Bloom's Taxonomy And Introductory College/University Transfer Science Courses: Does It Contribute To or Damage Student Success in Freshman Courses?

An Evidence-Based Mental Assessment Exercise in General Chemistry I

by

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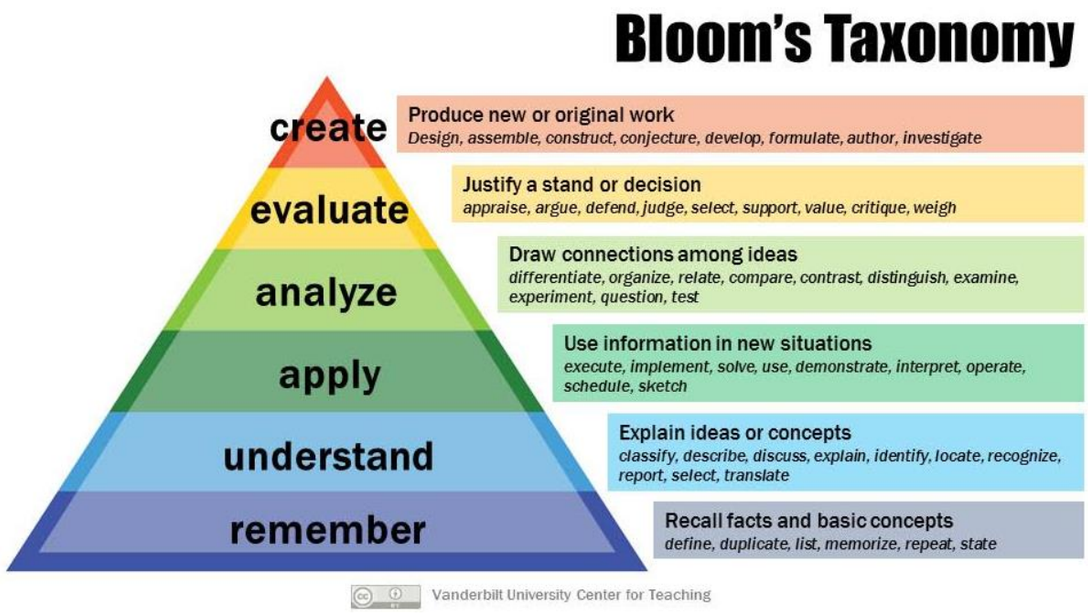
Abstract/Executive Summary

Bloom's Taxonomy has gained a great deal of traction in higher ed as a result of accreditation vis-à-vis mandatory assessment (evidence-based learning) activities (e.g., Student Learning Outcomes – SLO's). A cursory overview of Bloom's suggested that it may have limitations in teaching students how to solve Introductory College/University transfer courses in General Sciences. A General Chemistry I problem was used to demonstrate a modification of a problem-solving system (method?) that derives from modifying Bloom's Taxonomy. It's concluded that Bloom's, as currently designed and applied, is not helpful in teaching students how to solve General Chemistry I problems in a systematic manner.

Introduction

Upon completion of a Google Search [3], one can find any number of graphical representations to illustrate Bloom's Taxonomy, below. This initial Bloom's Taxonomy depiction for this report comes from Vanderbilt University [6]:



Bloom's Taxonomy was first developed in 1956 [1]. It was eventually revised in 2001 [2]. Of interest is that Bloom's, in the pyramidal format, substantially resembles Maslow's Hierarchy of Needs [4], Image, below [5].

Both approaches (Bloom's and Maslow's) appear to be rather rigid, i.e., static as opposed to dynamic. This rigidity vis-à-vis Bloom's Taxonomy may be problematic in some fields outside of education (as a field of study, not as a business that encompasses many, many, many fields of study) and the social sciences. In addition, it seems as though the origination of "Student Learning Outcomes" is from, perhaps, an overzealous application of Bloom's Taxonomy with equally misguided direction from,

hopefully, well-meaning faculty colleagues and accrediting institutions, e.g., in the case of Western Nevada College, Northwest Commission on Colleges and Universities.

