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Creating an Empirically Derived Bloom's Wheel for Use as a Tool of Institutional and Disciplinary Assessment

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Abstract: Bloom's Taxonomy is ubiquitous in the higher education assessment community. It can be used as a tool for writing learning outcomes/objectives, a mechanism to define levels of learning anticipated across programs, and as a conversation starter in curriculum development. Resources regarding the use of Bloom's Taxonomy in higher education abound. However, many of these resources are not empirically derived, providing room for improvement. After providing context on the utility and possibilities presented by a Bloom's Wheel visualization of Bloom's Taxonomy, this manuscript describes a process for creating an empirically derived Bloom's Wheel as a tool to guide alignment and the creation of meaningful assessment measures. This tool can be customized for specific disciplines, departments, colleges, etc., to increase applicability utilizing the methodology found herein. Higher education assessment professionals can use this process to create an empirically derived Bloom's Wheel in the interest of serving as facilitators/guides to their colleagues.

Keywords: *Assessment, Bloom's Taxonomy, Faculty Development, Assessment Professional Development*

Introduction

Assessment professionals' daily practice spans tasks including coordinating schedules, designing/providing professional development for faculty and staff participating in assessment processes, and strategizing responses to accreditation requirements around assessment processes. Although each unique institution's parameters dictate limitations on specific roles, scholars have found commonalities in assessment professionals' roles across diverse types of institutions from interviews with experienced professionals (Jankowski & Slotnick, 2015). Further scholarship has found common skills and dispositions needed to successfully perform the various roles of the assessment professional (Morrow et al., 2022). One such role is the facilitator/guide for faculty and other colleagues engaging in assessment processes, in which the assessment professional seeks to serve as, provide, and continuously improve resources for faculty and staff (many of whom have no formal education-centered training) in designing and implementing assessment measures (Jankowski & Slotnick, 2015). This manuscript details one new strategy assessment professionals can utilize to perform their role more effectively as facilitators/guides: creating and utilizing an empirically derived tool to suggest well-aligned assessment measures.

Assessment professionals acting as facilitators/guides often provide faculty with resources, including theoretically derived Bloom's Taxonomy interpretations. Even when provided with resources, assigning Bloom's levels to assessment measures is inconsistent for most faculty (Welch et al., 2017). Decades of development have produced learning outcomes undifferentiated at academic levels, and considered "poor" (Schoepp, 2019). Though assessment roles have existed for many years and the history of assessment processes in higher education has been well-documented (Nicholas & Slotnick, 2018), conversations continue in the literature about the extent to which the field has demonstrated the effectiveness of assessment processes for improving student learning and experience (Havnes & Prøtiz, 2016; Hussey & Smith, 2002).

To overcome the shortcomings identified in the literature, empirically derived resources for faculty may be more impactful than those created solely utilizing a theoretical basis. The process described in this manuscript provides a means for assessment professionals to create an empirically derived resource from existing assessment reports. The tool is customizable to a discipline, college, department, full institution, or other chosen context, and may empower faculty to identify assessment measures that are better aligned to appropriate Bloom's Taxonomy levels. In this way, the customized Bloom's Wheel (further described in the forthcoming review of literature) can serve as one tool in the toolbox for the field of assessment that can overcome criticisms and demonstrably improve student learning by empowering faculty to collect, interpret, and use more meaningful and aligned assessment results.

Bloom's Taxonomy: A Brief History

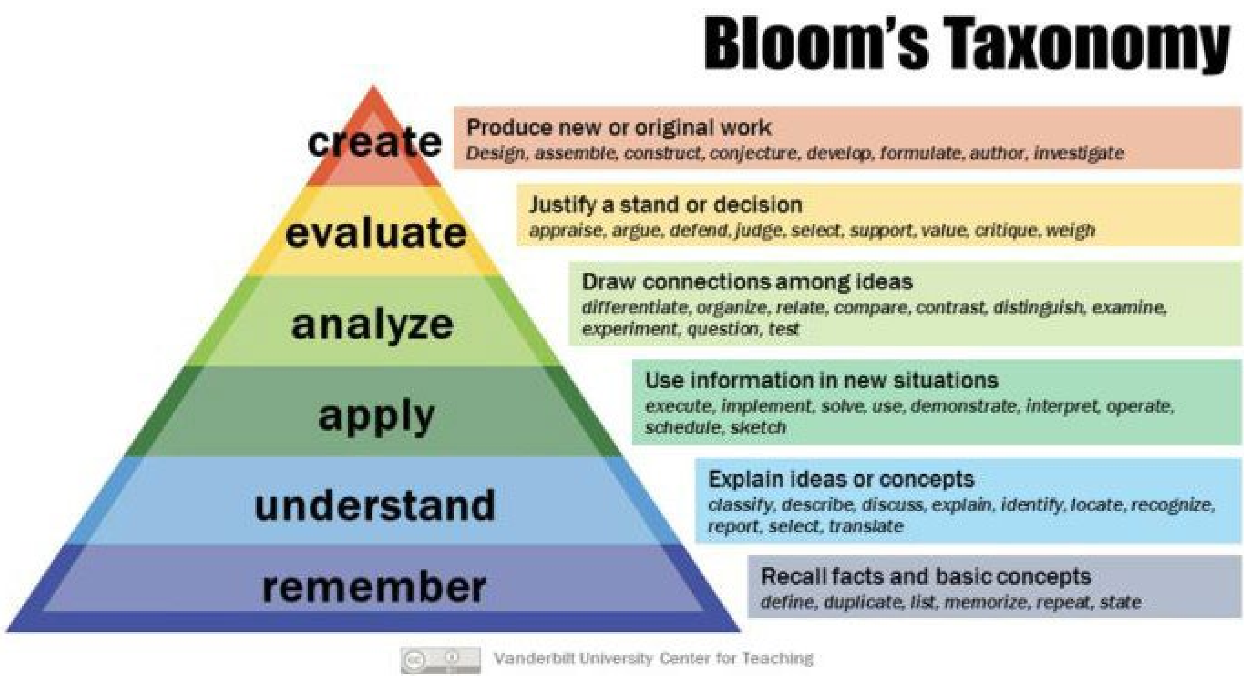
Bloom's Taxonomy is one of the most prolific theoretical understandings of how learning works. Its origins come from educational psychology, and most of its initial applications were in the K-12 educational context (Bloom, 1956). Bloom's Taxonomy explores the cognitive domains of learning, highlighting the cognitive process categories (levels) labeled as Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. Bloom's Taxonomy provides a cumulative hierarchy, where mastery of one category cannot be completed without mastery of the preceding category. Further, the processes at the top of the hierarchy increase in degrees of abstraction. The introduction of Bloom's Taxonomy to educational practice promoted a more thorough consideration of thinking and learning and described processes that moved beyond mere recall of facts to include analysis and evaluation of concepts, processes, procedures, and principles (Bloom, 1956).

