

Department Head Perspectives on the Current CEPC and the BOK3

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Civil Engineering Department Head Perspectives on the Civil Engineering Program Criteria and the Body of Knowledge, 3rd Edition

Abstract

The American Society of Civil Engineers (ASCE) Body of Knowledge 3 Task Committee has finalized and will soon publish the third edition of the Civil Engineering Body of Knowledge (BOK3). The second edition was used in development of the Civil Engineering Program Criteria (CEPC) that have been in effect since the 2016-17 accreditation cycle. In similar fashion, the BOK3 will provide information that will be used in the next review of the CEPC, scheduled to begin in October 2020. The Civil Engineering Department Heads can provide valuable feedback on the importance of, and effort required to implement, the BOK3 undergraduate outcomes and ABET Civil Engineering Program Criteria (CEPC). Results and analysis of feedback gathered from the Civil Engineering Department Heads are presented in this paper.

A survey addressing the BOK3 outcomes was developed using SurveyMonkey and delivered through ASCE's Department Head Collaborate online community. The intent of the survey was to capture the perspectives of civil engineering educators and leaders as related to the BOK3 and the CEPC. For each of the 21 outcomes listed in the BOK3 and individual curricular topics included in the CEPC, respondents were asked to provide feedback on:

1. importance of the Outcome, and
2. ease of implementing an Outcome or curricular topic into their existing civil engineering curriculum.

The survey collected demographic information to characterize the program and institution (e.g., program size, public versus private, highest degree granted). Responses were examined to identify any differences in feedback provided. A total of 82 unique and complete survey responses were obtained. Feedback from Civil Engineering Department Heads provided important insight that will assist the ASCE education community in its work, and will assist in the next review and if needed, revision, of the CEPC.

Introduction

Programs accredited under the Engineering Accreditation Commission of ABET, Inc. must satisfy the EAC/ABET General Criteria as well as specific program criteria written by the appropriate lead technical society. Any engineering program with a program name that includes the word "civil" (or similar modifier) must satisfy the Civil Engineering Program Criteria. The American Society of Civil Engineers (ASCE) serves as the Lead Society for the Civil Engineering Program Criteria [1]. The EAC/ABET General Criteria and the Civil Engineering Program Criteria define the minimum requirements for accreditation of Civil Engineering programs.

ASCE's Committee on Accreditation (COA) has adopted an eight year cycle for reviewing and revising the civil engineering program criteria. The plan for long term management of change was discussed by Ressler and Lynch [2]. To initiate the cycle, the ASCE Committee on Education (COE) assembled a Task Committee to review the current Civil Engineering Body of Knowledge (BOK) and to determine if revisions are needed. The BOK defines the knowledge, skills, and

attitudes necessary for entry into the practice of civil engineering at the professional level. Once a new BOK is published, COA appoints a Civil Engineering Program Criteria Task Committee (CEPCTC), which is charged with reviewing the criteria in place, and if needed, revising the criteria using the new BOK, input from the civil engineering community, and other relevant information. The BOK is developed based on an extensive review of the scholarly literature, relevant visionary documents, and by identifying the needs of the profession with input from, and review by, practitioners and educators. The BOK also reflects the strategic goals of ASCE and is approved by the ASCE Board of Direction. As such, use of the BOK to develop the Civil Engineering Program Criteria ensures that the needs of, and strategic goals for, the profession are reflected in the minimum requirements established for Civil Engineering programs.

As shown in Table 3 of the paper by Ressler and Lynch [2], the 2nd Edition of the BOK (BOK2) was published in 2008, the CEPCTC was formed in October 2012, and draft Civil Engineering Program Criteria were published for review in March 2014. The first reviews under the new criteria took place in September 2016. As part of their work, the CEPCTC also developed a “Commentary” on the new Civil Engineering Program Criteria to help guide programs and ABET Program Evaluators in interpretation of the Program Criteria [3].

The 3rd edition of the BOK (BOK3) was completed in Fall 2018 and is scheduled for release in May 2019 [4]. The ASCE Committee on Accreditation is expected to convene a new Civil Engineering Program Criteria Task Committee, whose work on reviewing and if needed, revising, the Program Criteria, is scheduled to begin in October 2020. Draft criteria are scheduled for publication in March 2022. The first ABET reviews under the new criteria will take place in September 2024.

The BOK2 and BOK3 were developed as part of a systematic process [2], [4], and [5] using a scholarly and well-documented approach, including broad input from across the civil engineering profession, and considering the changing needs of the civil engineering profession [6]. Recognition of the need for a civil engineering body of knowledge is supported through the American Society of Civil Engineers (ASCE) Policy Statement 465 (Academic Prerequisites for Licensure and Professional Practice), that begins with the statement: “The American Society of Civil Engineers (ASCE) supports the attainment of the Civil Engineering Body of Knowledge for entry into the practice of civil engineering at the professional level, i.e., practicing professional engineer, through appropriate engineering education and experience, and validation by passing the licensure examinations.” [7]. At its meeting in October 2017, the ASCE Board of Direction members affirmed that achieving the BOK outcomes is equally important and applicable for all civil engineers, regardless of their plans to pursue licensure (Personal communication).