Bloom's Taxonomy wasn't part of this author's academic preparation in the latter part of the previous century. Indeed, it wasn't until about 2001 that Social Science faculty at WNC began to "spread the word" regarding Bloom's Taxonomy across all of WNC's campuses.

In order then, to understand Bloom's Taxonomy in a more appropriate manner, a superficial exploration was initiated and shared amongst the author's classes to provide both professor and student with some rationale for the approach to the courses.

E-discussions regarding Bloom's Taxonomy and its apparent rigidity were also initiated (**Mr. Scott Morrison**, Interim VPASA-WNC, 14 Mar 2017, 18 Dec 2018, 16 Feb 2019; **Dr. Rebecca Bevans**, Instructor of Psychology, WNC-Carson City, 16, 18 and 19 Feb 2019, 5 Mar 2019 and 11 Apr 2019, *personal communications*) in order that this writer better understand and apply Bloom's Taxonomy to Introductory College/University Transfer and pre-Nursing General Biology and General Chemistry courses.

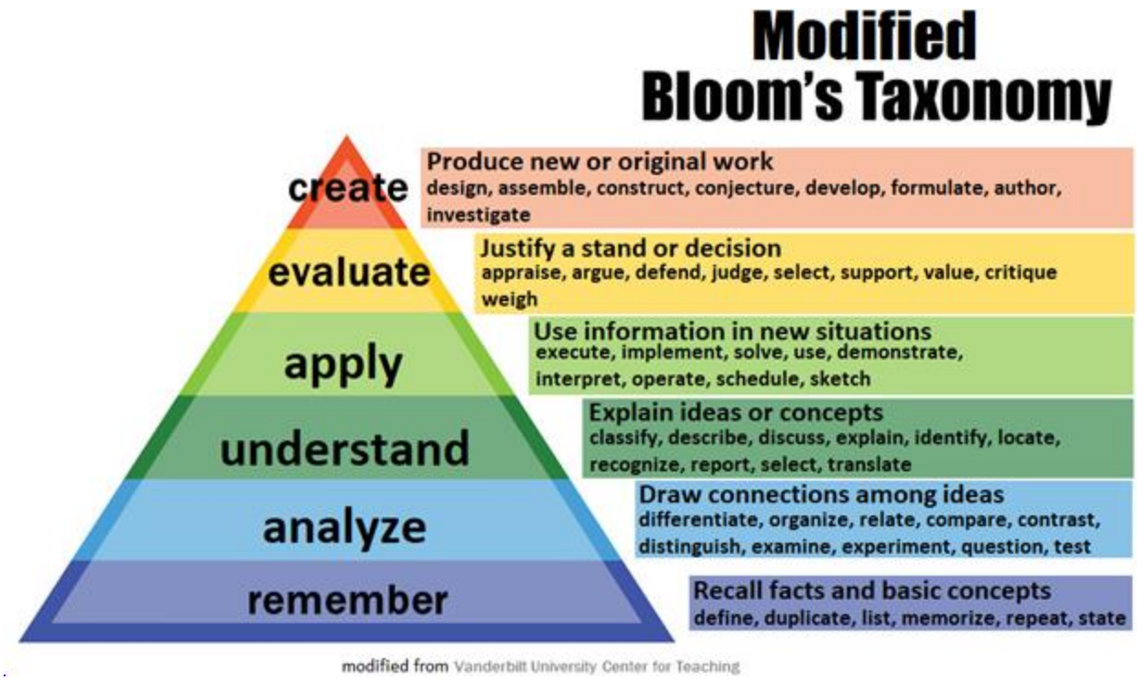
Materials and Methods

Representative General Chemistry I problems were chosen from typical (traditional) College/University Transfer General Chemistry Textbooks, e.g., Brady and Humiston: **General College Chemistry: Principles and Structure**, 2 Ed. (John Wiley and Sons: New York) ©1975 [7].

Representative graphical illustrations of Bloom's Taxonomy were obtained online and utilized within the practice of Fair Use Copyright Laws in the US and are cited as necessary so as to maintain the academic integrity of this report. In addition, sequential graphical modifications that are made and/or represented, in this report are unique to the author and his best knowledge and awareness. Any resemblance to modifications that may be observed by others after this report is uploaded is purely coincidental in nature.