Eventually, Bloom's Taxonomy became a widespread tool of educational planning. With its distribution, however, there were key assumptions identified as unsupported by empirical evidence. For example, knowledge (or a general ability) as an underlying construct was found to support all six of the categories, rather than serving only as a concrete, prerequisite construct (Madaus et al., 1973). Similarly, the cognitive-process categories were not aligned with the hierarchical structure predicted with respect to knowledge (Stoker & Kropp, 1971). Empirical investigations also indicated that Bloom's category-based levels were not necessarily directly aligned with item difficulty, further stretching the strict-hierarchy assumption (Huxam & Naeraa, 1980; Kibble & Johnson, 2011).

The taxonomy was later revised by Anderson and Krathwohl (2001) to differentiate between the knowledge and cognitive dimensions of learning within each category. The revision also reduced the strictness of, but did not eliminate, the hierarchy communicated in the original taxonomy. The updated taxonomy identifies cognitive process skills categories labeled as Remember, Understand, Apply, Analyze, Evaluate, and Create (Figure 1; this manuscript focuses on the cognitive process skills rather than the knowledge dimension). These process skills describe learners' abilities to demonstrate the skill, rather than the original Bloom's Taxonomy categories, which only provided descriptions of the skills (Anderson & Krathwohl, 2001). Learning, therefore, lies along a continuum from simple to complex and concrete to abstract within each category.

Figure 1

Vanderbilt Center for Teaching Bloom's Taxonomy Interpretations (Armstrong, 2010)



The revised taxonomy's cognitive process dimension describes the cognitive process skills by listing and detailing possible verbs that describe the action in each cognitive process skill (Figure 1). In addition, Anderson and Krathwohl (2001) reversed the order of the two upper categories (Synthesis and Evaluation) and changed Synthesis to Create. In the revision, the Remember category represents the retrieval of knowledge from memory; the Understand category represents the process of determining meaning from content; the Apply category includes procedural action; the Analyze category represents the creation and collection of disparate pieces into the organizational structure; the Evaluate category includes assigning judgment; and finally, the Create category requires the generation of a novel product (Anderson & Krathwohl, 2001; Krathwohl, 2002).

Bloom's Taxonomy in Modern Higher Education Assessment

Due to its straightforward interpretations in context and ease of practical application, Bloom's Taxonomy has become one of the key tools in an assessment professional's toolkit when acting as a facilitator/guide for faculty and staff (Razzouk & Razzouk, 2008). It is highlighted in some of the foundational texts guiding the work of assessment professionals, such as Assessing student learning: A common sense guide (Suskie, 2018), Designing effective assessment: Principles and profiles of good practice (Banta et al., 2009), Maki's guide on building a "Sustainable Commitment" to assessment (Maki, 2010), and To imagine a verb: The language and syntax of learning outcomes statements (Adelman, 2015). This widespread documentation demonstrates the importance of understanding and interpreting Bloom's Taxonomy to assessment professionals and its stronghold on the field of higher education assessment.

Essential skills for assessment professionals include embracing and supporting faculty's unique disciplinarity; acting as translators of discipline-specific jargon to reach the heart of the assessment process; and understanding student learning in the interest of improving (Jankowski & Slotnick, 2015; Morrow et al., 2022). The taxonomy provides a rough translation of complex educational psychological theory into everyday language, and serves as a medium for assessment professionals and faculty to communicate the nature of learning across academic programs and institutions and within diverse contexts of student success assessment; this was part of Bloom's Taxonomy's stated intention (Krathwohl, 2002). The importance of Bloom's Taxonomy as a unifying language has spurred its successful application in disciplines such as computer science (Thompson et al., 2008), family and consumer sciences (Pickard, 2007), music education (Hanna, 2007), history (Guo, 2021), and sustainability (Pappas et al., 2013), and extends into interdisciplinary contexts such as engineering design across STEM (Asunda & Ware, 2015).

In the field of higher education assessment, Bloom's Taxonomy has been instrumental in creating innumerable resources about student learning outcomes (SLOs). Lists of verbs aligned with the levels of Bloom's Taxonomy (as seen in Figure 1) help guide faculty in creating SLOs as well as assessment measures (i.e., exams, rubrics). Most of the available Bloom's Taxonomy resources seem to be based on the authors' interpretations of the taxonomy. Several of the more widespread Bloom's Taxonomy resources are from unknown origins, such as the Bloom's Taxonomy verb list linked on the National Institute for Learning Outcomes Assessment's (NILOA) New to Assessment webpage (NILOA, n.d.), still, verb lists created by subject matter experts such as those at NILOA do offer a valuable starting point for developing SLOs and assessment measures. However, years of assessment practice in higher education have provided scholars with opportunities to create empirical data-based resources that go beyond theory to provide insights not only about appropriate verbs but also about assessment measures, offering the opportunity to create increasingly credible resources.

To date, attempts at empirically deriving verb lists for Bloom's Taxonomy are poorly documented in the literature. Stanny's (2016) empirical investigation analyzed verb lists from various resources to identify a list of those most utilized. This process was repeated within the specific United Kingdom higher education context (Newton et al., 2020). The creation of guidance resources for assigning Bloom's levels to specific assessment items span disciplines. A group of faculty members collected sample examination items from advanced placement biology and undergraduate biology courses, the Graduate Record Examination, the Medical College Admission Test, and a medical school exam, and compared the assigned Bloom's levels to those items across disciplines (Zheng et al., 2008). A group of these faculty then created the Blooming Biology Tool, a guide to identify Bloom's levels of specific examination items as well as a student-facing guide on how to apply learning strategies for aligned Bloom's levels (Crowe et al., 2017). Similarly, Thompson & O'Laughlin (2015) used a large-scale analysis of exam items from anatomy courses to create their guide.

Alignment

One reason Bloom's Taxonomy has become so widespread in the field of higher education assessment is its usefulness in helping align SLOs with assessment measures. Alignment is described and defined in several ways throughout the field of higher education assessment, though it is commonly stated that for assessment processes to become meaningful and useful for improving student learning, SLOs should be measured as accurately as reasonably achievable. Indiana University (2024) provides the following example:

> "Assessments should align with (intended) course learning outcomes. For example, if a learning outcome was, "Order the stages of Maslow's Hierarchy of Needs," an appropriate assessment [measure] could be a matching or labeling question. If instead the learning outcome was, 'Explain the relationship between the stages of Maslow's Hierarchy of Needs' then an appropriate assessment [measure] might be an essay question or a diagramming project. Although the subject of both learning outcomes is the Hierarchy of Needs, the assessment [measure]s are measuring very different behaviors: ordering versus explaining." (p. 1).