The Body of Knowledge and Civil Engineering Program Criteria have been responsive to ASCE’s strategic priorities and goals. For example, inclusion of sustainability and consideration of risk and uncertainty in the current CEPC were directly responsive to ASCE’s strategic goals at the time, namely, promoting sustainability, and safe and resilient infrastructure. Hains and O’Connor [8] present a case for using the BOK3 to support ASCE’s “Grand Challenge” of enhancing the performance and value of infrastructure projects over their life cycles [9].

Based on lessons learned from development of the Civil Engineering Program Criteria, Estes et al. [10] compared the BOK2 outcomes to outcomes and curricular elements included in the ABET General Criteria and Civil Engineering Program Criteria. Their recommended changes included consideration of some outcomes (e.g., Materials Science; Risk and Uncertainty) and the level of attainment of some outcomes (e.g., Sustainability) to reduce the gaps existing between the BOK and ABET criteria. In preparing the BOK3, Fridley et al. [11] reviewed over 50 publications and found that many sources affirmed many outcomes presented in the BOK2, but that revision and clarification were needed. Some outcomes were missing from the BOK2, and needed to be considered for addition, but none of the outcomes in the BOK2 required removal.

BOK2 Elements Reflected in the Civil Engineering Curriculum

The Civil Engineering Program Criteria in effect for reviews conducted up to and including 2015 – 2016 accreditation cycle [12], the curriculum portion of the Civil Engineering Program Criteria read:

“The program must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science, consistent with the program educational objectives; apply knowledge of four technical areas appropriate to civil engineering; conduct civil engineering experiments and analyze and interpret the resulting data; design a system, component, or process in more than one civil engineering context; explain basic concepts in management, business, public policy, and leadership; and explain the importance of professional licensure.” (ABET 2014)

For the 2016 – 2017 cycle [13], the Civil Engineering Program Criteria were revised to what is currently in effect:

“The *curriculum* must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science; *apply probability and statistics to address uncertainty; analyze and solve problems* in at least four technical areas appropriate to civil engineering; conduct experiments in at least two technical areas of civil engineering and analyze and interpret the resulting data; design a system, component, or process in at least two civil engineering contexts; *include principles of sustainability in design*; explain basic concepts in project management, business, public policy, and leadership; analyze issues in professional ethics; and explain the importance of professional licensure.” (ABET 2018)

The two major changes, italicized above, were related to risk and uncertainty and to sustainability in design. At the time they were prepared, input from Civil Engineering Department Heads was gathered and used to revise the CEPC [12] currently in use. The motivation for the present study was to gather feedback on the importance of outcomes included in the BOK3 and in the CEPC and on the level of ease with which these outcomes are implemented in the civil engineering curriculum. This information can assist decision makers and the ASCE education community in developing the next CEPC and BOK.

Comparison of BOK2 and BOK3

Upon review of the BOK2 and other documents, including bodies of knowledge from other disciplines, revisions to the BOK2 were deemed appropriate. The BOK3 was developed using a comprehensive process to identify the current and future needs of the civil engineering profession. The differences between the BOK2 and BOK3 are summarized below.

Renaming Outcomes

In the BOK3, outcome titles were changed to reflect the meaning of the outcome and the language currently in use. For example, “Problem Recognition and Solving” (BOK2) was changed to “Critical Thinking and Problem Solving” (BOK3) to highlight the importance of critical thinking for civil engineers. Additionally, this particular name change was made in response to data collected as part of the BOK2 review survey and BOK3 formulation survey wherein respondents noted critical thinking is a necessary skill for civil engineers. The BOK2 Outcome “Mechanics” was changed to “Engineering Mechanics” to emphasize engineering in BOK3. Lastly, the “Experiments” outcome (BOK2) was changed to “Experimental Methods and Data Analysis” (BOK3). An experiment is a procedure employed by civil engineers to determine an unknown, evaluate a hypothesis, demonstrate a fact or provide insight into cause and effect. Although civil engineers must execute experimental procedures, a civil engineer’s ability to select the appropriate experimental method and analyze the data generated by the procedure is key in generating solutions to civil engineering challenges. Thus, the BOK3 Task Committee decided the name should reflect more than experiments and provide insight in the skills and knowledge civil engineers should apply in selecting experimental methods and applying experimentation data in civil engineering design.

Outcomes Removed

Two outcomes present in BOK2 were not included in the BOK3: “Contemporary Issues” and “Historical Perspectives and Globalization.” This decision was made based on constituent input gathered on the BOK2 outcomes and proposed BOK3 outcome in conjunction with critical review of the literature.