Results and Discussion

The following representation of Bloom's Taxonomy is the author's intuitive modification of the previously cited image from Vanderbilt University [6] for application to General Chemistry I (GC1) problems prior to implementation/practice:



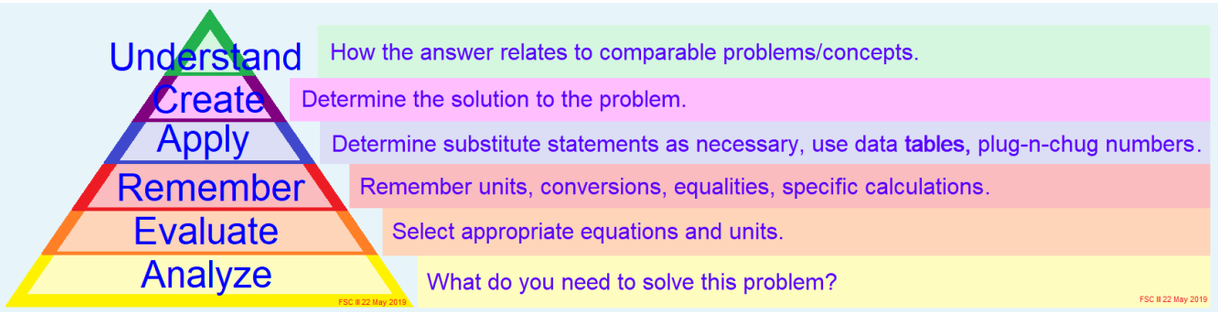
When this format was applied to GC1 problems, it became clear very quickly that it didn't provide a logical sequence of actions, so to speak, for the student to take, i.e., it wasn't as helpful for students as it was hoped to solve GC1 problems systematically.

The author returned to the drawing board and selected a "different" sort of GC1 homework problem and walked through its solution a step at a time, re-arranging the Taxonomy as necessary.

The problem is as follows [7]:

> *Problem 6.68. During a rainstorm in July in New York City the humidity was found to be 100%. The atmospheric pressure was 740 Torr and the temperature was 31°C. Dry air has an average molecular weight of 28.8. Calculate the weight of water in 1.00 liter of the air during the storm.* ***p. 199****.*

The general sequence that was determined to be the most instructive to solving this sort of GC1 problem was: Analyze, Evaluate, Remember, Apply, Create and Understand. Graphically, this sequence translates as follows:



The details using this approach (above) is:

Analyze: What do you need to solve this problem?
Table 6.1
Correct formulas
Information (data) in Question

Evaluate: Select appropriate equations
Evaluate: Which gas laws formulas do you need?
Evaluate: Which pressure units do you need

Remember: Appropriate R (units)
Remember: Temp conversion
Remember: Universal Gas Law
Remember: Calculating moles
Remember: Determining molecular weight
Remember: 1 atm of pressure equivalent values

Apply: Determine substitute statement for mol in universaal gas law equation
Apply: Substitute mol expression in universal gas law equation
Apply: Determine water vapor pressure from table 6.1
Apply: plug-n-chug numbers

Create: The answer to the problem

Understand: the answer by using proper units
Understand: how the answer relates to Relative Humidity Concept

This sequence was developed both from empirical practice and in e-discussion (Dr. Bevans, *op. cit., personal communication, previous page*). The e-discussion began with the inquiry, "*I have wondered if students were able to solve some problems without completely understanding them*." (Dr. Bevans, *Ibid*.)