SLO alignment with assessment measures is essential to the success of an assessment process. When the assessment measure used to identify whether students have mastered an SLO does not correspond with the SLO, the accuracy of the information provided is diminished. Decisions informed by poorly aligned data will not inherently improve learning as intended. The importance of alignment has also been communicated by assessment professionals. In a national survey, 85% of assessment professionals indicated that "mapping learning outcomes" was "moderately/very important" to succeed in such a role, and "selecting appropriate data points/assessment measures" was rated as "moderately/very important" by 87% of respondents (Morrow et al., 2022). As such, knowledge of how to achieve alignment in assessment processes is important for the assessment professional serving in the facilitator/guide role for their colleagues.

Despite the importance of alignment and the availability of alignment resources, empirical investigations have not found that SLOs and assessment measures are well-aligned across the academy. The prevailing understanding of Bloom's level alignments to assessment measures is that examinations can only adequately assess lower-level learning (Barnard et al., 2021). In both physics and biology, assessment measures designed to elicit higher-order cognitive process skills delineated in Bloom's Taxonomy were not found to result in increased student performance (Momsen et al., 2010; Momsen et al., 2013). Another case found poor alignment between cognitive process skills and knowledge types using the updated Bloom's Taxonomy in biology assessment measure items. The researchers concluded that verbs associated with cognitive process skills might not accurately identify which Bloom's level an assessment measure is expecting a student to perform (Larsen et al., 2022). In this age of artificial intelligence, it is more important than ever to provide faculty with tools to create strong alignment in the classroom. For example, the GPT-4 language model was found to perform better on examination items aligned with higher levels of the taxonomy and more poorly on those at the lower levels; indicating that direct level alignment between verbs and measures may help faculty members design assessment measures better suited at identifying students' ability to remember and understand content (Herrmann-Werner et al., 2024). Tools to help improve the alignment of assessment to the desired level of cognitive processes are imperative to help resolve concerns regarding misaligned action verbs and measures.

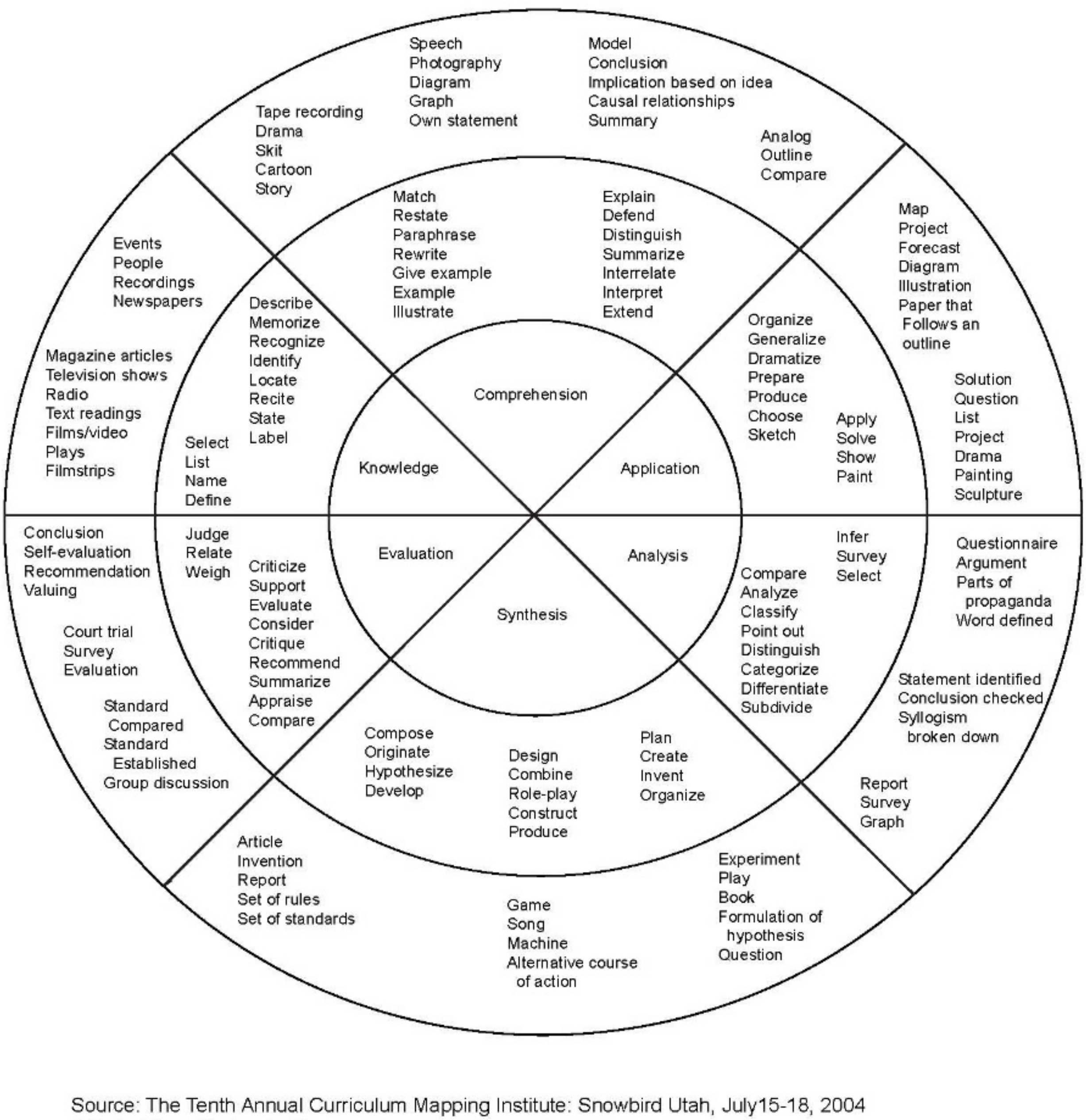
The Bloom's Wheel

The most common resources provided by centers for teaching and learning or assessment experts are lists of verbs that can be utilized to write SLOs aligned with Bloom's Taxonomy levels. At the end of its Bloom's Taxonomy verb list, NILOA depicts the taxonomy differently, using a circular, bull's eye model, presented by unidentified creators at the Tenth Annual Curriculum Mapping Institute, to align verbs to assessment measures (Anonymous, 2004; recreated with NILOA permission in Figure 2). This model of the taxonomy is referred to as a Bloom's Wheel. A Bloom's Wheel extends its value as a resource beyond a list of verbs to include measures. The Bloom's Wheel provides the six Bloom's levels in a central wheel. Radiating outward from each level are examples of verbs and potential appropriate assessment measures aligned with those verbs (see Figure 2). This version is the oldest Bloom's Wheel identified by the authors of this manuscript.

