Achieving the Civil Engineering Body of Knowledge in the Affective Domain

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The American Society of Civil Engineers (ASCE) Civil Engineering Body of Knowledge Task Committee (CEBOKTC) recently completed the third edition of the Civil Engineering Body of Knowledge (CEBOK3). This edition the Civil Engineering Body of Knowledge describes 21 outcomes and levels of achievement that are required for entry into the practice of civil engineering at the professional level. These outcomes are grouped in four categories; Foundational, Engineering Fundamentals, Technical, and Professional. Levels of achievement in the cognitive domain are defined for all 21 outcomes, while achievement in the affective domain is defined for only seven of the 21 outcomes. This paper summarizes the committee's rationale for explicitly addressing achievement in the affective domain in the CEBOK3 and for addressing only seven of the 21 outcomes in the affective domain. It provides insight into how the levels of achievement were defined and discusses how comments received during the final public comment period were addressed in the final version of the CEBOK3. Unlike the cognitive domain where objective measures can be developed to determine a level of achievement for an outcome, the affective domain deals with an individual's values and attitudes, concepts that are difficult to measure objectively. As a result, this paper is devoted to describing potential mechanisms by which one could demonstrate achievement at various levels in the affective domain for both academic and work settings. A section of the paper is also devoted to describing how achievement in the affective domain could be expanded to other outcomes currently defined in the CEBOK3.

Introduction

The authors of this paper were members of an American Society of Civil Engineers (ASCE) Task Committee created to revise the Civil Engineering Body of Knowledge, officially termed the Body of Knowledge 3 Task Committee (CEBOK3TC). The purpose of this paper is to provide a general overview of ASCE activities that led to the third edition of the Civil Engineering Body of Knowledge (CEBOK3), provide a brief discussion of the educational taxonomies adopted in the 3rd Edition of the Civil Engineering Body of Knowledge, and to discuss specifically the incorporation of the affective domain in assessing attainment of the BOK outcomes and how one might demonstrate attainment.

ASCE has been engaged in defining and refining a body of knowledge for civil engineers for nearly 20 years in support of its Policy Statement 465 - Academic Prerequisites for Licensure and Professional Practice [1]. The Society published the first Civil Engineering Body of Knowledge (CEBOK) in 2004. In that document, a distinguished group of educators and

practitioners, who formed the Body of Knowledge Committee, outlined the general knowledge all civil engineers should possess for entry into the professional practice of civil engineering. The document defined 15 distinct outcomes that would be achieved through a combination of education and engineering work experience at the time of licensure [2]. Further, a prescribed level of attainment was defined for each outcome. The levels of attainment loosely followed the Taxonomy of Educational Objectives in the Cognitive Domain created by Bloom and his colleagues in 1956 [3]. In the first edition of the BOK, only the equivalent of the lowest three levels of Bloom's Taxonomy (recognize, understand and apply) were used. While there was no mention of assessment in the affective domain, the first edition alluded to attitudes and values an engineer must possess to enter the professional practice of civil engineering.

When ASCE published the second edition of the Civil Engineering Body of Knowledge (CEBOK2) in 2008, the number of desired outcomes was increased from 15 to 24 [4]. These outcomes were organized into three categories; foundational, technical and professional. Attainment levels in the cognitive domain were developed for each of the 24 outcomes and were defined by working statements that covered all six levels of Bloom's Taxonomy for the cognitive domain. Target levels of attainment were defined for the various stages along the path to entry into the professional practice of civil engineering, then defined as professional licensure. Progressive levels of attainment were defined at the completion of the baccalaureate degree, the completion Master's degree or 30 credit hours beyond the baccalaureate degree (plus 30), and through engineering experience [4]. While the CEBOK2 Task Committee crafted attainment statements in the affective domain for certain outcomes that were similar in format to the statements for cognitive achievement, it concluded that the ability to measure attainment in the affective domain was far less certain than measuring attainment in the cognitive domain and chose to relegate the assessment in the affective domain to an advisory appendix of the CEBOK2.

ASCE reconstituted the ASCE Task Committee on the Body of Knowledge in early 2016 and selected a mixture of seasoned practitioners and educators as members. The committee's initial charge was to determine if there was a need for the creation of a 3rd edition of the CEBOK. Committee members attempted to identify new concepts and developments in the practice of civil engineering that were not addressed ten years earlier in CEBOK2. The committee decided collectively that there was sufficient change in practice to warrant a 3rd edition of the Body of Knowledge for Civil Engineers (CEBOK3). While the committee identified several new outcomes and the need for revisiting several existing outcomes, it felt that it needed the broader perspective of the general membership of ASCE on what a revised CEBOK should look like. As a result, a survey was designed to encourage the membership of ASCE to rank order the importance of the existing 24 outcomes of CEBOK2 and to identify the need for new emphasis areas or outcomes. This survey was sent to a large and diverse population of ASCE members. Based on the results of the survey, a pre-draft list of desired outcomes tentatively grew from 24 to 36. Due to the nature of some of the proposed outcomes, and comments regarding some

existing outcomes, the BOK3 Task Committee felt that a number outcomes required not only cognitive knowledge of the outcome, that is the recognition of knowledge at successively higher intellectual levels, but also assessment in the affective domain, which demonstrates a sense of ownership or internal valuing of the outcome. Hence the committee resurrected idea of assessing each outcome in the affective domain, using the Taxonomy of Education Objectives Volume II - Affective Domain [5] as a guide.

