating thinking with a view of improving it. [5]

Primary Trait Analysis for Engineering Technology Courses

The features used in a primary trait analysis (PTA) should be chosen to support the goals of the program and to follow the criteria set by the accreditation agency. Engineering technology education focuses primarily on analyzing, applying, implementing, improving existing technologies, and meeting the criteria set by the TAC of ABET. Consequently, the features in the PTA table are designed to support the engineering technology focus. The PTA table can be utilized as a tool to collect data to examine the goals of a program.

Bloom's Taxonomy is a good tool for developing a PTA because all of the features discussed in Bloom's are applicable to engineering technology programs, and more categories can be added to customize the PTA for a given program. For the engineering technology programs, technical skills and communications are important features as it is emphasized in the Criteria for Accrediting Engineering Technology Programs TAC of ABET as discussed below. According to the Criteria for Accrediting Engineering Technology Programs published by the Technology Accreditation Commission (TAC) of ABET Effective for Evaluations during the 2006-2007 Accreditation Cycle,

> Criterion 2. Program Outcomes
>
> Although institutions may use different terminology, for purposes of Criterion 2, program outcomes are statements that describe what units of knowledge or skill students are expected to acquire from the program to prepare them to achieve the program educational objectives. These are typically demonstrated by the student and measured by the program at the time of graduation.
>
> An engineering technology program must demonstrate that graduates have:
> a. an appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines.
> b. an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology
> c. an ability to conduct, analyze and interpret experiments and apply experimental results to improve processes,
> d. an ability to apply creativity in the design of systems, components or

processes appropriate to program objectives,

e. an ability to function effectively on teams,
f. an ability to identify, analyze and solve technical problems,
g. an ability to communicate effectively,
h. a recognition of the need for, and an ability to engage in lifelong learning,
i. an ability to understand professional, ethical and social responsibilities,
j. a respect for diversity and a knowledge of contemporary professional, societal and global issues, and
k. a commitment to quality, timeliness, and continuous improvement

The features that are discussed in this Criterion 2 can be included as features in a PTA to collect data as one measurement to meet this criterion. The examples below show that data can be collected by assigning questions in exams or assignments for a particular competency.

Development of Primary Trait Analysis

The categories that are used for measurement in each course must be defined prior to PTA construction, since the categories under consideration are not the same for every course. The Table 1 represents the chosen categories that are used as part of measurement for each course. As an example, in EET 110, the first course in electronics engineering technology, only four features are measured through exams, laboratory assignments, and homework. However, in EET 490, the capstone course (Special Project), all the features in the table can be measured.

Table 1. EET Assessment Matrix
(Exams are used to measure competencies except the technical skills that are measured in the laboratory)

EET Course	101	110	111	210	237	241	242	……	441	450	457	472	490**
Knowledge	X	X	X	X	X	X	X						X
Comprehension		X		X	X	X	X		X	X	X	X	X
Application	X	X	X	X	X	X	X		X	X	X	X	X
Analysis		X	X	X	X	X	X		X	X	X	X	X
Synthesis							X		X	X	X	X	X
Evaluation													X
Technical Skills				X			X		X	X	X	X	X
Communications*									X	X	X	X	X

* Communications competency is measured through project reports.
****** Competencies are measured through project assignments.

In the Table 2 the first six categories are all based on Bloom's Taxonomy. In this table, success of each student is reported for a given trade for a particular course. For example: for the category of knowledge, fourteen students participated in exam 1. Out of the fourteen students four students mastered the knowledge at an excellent level, four students showed good level of knowledge, two students did average, and four performed poorly. Since knowledge is a foundation for being able to master higher levels of learning, the indicated data can provide the faculty with suggestions for revising the instruction for this course. The numbers in the

following tables are derived not by how many passed the exams or the course, rather by level of success on the given category.

Table 2. Primary Trait Analysis EET Course: Sequential Circuits and Applications

Category	Class and Exams EET 242	# of Persons Assessed	Number of Persons Scoring at Levels			
			Excellent A	Good B	Average C	Poor D - F
Knowledge	Exam 1	14	4	4	2	4
	Exam 2	14	4	0	8	2
Comprehension	Exam 1	14	4	2	6	2
	Exam 2	14	8	0	2	4
Application	Exam 1	14	0	4	6	4
	Exam 2	14	6	0	2	6
Analysis	Exam 1	14	4	0	2	8
	Exam 2	N/A	N/A	N/A	N/A	N/A
Synthesis	Exam 1	N/A	N/A	N/A	N/A	N/A
	Exam 2	14	6	0	2	6
Evaluation	Exam 1	N/A	N/A	N/A	N/A	N/A
	Exam 2	N/A	N/A	N/A	N/A	N/A
Technical Skills	Labs	14	4	6	4	0
Communications	Oral	N/A	N/A	N/A	N/A	N/A
	Writing	N/A	N/A	N/A	N/A	N/A

The Table 3 represents data collected from the Special Project course. In this course students are required to do two projects and give three presentations and reports
for each project. This is the capstone course of the program and students take this course in the senior year.

Table 3. Primary Trait Analysis EET Course: Special Project

Category	Class and Exams EET 490	Number of Persons Assessed	Number of Persons Scoring at Levels			
			Excellent A	Good B	Average C	Poor D - F
Knowledge	Projects	9	N/A	N/A	N/A	N/A
Comprehension	Projects	9	N/A	N/A	N/A	N/A
Application	Projects	9	2	3	2	2
Analysis	Projects	9	1	4	2	2
Synthesis	Projects	9	1	4	2	2
Evaluation	Projects	9	1	4	2	2
Technical Skills	Projects	9	3	4	1	1
Communications	Oral	9	4	4	1	0
	Writing	9	2	5	1	1

Conclusion

Once a table has been developed, then the teacher can analyze the data to know where improvements are needed. The above tables are representing one or two measurements. More data are required to be conclusive on performance of students in a category. Looking at the Table 3 for the Special Project course, data suggest that students' analysis, synthesis, and evaluation were not as efficient as expected this time. Only one student received grade of Excellent. For the following semester different pedagogy can be chosen to investigate the concerned categories. If collected data represent the same problem, then the prerequisites and the course materials need to be restructured. Thus using Bloom's Taxonomy primary trait analysis assists student learning, and with more tracking teachers will be informed for future changes.

Bibliography

[1] Walvoord B. & Anderson V. J. (1998). Effective Grading, A Tool for Learning and Assessment. Jossey-Bass Publishers.

[2] Angelo T. A. & Cross K. P. (1993). Classroom Assessment Techniques, A Handbook for College Teachers, Jossey-Bass Publishers.

[3] Eder D. (2001). Undergraduate Assessment, World-Wide Web URL http://www.siue.edu/~deder/.

[4] World-Wide Web URL http://www.coun.uvic.ca/learn/program/hndouts/bloom.html

[5] Morse J. (2001). Promoting Critical Thinking SkillsThrough Effective Grading, Techniques, Proceedings of the 2001 American Society for Engineering Education Annual Conference and Exposition.

Bibliography

Mohamad H. Ahmadian is a senior member of the IEEE and a professor of Electronics Engineering Technology at Eastern New Mexico University. He also serves as a program evaluator for electronics and computer engineering technology programs for TAC of ABET. He received his B.S., M.S., and Ph.D. in Electrical Engineering from the University of Missouri-Columbia. Before starting Ph.D. work, he worked three years as a project engineer.