Figure 2

Tenth Annual Curriculum Mapping Institute Bloom's Wheel (Anonymous, 2004; NILOA, n.d.; reproduced with permission)

Bloom's Verbs
And Matching Assessment Types



Source: The Tenth Annual Curriculum Mapping Institute: Snowbird Utah, July15-18, 2004
Adapted from Benjamin Bloom

The Bloom's Wheel is less well-distributed than are lists of Bloom's Taxonomy-aligned verbs, however a search of higher education websites for Bloom's Wheels resulted in locating different models with varying verbs and measures. For example, the State University of New York at Stony Brook (n.d.) has an interactive Bloom's Wheel displaying possible verbs and assessment measures for each Bloom's level. Despite the name, not all Bloom's Wheels are depicted in a circular format; for example, Quinnipiac University Online Programs (n.d.) provides both a Bloom's Wheel in a circular version as well as a table format (Table 1).

Table 1

Bloom's Taxonomy - Levels of Knowledge, Associated Assessments & Verbs Bloom's Wheel (based on Quinnipiac University Online Programs (n.d.))

Knowledge Level	Verbs	Assessment Measures
Remember	Cite, Collect, Count, Clarify, Define, Examine, Enumerate, Find, Identify, Label, List, Memorize, Recall, Recognize, Show, State	Multiple-choice test, Short-answer test, Fill-in-the-blank test, Matching test, Labeling, Presentation, Illustration, Visualization, Lecture, Analogy, Example
Understand	Ask, Associate, Cite, Classify, Compare, Describe, Discuss, Exemplify, Interpret, Recall, Report, Select, Summarize, State, Tell	Diagram, Story, Written report, Speech, Outline, Matching test, Model, Photograph, Multiple-choice test, Discussion board, Presentation, Summary, Statement, Short-answer test, Comparison, Oral report, Analogy
Apply	Administer, Calculate, Choose, Demonstrate, Examine, Execute, Experiment, Illustrate, Implement, Instruct, Interpret, Modify, Operate, Prepare, Solve, Sketch, use	Diagram, Building, Creation, Drama, Illustration, Role-play, Project, Sketch, Simulation, Sculpture, Q&A, Map, Prototype, List, Demonstration, Painting, Poetry
Analyze	Appraise, Arrange, Calculate, Categorize, Classify, Compare, Contrast, Connect, Criticize, Diagram, Deconstruct, Differentiate, Discriminate, Divide, Examine, Explain, Experiment, Infer, Order, Organize, Outline, Question, Select, Separate	Survey, Problem exercise, Case study, Debug, Discussion, Graph, Syllogism breakdown, Questionnaire, Argument, Critical incident, Propaganda

Evaluate	Appraise, Assess, Argue, Choose, Compare, Critique, Conclude, Convince, Decide, Discriminate, Defend, Estimate, Explain, Establish, Grade, Interpret, Judge, Justify, Measure, Predict, Prioritize, Prove, Rank, Recommend, Rate, Select, Support, Summarize, Test, Value	Appraisal, Case study, Critique, Court trial, Project, Self-Evaluation, Simulation, Survey, Compare/Establish standards, Writing a conclusion, Valuing
Create	Arrange, Assemble, Combine, Compose, Construct, Design, Development, Describe, Explain, Formulate, Generalize, Integrate,	Article, Action plan, Case study, Creative exercise, Coding, Construct a simulation, Develop a

Problem of Practice

In recognizing the challenges of aligning SLOs and assessment measures, the quality of existing resources, and after a selected review of centers for teaching and learning websites of various types of higher education institutions, the authors identify a problem of practice. Diverse depictions of Bloom's Taxonomy are often provided as samples for faculty. Most of the depictions reviewed by the authors were not demonstrably derived from empirical investigations of how faculty and staff engage in assessment processes. Moreover, when provided with similar resources, faculty are inconsistent when assigning Bloom's levels to assessment measures (Welch et al., 2017). In this manuscript, the authors posit that a Bloom's Wheel that is both grounded in theory and derived from local data (institutional and/or disciplinary) is more useful for faculty and staff than one derived from theoretical models alone. The authors seek to provide a methodology for generating a Bloom's Wheel that an assessment professional embedded within an institution of higher education can practicably complete.

In this manuscript, the authors describe a method for empirically deriving a Bloom's Wheel from a set of SLOs and assessment measures, converting the text of each SLO and measure text into quantitative data for an analysis process, and re-converting to text to create a unique Bloom's Wheel. The method can be used to answer any number of guiding questions about the nature of alignment currently existing within the discipline or institution. The empirically derived Bloom's Wheel could also provide a starting point for identifying SLOs and assessment measures that are more likely to be aligned with the desired Bloom's Taxonomy level, empowering faculty to more easily collect, interpret, and use more meaningful assessment results.

Process of Designing an Empirically Derived Bloom's Wheel

To address this identified problem, the authors introduce a step-by-step process through which a Bloom's Wheel can be derived using existing assessment process artifacts such as assessment reports, including SLOs and assessment measures. To demonstrate the steps by which a Bloom's Wheel can be produced from native data, the authors used a sample generated from publicly available artifacts associated with programs accredited by the Commission on Sport Management Accreditation (COSMA) in the field of sport management. This process is designed to be targeted so that both the process and resultant Bloom's Wheel can help assessment professionals answer guiding question(s) such as: What verbs are being used at each level? What measures are programs using at each Bloom's level to assess student learning? Are those measures aligned with Bloom's level indicated in the SLO? What are the commonly used measures and verbs on my campus or in my discipline?

Collecting and Preparing Data

To initiate the process of designing an empirically derived Bloom's Wheel, an assessment professional must have access to data. These data must include the text of SLOs and their associated assessment measures with sufficient detail available to identify the type of measurement tool being used (i.e., quiz, assignment). In this process, data analysis tools such as Microsoft Excel or Google Sheets, and a data visualization tool such as Microsoft Word or Canva are the only software needed, and most institutions of higher education have access to these with no additional cost (these tools are used in this sample case). Assessment professionals engaging in this process can also incorporate qualitative (MaxQDA), quantitative (i.e., SPSS), and other analysis tools, especially when using larger data sets.

Some assessment management systems (e.g., Planning and Self-Study by Watermark) include features that can facilitate the data collection process by exporting a spreadsheet with content that is easily acquired and formatted. Institutions without such systems may need to access SLOs and assessment measures from submitted assessment reports and transfer such data into a spreadsheet to prepare for analysis. As a result, the time spent on this component of the process will vary by institution.

The columns of the data collection table should be based on the information needed from each SLO and the corresponding measure to answer the intended guiding question(s). Data collection tables could include additional information for other explorations in the future. The table should include at a minimum: (1) the entire SLO text and (2) measure information. In cases where many programs' data are being used, the authors recommend including helpful program demographic information such as (3) program name, (4) degree program level, and (5) institutional unit/alignment (i.e., in which college or department the program is located) to answer additional questions.