History of Educational Taxonomies

Much of the information presented in this section is a summary of that presented by Dennis, Hains and Brandes [6] and is provided here for completeness in describing educational taxonomies in general and specifically the development and description of the affective domain taxonomy.

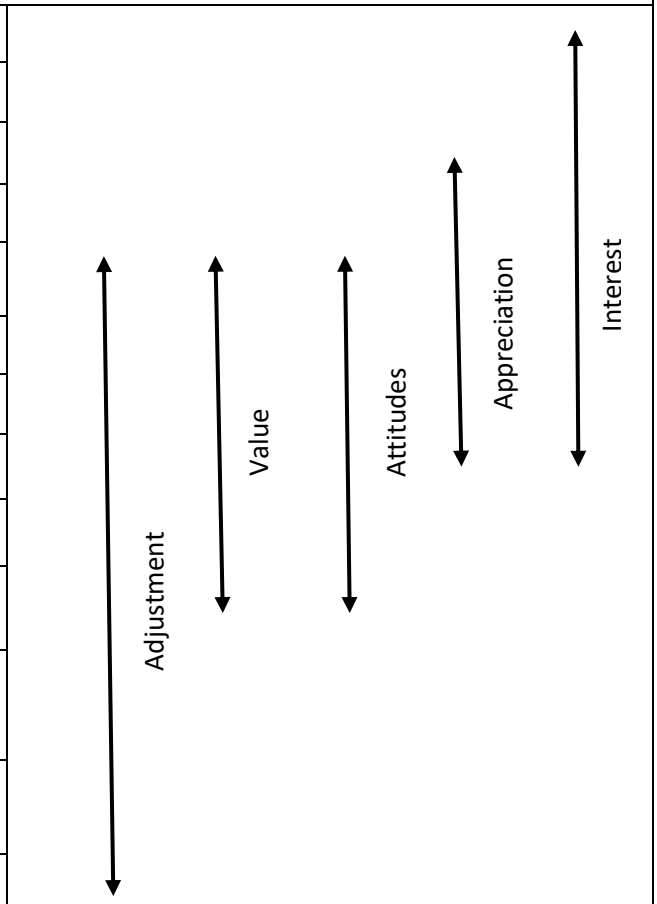
Frameworks for assessing intellectual and emotional development have existed since at least the late 1800s, but a common framework and language that defined activities and concepts to effectively classify and assess intellectual and emotional development across the disparate groups in education did not exist [7]. In the mid-twentieth century a group of educational examiners, (state and federal employees who create standardized tests to assess educational development of students in primary and secondary schools) led by Benjamin S. Bloom, committed themselves to create this common framework. They met annually as a working group through the late 1940s and early 1950s to create a common framework for the characterization and assessment of educational activities. Their goal was to create a common hierarchal set of terms and language that characterized educational objectives in a uniform and repeatable way.

The publication describing their early work presented the concept of three domains of educational activities. Those domains included the cognitive, which deals with the recognition of knowledge and the progressive development of intellectual abilities; the affective domain, which describes changes in interests, attitudes, and values; and the psychomotor domain, which categorizes manipulative or motor skills [3]. While the group found ample evidence in the literature to support development of a common framework in both the cognitive and affective domains, they found little research to support a common framework in the psychomotor domain. Given that previous research found the relationship between cognitive achievement and attitudes and values were poorly correlated [8], the group chose to first focus on the cognitive domain. Thus, the 1956 publication of this group provided a thorough description of the cognitive domain and established six levels of successively higher intellectual development. In addition, various key words were suggested to describe activities that might be associated with attaining a particular level of intellectual development. The work in the cognitive domain by Bloom and his colleagues served as a seminal work in curriculum development for many years, with a number of researchers either developing refinements to the implementation of the taxonomy or deriding the taxonomy as having only limited benefit in assessing intellectual development, (see the work of Ormell, Roberts or Seddon [9][10][11], to mention a few).

Major revisions to Bloom's taxonomy did not occur until 2001 when Anderson and Krathwohl proposed a revision to the hierarchy (i.e., by reversing the order of *synthesis* and *evaluation*), added a new dimension describing cognitive processes associated with each level of the taxonomy, and added a category of metacognitive knowledge [12]. All of these revisions were considered and rejected by the CEBOK2 Task Committee, who chose to use the original taxonomy to prescribe the levels of attainment for the 24 outcomes of CEBOK2. The CEBOK3 Task Committee concurred with the reasoning of the CEBOK2 Task Committee, believing that an engineer must first be able to create something before he or she could evaluate the creations of others. Thus, *evaluate* remained at the top of the hierarchal pyramid. The CEBOK3 Task Committee also felt that the addition of the dimensions of cognitive processes and metacognitive knowledge added an unnecessary complexity to determining a level of attainment for each outcome of the CEBOK3.