The follow-up in the e-discussion (from this author) was:

> [...] *and the answer is "yes".* […] *-- the best* [anecdote] *is from my own education. The Nernst equation is an equation we use in CHEM and BIOCHEM to determine energy changes and/or potential (voltages) changes. I first encountered it in Gen Chem II. I simply memorized it, applied it and got past it -- did NOT understand it, however! Saw it, again, in Analytical CHEM, P. Chem and Instrumental Analysis and it came a little clearer each time. It wasn't, though, until grad school in Metabolic Regulation (good Ol' Chuck Heissler!) that I actually "got it".* Dr. Carman*, Ibid*

$$P_T = P_{H_2O}$$

$$@\ 31^{\circ}C\ P_{H_2O} = 33.7\ \text{Torr}$$

$$PV = nRT$$

$$n_{H_2O} = \frac{m}{MW}$$

$$MW_{H_2O} = 18\ \text{g/mol}$$

$$PV = \frac{mRT}{MW}$$

$$P = P_{H_2O} = \frac{33.7\ \text{Torr}}{760\ \frac{\text{Torr}}{\text{atm}}} = 0.0443\ \text{atm}$$

$$\frac{(PV)\ (MW)}{RT} = m = \frac{(0.0443\ \text{atm})\ (1\ \text{L})\ (18\ \text{g/mol})}{(0.0821\ \frac{\text{L-atm}}{\text{mol-K}})\ (304\ \text{K})}$$

$$m = 0.03198\ \text{g}\ H_2O\ \text{in the liter of air during the storm}$$

The solution, then, to the GC1 problem in standard CHEM 121 jargon is illustrated above.

In order to determine if this was a viable and, hence, applicable, method with which to teach GC1 students how to problem solve, the detailed sequence, this exact example question and this exactly-worked-out solution was emailed to the entire CHEM 121 1001/1002 Spring 2019 Class in advance of lecture. The emailed information was sent 5 Mar 2019, the in-class discussion that utilized the identical information was held 6 Mar 2019 and a Canvas worksheet (Empirical Formula and Storm Humidity) was built in Canvas to re-enforce the concept. The Canvas file was set to open 11 Mar 2019 at 2100 hours, PDT and due to close at 21 Mar 2019 at 2359 hours PDT (due to earlier conflicting assignments/exams).

While the in-class feed-back was positive regarding this specific topic, the Canvas worksheet results were remarkably and dismally disappointing: of 17 students who completed the worksheet, four (4) students obtained the correct responses to three (3) of the identically designed (with different information per question) questions.

One likely explanation came from a student's email who inquired as to the location of the information to complete the Canvas worksheet. Upon reminding the student that an email had been sent out previously, the student replied indicating that she had forgotten about that. Nothing was said by the student about the student's in-class notes from the lecture.

An additional explanation may have been inadvertently presciently stated during a pre-Spring 2019 CHEM 121 class by another student: "I'd rather guess and get it wrong, than take the time to look it up and get it right." (Note: While this student did manage to meet the minimum CHEM 121 grade to advance to BIOL 223, the student was unable to make the minimum grade in BIOL 223 to advance to BIOL 224.)

Finally, in an un-related course, one of the reading assessments has to do with students being able to read the diagnosis **as written** on a single electrocardiographic cardiac cycle. The previous two classes failed 100% to read it the first time through. A failure of students to pay attention to detail seems to be in pandemic form.

Lastly, during e-discussions, a link to an external faculty member's blog [8] was shared with the author. The general gist of the blog is that Bloom's Taxonomy isn't working in higher education and may very well be part of what is perceived as symptoms of the demise of higher education. The blogger's statements seem broadly consistent with the approaches taken in this little mental exercise, i.e., one size doesn't fit all and that, perhaps the "old school" way of doing "academic stuff" wasn't so bad, after all.

Conclusion

It's clear that Bloom's taxonomy for General Chemistry I is problematic and difficult to tease out (certainly, and especially, without student buy-in) from other factors. Additionally, based upon a previously submitted assessment report [9], it's entirely possible that the CHEM faculty at WNC may not be designing, much less assessing, SLO's that "fit" Bloom's – and that the etiology of that difficulty is that the SLO concept simply isn't of a contortional-enough nature to conform to General Chemistry I national standards. Furthermore, regardless of Northwest mandates, it's possible that, at worst, the utilization and implementation of SLO's may be hurting the students in higher education more than it's helping, [10].

The idea that Bloom's Taxonomy may be more of a problem than a solution for General Chemistry I students and their learning, while potentially likely, requires further exploration and investigation during academic year 2019-2020.