The Bloom's Wheel includes the alignment between the assessment measure and the language of the SLO itself, so it is important to note that each row, representing a single unit of analysis, will include a unique SLO-measure dyad (SLO-measure dyad in this process refers to a pairing of an SLO to a measure). If more than one measure was used to assess an SLO, each should be listed in a separate row to enable the line of inquiry to be explored. Figure 3 demonstrates a possible data collection table.

Figure 3

Possible data collection table template

	SLO Text	Measure (incl. Brief description)	Program Name	Program Level	Institutional Alignment
SLO & Measure Number 1					

SLO & Measure Number 2					

Sample Bloom's Wheel Creation: Data Collection and Preparation

COSMA is a specialized accreditor that reviews and accredits programs at the bachelor's, master's, and doctoral levels. In each annual report sent by accredited programs to COSMA, the institution must demonstrate that it publicly posts its learning outcomes matrix with the information detailed in Table 2 (COSMA, 2023-2024). Programs also report their assessment results for improvement in the annual report document.

Table 2

Sample: information contained in the learning outcomes matrix required for all COSMA programs (COSMA, 2023-2024)

Identify Each Student Learning Outcome and Measurement Tool(s)	Identify Benchmark	Total Number of Students Observed	Total Number of Students Meeting Expectation	Assessment Results: Percentage of Students Meeting Expectation	Assessment Results: Does not meet expectation Meets expectation Exceeds expectation Insufficient data
SAMPLE SLO 1 – Solve problems using critical thinking.					
Internship Evaluation rubric (indirect)	100% of students will receive scores of 4 or higher				
Senior Capstone Project rubric (direct)	100% of students will receive scores of 80/100 or higher				

The text of the SLOs and assessment measures is a rich source of information. This information will allow its holder to derive a Bloom's Wheel like the one in this exemplar. It is important to consider the size and scope of the analysis within the context of available data/ In this case, there were 35 accredited institutions, with 53 total programs (34 undergraduate, 16 master’s, and three doctoral). Due to the large dataset, a 20% sample was used in the generation of the Bloom’s Wheel, allowing for a manageable data analysis process. To create a random sample, all degree programs were numbered 1-53. The numbers were then entered into a random number generator, and the first 20% of programs were selected for analysis. Because no doctoral program was included in the initial 20% sample, the first doctoral program on the list was also included. In sum, 11 programs were selected via random number generation, with one program intentionally added such that the doctoral programs were represented in the sample (eight undergraduate, three master’s, and one doctoral). Depending on the size of the sample being analyzed, the entire dataset may be utilized, or a random representative sample may be utilized. If a random sample is utilized, it is important to ensure representation across degree and program type.

Designing a Coding Scheme

This process uses content analysis methodology, in which the qualitative data (text SLOs and measures in this case) is processed through a methodical evaluation of the verbiage to generate quantitative data (Columbia Mailman School of Public Health, overview, 2025). Ultimately, in this case, inferences about the nature of SLO-measure dyad alignment are found and used to create a Bloom’s Wheel. In this style of analysis, the qualitative data (SLOs, measures, program type, etc.) are subjected to a coding scheme designed by the assessment professional developing a Bloom’s Wheel. The coding scheme allows the assessment professional to categorize the qualitative data into a quantitative analog for ease of further statistical analysis. The coding scheme needs to be aligned with the guiding questions identified at the outset by the assessment practitioner. To begin identifying the SLO-measure dyads, the assessment professional must first identify a primary source of body text (e.g., Bloom’s Wheel) used to identify which assessment measures are anticipated to be aligned with various levels of the taxonomy. This primary source could be any of the expert-designed Bloom's Wheels available. Upon selecting primary source material, the assessment professional must design a coding system in which specific verbs and measures are identified and assigned numbers to enter into a spreadsheet or table. The numbers serve as proxies for the corresponding category. The authors recommend using numbers for the Bloom’s level alignment codes, for ease of analysis, as the numbers can easily be sorted in data-processing software into their hierarchical order. If the assessment professional is planning to do a great deal of statistical analysis, including running tests for reliability (discussed in the limitation section of this manuscript), the authors recommend using a numeric code.

If the assessment professional plans to use Excel and pivot tables, codes could include the first letter or full name of the Bloom’s level, which makes recognition of a level easier. If full words or letters are used rather than numbers, it is important to ensure that the code is comprehensive enough to capture multiple measures (e.g., “case study” vs. “case study on sport marketing”) so that categories do not become exclusive, and to ensure that spelling and grammar match in each cell for data analysis. Another challenge to using words or letters as codes rather than numbers is that this use may increase the size of the dataset. A disadvantage of utilizing the number coding system is that the codes will need to be reverted back to text in the ultimate data visualization of the wheel. For more in-depth reading on the history and practice of quantitative and qualitative content analyses, the authors recommend Babbie (2020) and Wildemuth (2017).

Sample Bloom's Wheel Creation: Coding Scheme

In the example case of the analysis of COSMA-accredited programs, the primary source of body text for the coding scheme used was the Quinnipiac University Online Programs Bloom's Wheel (Table 1) due to its tabular format. The example case was designed to answer multiple guiding questions, such as: Which measures are most often aligned with which Bloom's level? Once the primary source material and guiding question were in place, the coding scheme was developed to include all the necessary information to answer the guiding question. The coding scheme identifies each column that will need to be added to the original data collection table.

Coding Scheme:

A. Assign a unique code ID number to each SLO-measure dyad.
B. Extract the highest-level measurable verb from the SLO. When an SLO has multiple verbs (double-barreled), the highest-order verb is used (more on this methodology can be found in Bender & Maxwell, 2024).
C. Codes for the Bloom's Taxonomy level for highest-level measurable verbs from Quinnipiac University Online Programs (n.d.)
   - 0 – Remember (cite, collect, count, clarify, define, examine, enumerate, find, identify, label, list, memorize, recall, recognize, show, state)
   - 1 – Understand (ask, associate, cite, classify, compare, describe, discuss, exemplify, interpret, recall, report, select, summarize, state, tell)
   - 2 – Apply (administer, apply, calculate, choose, demonstrate, examine, execute, experiment, illustrate, implement, instruct, interpret, modify, operate, prepare, solve, sketch, use)
   - 3 – Analyze (analyze, appraise, arrange, calculate, categorize, classify, compare, contrast, connect, criticize, diagram, deconstruct, differentiate, discriminate, divide, examine, explain, experiment, infer, order, organize, outline, question, select, separate)
   - 4 – Evaluate (appraise, assess, argue, choose, compare, critique, conclude, convince, decide, discriminate, defend, estimate, evaluate, explain, establish, grade, interpret, judge, justify, measure, predict, prioritize, prove, rank, recommend, rate, select, support, summarize, test, value)
   - 5 – Create (arrange, assemble, combine, compose, create, construct, design, develop, describe, explain, formulate, generalize, integrate, invent, make, manage, modify, modify, organize, plan, prepare, rearrange, rewrite, set-up, substitute)
   - 6 – other
D. Codes for assessment measure type derived from Quinnipiac, not comprehensive of all measures from Quinnipiac but established within the context of a cursory review of measures used in the dataset:
   - 0 – test, multiple choice
   - 1 – test, other
   - 2 – written report
   - 3 – case study
   - 4 – problems
   - 5 – presentation
   - 6 – report