A subset of the original group of examiners, led by David Krathwohl, chose to continue working for several more years to seek evidence to support the development of a taxonomy in the affective domain. The examiners found a large body of evidence to suggest that teachers regarded achievement in the cognitive domain to be public in nature and had no hesitation to assign a grade on the basis of performance. On the other hand, teachers felt that it was not appropriate to evaluate students based on their interests, attitudes, or character development, feeling these were more private in nature and certainly more difficult to assess [5]. Their work over the next eight years in organizing and categorizing behaviors in the affective domain ultimately resulted in the description of a continuum of activities ranging from simply being aware of a concept or phenomenon to completely internalizing the concept or phenomenon and making it a part of one's outlook on life [5]. The classification scheme developed by Krathwohl and his colleagues is briefly summarized in Table 1. Table 1 presents a collection of affective activities that represent an internalization continuum where level one, *receiving*, is the lowest level of internalization and level five, *characterization by a value complex* is the highest. *Receiving* is the most basic level of the continuum and is achieved when the engineer is simply made aware of material, ideas or phenomena and may or may not be willing to tolerate them. *Responding* is when an engineer is willing to participate in active discussion and perhaps question these new ideas or concepts in an attempt to better understand them. *Valuing* is when the engineer commits to a concept or idea and practices it because a perceived benefit can be derive or possibly because it is the right thing to do. *Organization* occurs when the engineer assigns a value to an idea or concept and internalizes it as a constant in their personal behavioral philosophy by developing a prioritization scheme that is based on resolving conflict between contrasting values. *Characterization* occurs when the engineer acts consistently in accordance with the values that they have internalized. The highest level of the value system then forms consistent behavior at this level under all circumstances. Also illustrated in Table 1 is a set of affective behaviors that are associated with the continuum of activities. It is generally accepted that one's set of values are not significantly adjusted until one is at least willing to respond to or accept a concept or phenomenon. Tables 2 and 3 offer simplified definitions of the activities and

Table 1. Levels of Internalization in the Affective Domain (Adapted from Krathwohl, et.al.,[5])

	Level of Internalization	
1 Receiving	1.1 Awareness	
	1.2 Willingness to receive	
	1.3 Selected Attention	
2 Responding	2.1 Acquiescence in Responding	
	2.2 Willingness to Respond	
	2.3 Satisfaction in Responding	
3 Valuing	3.1 Acceptance	
	3.2 Preference for a Value	
	3.3 Commitment	
4 Organization	4.1 Conceptualization of a Value	
	4.2 Organization of a Value System	
5 Characterization by a Value Complex	5.1 Generalized Set	
	5.2 Characterization	

possible examples of actions that would signify attainment of a particular level on the continuum. Just as in the cognitive domain, the affective domain has a list of action verbs that can be used in defining activities and actions for each level of the domain. Table 4 presents a partial list of those verbs.

Final CEBOK3 Outcomes

As previously stated, the pre-draft list of desired outcomes from a combination of CEBOK2 and the ASCE member survey included 36 unique outcomes. Initially, every member of the CEBOK3TC was assigned two or three outcomes with a charge of creating an attainment rubric in both the cognitive and affective domains, along with a rationale statement for inclusion of the outcome in the 3rd edition of the Civil Engineering Body of Knowledge (CEBOK3). Committee members completed their assignments individually and briefed the other members on their

Table 2. Simplified Definitions of Activities in the Affective Domain Continuum

Level	Definition
Receiving	Being aware of or attending to something in the environment.
Responding	Exhibit some new behaviors as a result of experience.
Valuing	Display some definite involvement or commitment.
Organization	Integrate a new value into one's general set of values, giving it some ranking among one's general priorities.
Characterization by Value	Act consistently with the new value.

Table 3. Actions Demonstrating Levels of Attainment for Ethics in the Affective Domain

Level	**Example**
Receiving	Individual reads a book passage and recognizes the relationship to ethical behavior.
Responding	Individual participates in a discussion about the book, reads another book by the same author or another book about ethical behavior, etc.
Valuing	The individual demonstrates acceptance of the concept by voluntarily attending a lecture on ethical behavior.
Organization	The individual organizes a study session for other students on topics related to ethical behavior.
Characterization by Value	The individual is firmly committed to the value of ethical behavior, being able to commit to ethical behavior in a wide variety of situations; potentially becoming a public advocate of a revised or new code of ethics for his or her profession.