7 – projects
8 – oral supervisor feedback
9 – other

E. Codes for the SLO-measure dyad alignment.
   0 – no
   1 – yes
F. Include full Program Name
G. Codes for program level:
   0 – undergraduate
   1 – master's
   2 – doctoral
H. Codes for institutional alignment:
   0 – College of Business
   1 – College of Science
   2 – College of Arts and Letters
   3 – Graduate School

Analyzing the data

Once coding is completed, the next step is analyzing the data collected. This is a multi-phased process beginning with categorical data to understand the number and types of measures occurring across campus and concluding with data that represents the intersection between Bloom's levels and measures, aligned as demonstrated in Table 3.

First, the assessment professional should assign a numerical ID to each SLO-measure dyad and assign any codes to the other categorical data being collected (i.e., program level, department). Then, they must read and analyze the SLOs' highest-level measurable verbs according to the scheme and assign the numerical codes for the aligned Bloom's level to the SLOs in an additional column. There may be some measurable verbs that do not align with any of the pre-defined Bloom's level categories, and in that case, the Other code can be assigned. Then, the measures are analyzed and designated in the same way. Once each SLO-measure dyad is assigned a code, the analysis continues by identifying whether the assigned Bloom's level of the SLO is aligned with the measure type per the primary source. This step is important so that only aligned measures are included in the Bloom's Wheel. Non-aligned measures are well-suited for further exploration. Finally, any further analyses can be conducted to answer the guiding questions, for example, by sorting and grouping by program level, institutional alignment, etc.

Tables 3.1 and 3.2 are examples of the coded data where each row is an SLO-measure dyad, and its code is alignment is the final piece of data.

Table 3

Sample Data Analysis Table

SLO and Measure #	SLO Measurable Verb	SLO Taxonomy Category	Measure Definition	Aligned According to Quinnipiac Map	Program Name	Program Level	Institutional Alignment	Bloom's Level and Measure Definition Alignment
Enter Number	Enter Text	Enter Corresponding numerical code	Enter Corresponding numerical code	Aligned According to Quinnipiac Map	Enter text of program name	Enter Corresponding numerical code	Enter Corresponding numerical code	Enter corresponding numerical code
Enter Number	Enter Text	Enter Corresponding numerical code	Enter Corresponding numerical code	Aligned According to Quinnipiac Map	Enter text of program name	Enter Corresponding numerical code	Enter Corresponding numerical code	Enter Corresponding numerical code

Table 3.1

Sample Dyad

	SLO Text	Measurable Verb	Measure Definition	Program Name	Program Level	Institutional Alignment
SLO & Measure Number 1	Construct a business plan	Construct	Students will be evaluated using a case study where they are asked to create a business plan	Theme Park Design	Bachelor's	College of Business

Table 3.2

Sample Dyad

SLO and Measure #	SLO Measurable Verb	SLO Taxonomy Category	Measure Definition	Aligned According to Quinnipiac Map	Program Name	Program Level	Institutional Alignment	Bloom's Level and Measure Definition Alignment
1	Construct	5	3	1	Theme Park Design	0	0	1

Sample Bloom's Wheel Creation: Data Analysis

In the example case of COSMA-accredited programs, the SLOs and measures were coded per the scheme listed above. Data were then analyzed to answer the guiding questions and create an empirically designed Bloom's Wheel. To answer the guiding questions, data were sorted in MS Excel, and pivot tables were created. Here, verbs used in the data set that did not align with a Bloom's Taxonomy level according to the coding scheme were grouped together for further research (Table 4).

Table 4

Sample Data from COSMA collection

ID	Program Level	Total SLO #	Program SLO #	SLO Measure number	SLO Verb	SLO taxonomy category Quinnipiac	Measure Type	Measure actual type	Measure description	Measure description Other	Rubric	Aligned
1	0	1	1	1	Demonstrate	2	2	1	8	Content Coverage	1	0
2	1	7	1	1	Demonstrate	2	0	0	7	Project	1	1
3	0	14	3	2	Utilize	6	2	0	2	Paper	3	0

Designing the Product: An Empirically Derived Bloom's Wheel

The creation of the empirically designed Bloom's Wheel comes from converting the numerical data back to the full text (verbs and measures) so that the final product identifies the SLOs and assessment measures at the various Bloom's levels. Since prior investigations of assessment measures have found them to be poorly aligned (Larsen et al., 2022), it is essential to focus on the assessment measures being used by programs that were assigned the code for "Yes" for alignment of the SLO-measure dyad.

The easiest way to complete the final product is to begin with a user-friendly format, so the authors recommend that the assessment professional first create a final product based on the Bloom's Wheel tabular format. The assessment professional can collate the listed SLO measure dyads aligned to each level in the table for easier interpretation. Starting within the analysis table, the data should be sorted into ascending taxonomy level order. Then, the assessment professional can sort the measurable verbs within each taxonomy level in alphabetical order. Finally, the assessment professional can sort the corresponding measures in ascending order per the coding scheme. As a result, the listed verbs and measures can be added to the user-friendly tabular format of a Bloom's Wheel.

Once the tabular format is complete, the empirically derived Bloom's Wheel can be enhanced by incorporating a visualization component. True to its name, the Bloom's Wheel should be depicted in a circular format as a visually appealing asset that can be easily shared with faculty to engage their interest. Free graphic design software such as Canva can be used to create the wheel. The authors have constructed a template available here. The Bloom's Wheel can be color-coded to use color schemes corresponding to the dataset as well.

Sample Bloom's Wheel Creation: final product

In the example analysis conducted on programs accredited by COSMA, the Bloom's Wheel created includes separate columns for both direct and indirect measures (Table 5).

Table 5

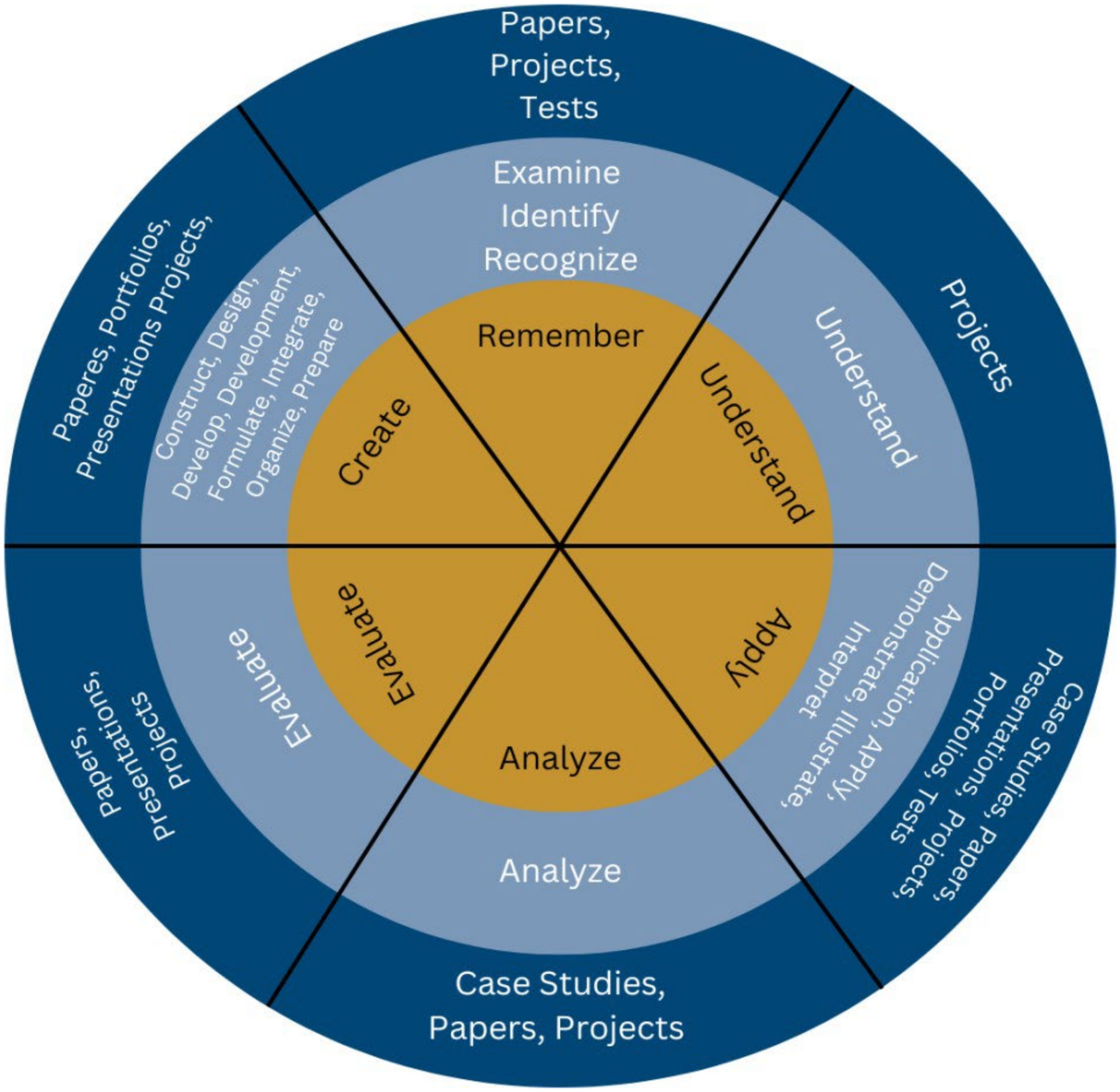
COSMA-Assessment Derived Bloom's Wheel from Sample (Table Format, designed in Microsoft Word)

Taxonomy Level	Possible Verbs	Possible Direct Measures	Possible Indirect Measures
Remember	Examine, Identify, Recognize	Papers, Projects, Tests	
Understand	Understand	Projects	
Apply	Application, Apply, Demonstrate, Illustrate, Interpret	Case Studies, Papers, Presentations, Projects, Portfolios, Tests	Course Evaluations, Exit Surveys, Internship Site Supervisor Evaluations
Analyze	Analyze	Case Studies, Papers, Projects	
Evaluate	Evaluate	Papers, Presentations, Projects	
Create	Construct, Design, Develop, Development, Formulate, Integrate, Organize, Prepare	Papers, Portfolios, Presentations, Projects	
Other	Craft, Display, Employ, Exhibit, Investigate, Perform, Think, Utilize		

The example from the COSMA dataset (Figure 4) uses the COSMA colors for ease of identification.

Figure 4

COSMA-Assessment Derived Bloom's Wheel from Sample (Circular Format, designed in Canva)



Discussion

The methods detailed in this manuscript provide the assessment professional a mechanism to enhance their role as a facilitator/guide to colleagues by empirically deriving a resource related to Bloom's Taxonomy. Creating this resource is accessible to most assessment professionals; the tools needed are not complex or costly, as most institutions have access to basic word and number processing software. The visual components can be created through free resources such as Canva. In addition, the scope and scale of the data utilized to produce such a tool can be increased or decreased based on the capacity of an assessment professional within their specific context. The empirically derived Bloom's Wheel provides greater benefits over a general model and a theory-only-based wheel because it allows for a contextualized depiction of alignment based on extant assessment practice and experience. For example, while an in-depth case study measure may be an ideal assessment tool theoretically to use for SLOs at the Evaluate level, a program may not have a sufficient curricular structure to build such projects into capstone courses due to content coverage. An empirically derived Bloom's Wheel may assist faculty tasked with developing assessment measures to more easily identify meaningful and well-aligned measures for each SLO level, and congruent with the institutional or disciplinary context. In the example case from sport management programs described above, the discipline-specific assessment information inputted into the Bloom's Wheel allows the wheel to serve as a resource for faculty planning in meeting specific accreditation requirements and comparing assessment processes from across the discipline. As such, the empirically derived Bloom's Wheel is well-suited to serve its primary purpose as a resource for faculty and staff, providing a more valid list of verbs and aligned measures.

Because of its development process and the data produced when completing the process, it can serve many other roles to suit assessment professionals. The authors propose that the tool of the empirically derived Bloom's Wheel extends beyond being a faculty resource; it can also serve as a strategy for studying and identifying areas for improvement within an assessment process at an institution or within a discipline. The process of creating the Bloom's Wheel from an existing data set of SLOs and assessment measures will provide the assessment professional with an in-depth understanding of how assessment processes are being implemented for quality assurance and quality improvement purposes. Key among these investigations is the opportunity to produce in-house data and related decision-making related to the alignment of assessment measures with the indicated Bloom's Taxonomy levels. For example, one question elucidated through the empirically derived Bloom's Wheel for sport management was the percentage and number of SLOs that were aligned as intended. Within an institution, the question of percentage of aligned SLOs can be asked and answered to produce reports or other insights to help inform future decision-making. The Bloom's Wheel as a source of information is particularly rich because the wheel itself is derived only from those SLOs and measures that were aligned in accordance with the primary source material. Because of this alignment, a potentially large amount of data from non-aligned SLO-measure dyads is left to analyze, explore, and attempt to remediate.