Table 4. Partial List of Action Verbs Appropriate for Each Level of the Affective Domain

Receiving	Responding	Valuing	Organization	Characterization by Value
Acknowledge	Complete	Accept	Codify	Affect
Attend	Comply	Apply	Discriminate	Attest
Aware	Cooperate	Defend	Display	Confirm
Develop	Discuss	Devote	Order	Corroborate
Identify	Examine	Pursue	Organize	Internalize
Receive	Obey	Seek	Systematize	Substantiate
Recognize	Respond	Support	Weigh	Verify

product via weekly teleconferences. At the conclusion of this development and telephonic briefing exercise the committee came together for two days in in late 2017 for a face-to-face meeting to determine which outcomes would be included in the CEBOK3. The goal of the meeting was to reduce the number of outcomes to a manageable and practical level. Based on deliberations during this meeting, responses from the member survey, and persuasive discussion among committee members, several of the existing CEBOK2 outcomes were eliminated. Notably, globalization, public policy, business and public administration, and contemporary issues and historical perspectives were eliminated as stand-alone outcomes. Additionally, some of the existing 24 outcomes were recast to include elements of suggested new areas without explicitly creating a new outcome. Examples include: the outcome ‘Experiments’ in the CEBOK2 became ‘Experimental Methods and Data Analysis’ in CEBOK3 to include a new suggested outcome of data analytics; ‘Problem Recognition and Solving’ in the CEBOK2 became ‘Critical Thinking and Problem Solving in CEBOK3; and ‘Attitudes’ in theCE BOK2 became ‘Professional Attitudes’ in CEBOK3. Through this process of combination, elimination and aggregation of concepts, the number of outcomes was ultimately reduced to 21 in the final version of the CEBOK3. As in the CEBOK2 the outcomes are grouped into categories. While the CEBOK2 grouped the outcomes into three categories the CEBOK3 Task Committee elected to divide the 21 outcomes into four categories as illustrated in Table 5 [13].

Table 5 Civil Engineering Body of Knowledge Outcomes (Third Edition) [13]

Foundational	**Engineering Fundamentals**
1 Mathematics	5 Materials Science
2 Natural Sciences	6 Engineering Mechanics
3 Social Sciences	7 Experiment Methods & Data Analysis
4 Humanities	8 Critical Thinking & Problem Solving
Technical	**Professional**
9 Project Management	16 Communication
10 Engineering Economics	17 Teamwork & Leadership
11 Risk & Uncertainty	18 Lifelong Learning
12 Breadth in Civil Engineering Areas	19 Professional Attitudes
13 Design	20 Professional Responsibilities
14 Technical Depth	21 Ethical Responsibilities
15 Sustainability	

Initially the committee attempted to classify all 21 outcomes in both the cognitive and affective domains. Again, individual committee members were assigned an outcome and tasked to create a set of attainment levels for the outcome in both the cognitive and affective domains. The success of this exercise, however, was mixed. All members were able to easily create an attainment rubric in the cognitive domain, but only about half of the members were able to create an attainment rubric for the affective domain. Some members, especially those assigned the fundamental or technical outcomes, cited the parallelism between the suggested action verbs in the affective and cognitive domains as the chief reason for their inability to create two separate rubrics. For example they felt that *comply,* a verb indicating attainment at the second level in the affective domain, and *apply* or *use,* verbs indicating attainment at level three in the cognitive domain, signaled the same or similar behavior. As a result of this exercise, the full committee elected to specify attainment levels for all 21 proposed outcomes in the cognitive domain, but only the six professional outcomes and the technical outcome of sustainability were classified in the affective domain.

Once the decision was made on what outcomes would be classified in each domain, individual committee members drafted statements to define actions that would indicate attainment for each level in both cognitive and affective domains. These statement were reviewed among committee members multiple times during the development phase. An additional task was to establish target levels of attainment along the path to entry into professional practice of civil engineering. The work of the individual members was reviewed by the full committee where modifications were made to outcome statements and in some cases the level of attainment and the pathway to fulfillment were changed by the full committee. Finally, an editing subcommittee reviewed all of the outcome statements for both the cognitive and affective domains to produce a unified set

of outcome statements that were consistent with the concepts and key words from Krathwohl's Taxonomy for the Affective Domain [5] and Bloom's Taxonomy for the Cognitive Domain [3].

The information presented in Tables 6 through 12 for outcomes in the affective domain represents the demonstrated behaviors in the affective domain that the CEBOK3TC felt a civil engineer must possess and the manner in which each level of attainment is fulfilled for those outcomes assessed in the affective domain. The highest level of attainment in the unshaded and bold outlined region of the tables is the level that a civil engineer should attain for entry into the professional practice of civil engineering. Any level appearing in the shaded region is considered to be beyond the level necessary for entry into the practice of civil engineering at the professional level and would be attained through post entry level experience or education. The committee created three new pathways to attainment for both the cognitive and affective domains, which did not appear in CEBOK2, namely:

- Post Graduate Education (PG) - a replacement for the Master's or plus 30 designation in CEBOK2 and indicates formal education beyond the baccalaureate degree;
- Mentored Experience (ME) - experience gained under the mentorship of an engineer who has already satisfied the BOK requirements for entry into professional practice; and
- Self Directed (SD) - a program of learning initiated and pursued by the individual.

Two of these new pathways, in addition to the existing Undergraduate Education (UG) pathway appear in Tables 6-12. It should be noted that the listed pathways in these tables are only typical pathways and are not the only way a particular level can be attained.

Motivation for Assessing Outcomes in the Affective Domain

The 2006 ASCE Summit on The Future of Civil Engineering - 2025 [14] portrayed the engineer of the future to be knowledgeable, skillful, and one who embraces attitudes conducive to professional practice. While the first two attributes are conveniently measured in the cognitive domain, attitudes most often are a reflection of one's value system and, as such, outcomes related to attitude should be measured in the affective domain. Additionally, the U.S Department of Labor's Engineering Competency Model [15] describes the Tier I: Personal Effectiveness Competencies in terms such as: shows sincere interest, maintains open communication, values an inclusive environment, accepts responsibility, establishes trust, shows concern, and encourages others and demonstrates global, social and intellectual responsibility. While these phrases are not all directed to technical outcomes, they clearly point to the professional outcomes identified in the CEBOK3 and are all affective domain behaviors.

Even the original CEBOK Task Committee concluded that knowledge and skills measurable in the cognitive domain, while necessary, were not sufficient to be a fully functioning professional

Table 6. Demonstrated Abilities for CEBOK3 Outcome 15 - Sustainability

Affective Domain Level of Achievement	Demonstrated Ability/Evidence of Achievement	Fulfilled Through
1 – Receive (be aware of, be willing to receive, and be attentive to a particular phenomenon or behavior)	**Acknowledge** the importance of sustainability in the practice of civil engineering. Any evidence that the topic is covered in the curriculum.	Undergraduate Education
2 – Respond (actively participate in an activity, attend to a task, and react to motivation)	**Comply** with the concepts and principles of sustainability in the practice of civil engineering. Reflection piece on why concepts of sustainability were incorporated into a design. Participation in a service learning project which incorporated sustainability concepts.	Undergraduate Education
3 – Value (attach value to a particular object, phenomenon, or behavior)	**Value** the benefits of sustainability in the practice of civil engineering. Resume evidence that elements of sustainability have been considered and used in civil engineering projects.	Mentored Experience
4 – Organize (sort values into priorities by contrasting different values, resolving conflicts between them, and creating a unique value system)	**Integrate** a commitment to sustainability principles in everyday practice. Resume evidence that sustainability principles are considered in every project.	Self-Directed
5 – Internalize (follow a value system that controls behavior that is pervasive, consistent, predictable, and a defining characteristic)	**Advocate** for principles of sustainability.	

Table 7. Demonstrated Abilities for CEBOK3 Outcome 16 - Communication

Affective Domain Level of Achievement	Demonstrated Ability/Evidence of Achievement	Fulfilled Through
1 – Receive	**Acknowledge** the importance of effective and persuasive communication to technical and nontechnical audiences. Reflection piece on the importance of effective communication.	Undergraduate Education
2 – Respond	**Practice** effective and persuasive communication to technical and nontechnical audiences. Multi-modal presentation to a non-technical audience.	Undergraduate Education
3 – Value	**Value** effective and persuasive communication to technical and nontechnical audiences. Portfolio of documents illustrating persuasive communication.	Mentored Experience
4 – Organize	**Display** effective and persuasive communication to technical and nontechnical audiences. Resume evidence of persuasive presentations.	Self-Directed
5 – Internalize	**Advocate** for effective and persuasive communication to technical and nontechnical audiences.	

Table 8. Demonstrated Abilities for CEBOK3 Outcome 17 - Teamwork and Leadership

Affective Domain Level of Achievement	Demonstrated Ability/ Evidence of Achievement	Fulfilled Through
1 – Receive (be aware of, be willing to receive, and be attentive to a particular phenomenon or behavior)	**Acknowledge** the importance of teamwork, leadership, diversity and inclusion. Reflection piece on the ramifications of poor leadership.	Undergraduate Education
2 – Respond (actively participate in an activity, attend to a task, and react to motivation)	**Practice** concepts and principles of teamwork, leadership, diversity and inclusion. Peer assessment on leadership and teamwork assignments.	Undergraduate Education
3 – Value (attach value to a particular object, phenomenon, or behavior)	**Value** the need for teamwork, leadership, diversity and inclusion. Resume evidence of participation on diverse teams and increasing leadership responsibilities.	Mentored Experience
4 – Organize (sort values into priorities by contrasting different values, resolving conflicts between them, and creating a unique value system)	**Display** effective teamwork and leadership, including support of diversity and inclusion. Resume evidence of creating and leading diverse teams.	Self-Directed
5 – Internalize	**Advocate** for teamwork and leadership, diversity and inclusion.	