Also, separate Bloom's Wheels can be created based on degree level if such data were recorded in the data tables. To do so, the degree level variable can be used to sort the analyzed data. Pivot tables can be created, or separate Bloom's Wheels based on degree levels. Comparisons between wheels can be used as an analysis tool to identify whether programs at the undergraduate, graduate, and postgraduate levels are advancing in complexity.

Assessment professionals know that measures that do not capture student learning at the appropriate level do not allow programs to understand whether students have learned what the program intended for specific SLOs. Therefore, filtering to only the misaligned measures and SLOs can allow the assessment professional to target individual programs or disciplines that may need additional support and resources in developing well-aligned assessment plans. Additionally, exploring misaligned SLO-measure dyads that may be demonstrating innovative applications can allow the assessment professional to identify opportunities to deepen understanding of alignment and Bloom's Taxonomy.

Further, providing those writing SLOs and corresponding assessment measures with a tool that outlines aligned verbs and measures related to their specific context (whether it be discipline, college, or university specific) may provide a helpful starting point. Bloom's Wheels and taxonomies are widely available via internet search, and often have a wide range of verbs and measures. Creating an empirically derived wheel allows the assessment professional to suggest SLO-measure dyads that 1) more than a single person agrees aligns (i.e., the source code and the assessment data piece that was coded) and 2) are more narrowly situated to the context. This may alleviate some decision fatigue from those creating assessment plans.

Limitations

Challenges in implementing the processes described in other contexts may occur since most assessment offices consist of a small number of individuals who may not have the time to complete this kind of project institution-wide. For this reason, a single coder was used in the example presented to illustrate this context. Best practice for content analysis includes multiple coders and the establishment of interrater reliability (O'Conner & Joffee, 2020) to provide evidence that the coding scheme is reliable, which purports additional trustworthiness to the interpretations of the data collected via the coding instrument. Indeed, in Bloom's level assignment scenarios, inclusive of the full suite of categories, independent raters are not always in alignment before conversations about specific items or outcomes (Thompson et al., 2013). However, in the pursuit of professional development, organizations such as the Association for the Assessment of Learning in Higher Education, the Student Affairs Assessment Leaders, and the Grand Challenges in Assessment provide an environment of connection through which professionals can partner with other assessment professionals to produce work such as this. Raters could be trained on a single sample to gain acceptable inter-rater reliability and then code the remainder of a sample or body of programs at their home institutions.

Another challenge facing an assessment professional taking on this project is the possible scope of data included in the initial development of Bloom's Wheel. In this example case presented, a random sample of programs was used to create a manageable scope to complete the exemplar. This strategy, while resulting in a wheel based on a limited amount of data, does allow for a reliability check. After such a wheel has been created, it can be used as a tool for additional sets of data. This allows the practitioner to test the accuracy of the wheel and further refine any catchall "other" categories while adding additional measures, as necessary.

A final point of limitation to consider when pursuing the development of an empirically derived Bloom's Wheel is that the extant data might not have a high degree of initial alignment. As noted in the literature review, attempts to document Bloom's levels aligned with assessment measures with faculty members have not always been successful. Most faculty members and staff, when beginning their roles, have not had formal educational training. As such, the assessment measures that they produce may not begin with a high level of alignment. So, it is imperative for coders and assessment professionals to have increased awareness of the nuances of Bloom's Taxonomy and practice discernment in assigning the terms used in the wheel. In potential cases where none of the extant assessment report information includes aligned verbs and assessment measures, this process can still provide a unique opportunity for an assessment professional to leverage this finding to seek resources to increase opportunities for training for faculty and staff.

Future Research

Further investigation of the ways in which the empirically derived Bloom's Wheel is used by faculty within their institutional and disciplinary contexts needs to be explored. These investigations can and should include explorations of the contextual factors that enable or challenge the production of the Bloom's Wheel, such as support from leaders and institutional centralization of assessment reporting. The literature supports that using an empirically derived tool might help improve assessments: an empirically derived tool for aligning assessment based on Bloom's Taxonomy, along with the Zoller (1993) model of order of cognitive skills, has been demonstrated to be useful by faculty members (Crowe et al., 2017). This tool helped faculty to write specific examination questions aligned with the desired Bloom's level and more meaningfully analyze exam data (Crowe et al., 2017). Future research should explore if a Bloom's Wheel can produce the same results.

Bloom's is not the only taxonomy of learning utilized in higher education, although we assert that it is the dominant one used among higher education professionals. Some challenges have been well-established with the use of Bloom's, such as the non-linear nature of learning, which is skewed by the commonly utilized pyramid model of Bloom's Taxonomy which implies learning happens in the order of the categories of cognitive skills (Suskie, 2018). Other taxonomies, such as Wiggins and McTighe's Understanding by Design (2008), Fink's Taxonomy of Significant Learning (2003), and Biggs' and Collin's Structure of the Observed Learning Outcomes Taxonomy (1982), would be ideal targets for creating wheels (i.e., "wheeling"). The literature indicates that faculty are inconsistent in assigning taxonomic levels to assessment measures beyond only Bloom's Taxonomy (Coleman, 2017). The authors propose that an assessment professional can engage with the same process (i.e., content analysis) for these other taxonomies, and future investigations of empirically derived resource development, potentially including student-facing resources.

Generative artificial intelligence (AI) may provide a useful tool in future research. Machine learning applications for evaluating individual assessment measures for Bloom's level alignment have a high potential based on initial accuracy tests (Das et al., 2020; Das et al., 2022). Therefore, an AI tool can serve as an additional rater when generating the Bloom's Wheel and assigning levels to SLOs and categories to assessment measures. AI could also be used to more accurately identify the potentially aligned Bloom's level of verbs that were initially coded as "other." Combined, an empirically derived Bloom's Wheel and AI may allow faculty to create more meaningful and aligned assessment tools to improve student learning.

Conclusion

Assessment professionals serve many roles in higher education institutions and have needs that are unique based on their context. One universal role, identified through interview and survey research, is that of a facilitator/guide for faculty and staff. In fulfilling this role, assessment professionals often seek resources and development opportunities to increase the capacity of their institutional colleges to complete assessment processes with a high degree of impact and return on investment. By engaging with existing assessment reports to build empirically derived assessment tools, such as the Bloom's Wheel described in this manuscript, assessment professionals can contribute to the scholarly pursuit of their practice and continue to contribute to improving student learning.

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