Table 9. Demonstrated Abilities for CEBOK3 Outcome 18 - Lifelong Learning

Affective Domain Level of Achievement	Demonstrated Ability/Evidence of Achievement	Fulfilled Through
1 – Receive	**Acknowledge** the need for lifelong learning. Reflection piece on the importance of lifelong learning or how one could demonstrate lifelong learning.	Undergraduate Education
2 – Respond	**Participate** in lifelong learning opportunities. Assignment requiring original research or literature review. Attendance at technical seminars or extracurricular events.	Undergraduate Education
3 – Value	**Value** lifelong learning in the practice of civil engineering. Resume evidence of continuing education and or professional development activities.	Mentored Experience
4 – Organize	**Establish** a lifelong learning plan to support one's own professional development. Resume evidence of sustained continuing education or professional development hours.	Self-Directed
5 – Internalize	**Advocate** for lifelong learning in the practice of civil engineering.	

Table 10. Demonstrated Abilities for CEBOK3 Outcome 19 - Professional Attitudes

Affective Domain Level of Achievement	Demonstrated Ability/Evidence of Achievement	Fulfilled Through
1 – Receive	**Acknowledge** professional attitudes including creativity, curiosity, flexibility, and dependability in the practice of civil engineering. Reflection piece on the ramifications of failing to adhere to the principles of professional behavior.	Undergraduate Education
2 – Respond	**Practice** professional attitudes including creativity, curiosity, flexibility, and dependability in the practice of civil engineering. Peer and instructor assessment of professional behaviors when working in teams.	Undergraduate Education
3 – Value	**Value** professional attitudes including creativity, curiosity, flexibility, and dependability in the practice of civil engineering. Resume evidence that professional attitudes incorporated in the everyday work environment.	Mentored Experience
4 – Organize	**Establish** professional attitudes including creativity, curiosity, flexibility, and dependability in the practice of civil engineering. Resume evidence of a creation of an environment where positive professional attitude is rewarded.	Self-Directed
5 – Internalize	**Advocate** for professional attitudes including creativity, curiosity, flexibility, and dependability in the practice of civil engineering.	

Table 11. Demonstrated Abilities for CEBOK3 Outcome 20 - Professional Responsibilities

Affective Domain Level of Achievement	Demonstrated Ability/Evidence of Achievement	Fulfilled Through
1 – Receive	**Acknowledge** professional responsibilities relevant to the practice of civil engineering, including safety, legal issues, licensure, credentialing, and innovation. Evidence that these topic are covered in the curriculum.	Undergraduate Education
2 – Respond	**Examine** professional responsibilities relevant to the practice of civil engineering, including safety, legal issues, licensure, credentialing, and innovation. Summarize the analysis of failure case studies to show the impact of professional responsibilities on project design and delivery.	Undergraduate Education
3 – Value	**Value** professional responsibilities relevant to the practice of civil engineering, including safety, legal issues, licensure, credentialing, and innovation. Resume evidence of practicing in an environment where these responsibilities are taken seriously and implemented.	Mentored Experience
4 – Organize	**Form judgements** about professional responsibilities relevant to the practice of civil engineering, including safety, legal issues, licensure, credentialing, and innovation. Resume evidence of creating an environment where these responsibilities are taken seriously and implemented.	Self-Directed
5 – Internalize	**Advocate** for professional responsibilities relevant to the practice of civil engineering, including safety, legal issues, licensure, credentialing, and innovation.	

Table 12. Demonstrated Abilities for CEBOK3 Outcome 21-Ethical Responsibility

Affective Domain Level of Achievement	Demonstrated Ability/Evidence of Achievement	Fulfilled Through
1 – Receive	**Acknowledge** the importance of ethical behavior in the practice of civil engineering. Reflection piece on the ramifications of not following a code of ethics.	Undergraduate Education
2 – Respond	**Comply** with the ASCE Code of Ethics and statutory requirements. Adhering to institution's academic integrity or code of conduct policies.	Undergraduate Education
3 – Value	**Value** ethical behavior in the practice of civil engineering. Resume evidence of attending ethics training or participating in open discussions on ethical behavior.	Mentored Experience
4 – Organize	**Adhere** to ethical behavior in accordance with the ASCE Code of Ethics and statutory requirements. Resume evidence of conducting ethics training or leading discussions on the importance of ethical behavior.	Mentored Experience
5 – Internalize	**Advocate** for ethical behavior in the practice of civil engineering.	Self-Directed

civil engineer. A civil engineer's attitude, that is, the manner in which he or she approaches and values his or her work, determines how effectively he or she uses knowledge and skills. Additionally, the authors of the Vision for Civil Engineering in 2025 [14] concluded that attitude was an essential part of the CEBOK. Yet the CEBOK2 Task Committee did not address how to assess attitude nor did it describe any level of attainment. While the CEBOK2 Task Committee did address a methodology to address attitudes through the affective domain and even

established an attainment matrix for certain outcomes, they concluded that mechanisms to assess attainment in the affective domain would be ill-defined and it would be difficult to create a uniform assessment specification. Instead, the CEBOK2 Task Committee elected to create a separate, standalone outcome, *Attitudes*; however, the levels of attainment for the *Attitude* outcome were described entirely within the cognitive domain [3]. Based on the above considerations and other evidence in the literature the CEBOK3TC was motivated to reconsider attainment of CEBOK outcomes in the affective domain.

Achieving the CEBOK3 in the Affective Domain

From an instructional perspective, Duczyminski [16] points out that, regardless of topic, affective outcomes are often closely related to deeper levels of thinking. Students engaged in a subject who recognize its value, can exhibit a change of attitude, and ultimately achieve a consistent behavior. A fundamental teaching principle is to connect a topic to events or activities to which students can relate. Establishing the importance of a particular topic by making connections to everyday life allows students to form an opinion on the value of the topic to them personally. The authors have used videos or photos of failures and associated case studies to introduce a topic and promote interest, perhaps even excitement, about the topic among their students. For example, when introducing the topic of consolidation settlement, a photo of the Palace of Fine Arts in Mexico City, which has settled nearly four meters in the last century, making the original first floor the basement, is a dramatic motivator. Of course, students believe that modern engineering has certainly solved this settlement problem, so fast forward to the Millennium Tower in San Francisco which has settled over 0.5 meters in just the last decade and has had plenty of press coverage in the past three or four years. Thus, settlement is still an issue civil engineers must deal with. Civil engineering faculty are extremely fortunate in that they can find numerous examples in virtually every sub-discipline of our profession of a problem or failure where engineer(s) did not value the design process or fundamental principles which contribute to it. While the knowledge is certainly available, the value proposition to gather the information necessary to apply the knowledge is often ignored. Hopefully, appealing to the students' learning in the affective domain establishes the need for responding to an issue beyond the cognitive outcomes. A number of academics have recognized the need to supplement cognitive learning with affective outcomes to promote deeper learning and have incorporated specific learning strategies to accomplish this [17],[18],[19]. Bielefeldt [19], for example, used project based learning and project based service learning to reach the synthesis level in the cognitive domain and the valuing level and the organization level in the affective domain. These findings clearly suggest that students learn deeper when affective outcomes are addressed in addition to cognitive outcomes. Properly conducted cooperative and cooperative learning activities can certainly motivate students to consider the value of a topic in addition to the intellectual content of the topic. Brown [20] suggests that educators should consider the following questions to determine how effective these activities can be in affecting a student's value system:

- How are activities or tasks designed to make students perceive they are valuable?
- What support relationships do you have in place to ensure students have a clear understanding of tasks and procedures?
- What evidence do you have that students experience a direct relationship between their interests and the instructional tasks they are assigned?
- What evidence do you have that students volunteer opinions and feel that they are valued contributors to the work?
- What evidence do you have that students express enthusiasm and assurance they can be successful in completing the tasks they are given.

Failure to sense the learning climate in the classroom can make even the best intentioned collaborative learning activities a negative rather than a positive experience in affective domain for students.

Collecting evidence of achievement in the affective domain can be a daunting task if relying on direct assessment techniques. Noting the concerns of Krathwohl and his colleagues [5], students will provide responses to direct questions that correspond to what they believe instructor wants, rather than what they truly feel. On the other hand, indirect measures, such as one-on-one interviews, small group interviews, well designed climate surveys, portfolio content analysis, and written, video or audio taped student reflection pieces often provide more insight into how student attitudes have been affected through various learning activities.

Assessment of affective outcomes may be difficult to achieve in the work place through formal assignments to employees. However, employers should use tools like climate surveys and formal mentor relationships to assess the attitude of their employees on a wide variety of topics, including the CEBOK. Mentors should stress actions and activities that demonstrate an inculcation of a value system for professional behavior. Just as an engineer progresses to higher levels of cognitive development through work experience, employers should create a culture of positive professional and technical behavior to which employees can aspire. While Lynch [21] suggests there is overlap between the affective and cognitive domains, especially at the lower levels of attainment in each domain, he and his colleagues point out that in addition to overlap, there is synergy among the two domains throughout all levels. The two domains can express concern about different aspects of a topic, and clearly, knowledge about something is different than internalization of a value related to it. They conclude that value in professional action is an attribute that qualifies an engineer for entry into the practice of civil engineering at the professional level and it must be developed through both the educational and experiential processes. The need to create assignments and work related activities that afford the individual civil engineer an opportunity to express their own level of internalization are critical for their attainment of these outcomes in the affective domain.

Tables 6-12 provide examples of how attainment of various levels in the affective domain could be documented. The middle column in each table contains a statement regarding potential

evidence that could be used to demonstrate attainment of a particular level. While the outcomes achieved through formal education can be assessed or demonstrated through creative assignments, those levels attained through mentored experience, or self-direction would only be demonstrable through some sort of resume evidence. It is therefore important that educators and practitioners alike recognize the need for creating an environment that emphasizes the need for positive behaviors in each of these outcomes and encourage civil engineers to maintain portfolios which demonstrate their achievement in both the affective and cognitive domains.

Affective Domain for Additional Outcomes

Clearly, more outcomes can and should be classified in the affective domain. The professional outcomes are simply the low hanging fruit that were easy to classify in this first real venture into formally incorporating the affective domain into the CEBOK3. Engineers often lament that they see no need for instruction in the humanities and social sciences. Obviously, these areas, among others, are not well valued. If the profession believes these areas and outcomes are important in the cognitive domain, educators and practitioners need to find ways to connect this foundational knowledge to the creation of socially responsible as well as safe and economical solutions to problems. As an example of expanding the classification of other outcomes in the affective domain, Table 13 illustrates a parallel comparison of attainment statements for two the technical outcomes of *risk and uncertainty* and *design* in both the cognitive and affective domains. The action verbs selected to describe behavior at a given level of attainment in both domains were taken from lists provided in the original taxonomies [3],[5]. However, it should be noted that the action verbs selected for attainment in the affective domain are not necessarily those that appear in the final version of the CEBOK3. The actions of the editing subcommittee to reduce the number of action verbs used in both domains in an attempt to harmonize the attainment statements for all outcomes may have resulted in the perception among the committee that attainment statements in the affective domain tended to look like attainment statements in the cognitive domain, especially at the lower levels of attainment. Table 13 demonstrates that using a larger set of action verbs makes it possible to craft statements in one domain that focus on the progression of knowledge and intellectual development, and statements in the other domain that focus on the value and internalization of that knowledge in solving engineering problems. Perhaps, the next edition of the Civil Engineering Body of Knowledge will contain a set of outcomes that will be achieved in both the cognitive and affective domains.

Next Steps

As with previous editions of the CEBOK it is anticipated that a task committee will be created to compare the existing ABET criteria with the outcomes of the CEBOK3 to determine how the civil engineering program criteria may need to be modified to ensure all outcomes of the CEBOK3, which are attained through formal education at the baccalaureate level, are being addressed through a combination of the ABET general criteria and the civil engineering program criteria. Crafting a program criteria that incorporates attainment in the affective domain was

made easier by the CEBOK3TC through its harmonizing effort in selecting action verbs and because attainment levels for all outcomes assessed in the affective domain are at the level of 'Responding'. While Tables 6-12 provide examples of how evidence could be collected to demonstrate attainment of a particular level, the examples are by no means exhaustive. It will be incumbent on both faculty and employers to created mechanisms within the affective domain to move civil engineers to higher levels of internalization and incorporation into a value system for all outcomes of the CEBOK3, even if they are not formally addressed in the published document.

Table 13. Proposed Attainment Statements for Technical Outcomes in the Cognitive and Affective Domain

Outcome Level Descriptor Affective/Cognitive		**1—Receiving/ Remember**	**2—Responding/ Comprehend**	**3—Valuing/ Apply**	**4— Organizing/Analyze**	**5— Characterization/ Synthesize**	**6 -/Evaluate**
Risk and Uncertainty	Affective-	Be **aware** of uncertainties and variabilities in data and knowledge relevant to engineering design and project management.	**Acknowledge** the differences between uncertainties that are data-based and knowledge-based.	**Support** the application of the principles of probability and statistics to solve problems containing uncertainties.	**Weigh** the impacts of uncertainties on the demand and capacity of a well-defined system and project management.	**Advocate** criteria for the ill-defined design of an engineered system or project management to manage the risk.	
	Cognitive	**Identify** concepts and principles of probability, statistics and risk relevant to civil engineering.	**Explain** concepts and principles of probability, statistics and risk relevant to civil engineering.	**Apply** concepts and principles of probability and statistics to determine risk relevant to civil engineering.	**Select** appropriate concepts and principles of probability and statistics to analyze risk in a complex civil engineering problem.	**Integrate** risk analyses into the solutions to complex civil engineering problems.	**Assess** the acceptability of the risks associated with solutions to complex civil engineering problems.
Design	Affective	Be **aware** of the factors involved in the engineering design process	**Examine** codes, standards and constraints related to engineering design.	**Comply** with design principles and requirements in the solution of an engineering problem.	**Discriminate** between design alternatives based on client need, realistic constraints and responsibility to the public.	**Advocate** for responsible engineering designs which address concerns for public safety, sustainability and societal impact.	
	Cognitive	**Define** engineering design and the engineering design process.	**Explain** engineering design and the engineering design process.	**Apply** the engineering design process to a given set of requirements and constraints to solve a complex civil engineering problem.	**Analyze** a complex civil engineering project to determine design requirements and constraints.	**Develop** an appropriate design alternative for a complex civil engineering project that considers realistic requirements and constraints.	**Evaluate** design alternatives for a complex engineering project for compliance with customary standards of practice, user and project needs, and relevant constraints.

Note: There are six levels of attainment in the cognitive domain and only five levels in the affective domain.

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