New Outcome

The BOK3 contains a new outcome: “Engineering Economics,” which was based on the “Business and Public Administration” and the “Public Policy” outcomes included in the BOK2. Thus, Business and Public Administration as well as Public Policy continue to live on in this outcome and are not viewed as removed outcomes. Input gathered from constituents as part of the BOK3 development process highlighted the importance of engineering economics, which is the common term used for the application of business and economics in engineering projects. As mentioned in the previous section on Renaming Outcomes, the name “Engineering Economics” was intentionally selected to reflect the focus on knowledge and skills civil engineers will apply in making project decisions.

Coupling Outcomes

In the critical review of the BOK2, the BOK3 Task Committee found innate connections between outcomes that created an opportunity to couple BOK2 outcomes into new outcomes. For instance, Teamwork and Leadership were combined as they go hand-in-hand. Engineers frequently work in teams, as either team members or team leaders. Although the skills required for being a team member are different from those of being a team leader, knowledge about each role helps create a successful team.

The BOK2 outcome on “Attitudes” was woven into “Professional Attitudes,” following the intentional act of highlighting engineering and professionalism into the BOK3. The BOK2 acknowledged attitudes as important in influencing project outcomes, recognizing that positive attitudes are essential in professional practice. However, the list of desirable attitudes was long and included items such as confidence, honesty, integrity, judgement, optimism, positiveness, self-esteem, sensitivity, curiosity, and many others [5]. Respondents to BOK3 surveys highlighted the importance of professionalism and the need for civil engineers to be creative, curious, dependable and flexible. These qualities were viewed as professional attitudes, and as such, were woven into the “Professional Attitudes” Outcome.

Although elements of Public Policy and Business and Public Administration were woven into Engineering Economics, other elements were woven into Professional Responsibilities. In BOK3, Professional Responsibilities were defined to include safety, legal issues, licensure, credentialing and innovation. A civil engineer’s primary responsibility is to ensure public health, safety and welfare. To do so, a civil engineer must be aware of legal and regulatory responsibilities shaping civil engineering practice. Credentialing includes licenses and certifications to demonstrate a civil engineers expertise. Credentialing is shaping the civil engineering profession as civil engineers continue to develop their knowledge in their area of practice. Due to the current focus on credentialing, credentialing was included in BOK3. Survey respondents also noted that innovation was a skill and attitude that civil engineers should possess. Innovation is essential for civil engineers to create and advance society. Thus, innovation was included in the BOK3 as an important professional responsibility.

Bloom’s Verb Consistency

In Chapter 2 of the BOK2 report, use of Bloom’s Taxonomy is described as a framework to link BOK outcomes to learning and achievement [5]. Bloom’s Taxonomy emphasizes measurable, action-oriented verbs that are linked to development levels, such that the level of attainment of each outcome can be assessed. In most cases, the action-oriented verbs are mapped to only one level of the taxonomy; however, some action verbs may be appropriately mapped to multiple attainment levels of Bloom’s Taxonomy, which can create confusion in determining the level of attainment desired in achieving the outcome. As such, the BOK3 consistently used verbs used as part of Bloom’s Taxonomy to avoid confusion about the expected level of attainment of the outcome.

Outcome Organization

In the BOK2, outcomes were classified into three categories: foundational (i.e., mathematics, natural sciences, and humanities); technical (i.e., materials science, mechanics, experiments, etc.); and professional (i.e., communication, public policy, lifelong learning, etc.). To emphasize engineering within the BOK3, the outcomes were reorganized into four classifications: Foundational, Engineering Fundamentals, Technical, and Professional. The Foundational Outcomes include mathematics, natural sciences, social science and humanities. The Engineering Fundamentals Outcomes are materials science, engineering mechanics, experiment methods & data analysis, and critical thinking & problem solving. The Technical Outcomes are project management, engineering economics, risk & uncertainty, breadth in civil engineering areas, design, technical depth and sustainability. Finally, the Professional Outcomes include communication, teamwork & leadership, lifelong learning, professional attitudes, professional responsibilities, and ethical responsibilities. The key difference between BOK2 and BOK3 is the reclassification of 4 outcomes from the Technical category into the Engineering Fundamentals category to emphasize the importance of engineering knowledge and skills in BOK3.

Content within the Outcomes

In addition to the other changes to outcome language described above, all other outcomes in the BOK2 were also reviewed and revised, as needed. Two outcomes included in both the BOK2 and BOK3 are shown in Table 1. In the BOK3, numerical methods was included among mathematical concepts all civil engineers should be able to apply at the point of entering the practice of civil engineering. Numerical methods was not specifically identified as part of the mathematics outcome included in the BOK2.

For mathematics, the BOK3 outcomes stress “applying concepts and principles of mathematics” (BOK3) instead of “solving problems in mathematics” (BOK2), recognizing mathematics represents knowledge and skills used to solve challenges faced by civil engineers. Thus, the revised statement provides the context for using the tools instead of solving problems in the discipline. To drive this point home, the outcomes conclude with the phrase, “to solve civil engineering problems.” Similar revisions were made to the other Foundational outcomes.

Table 1. Comparison of BOK3 and BO2 Outcomes Mathematics and Natural Sciences

Outcome	BOK3	BOK2
Mathematics	<u>Apply concepts and principles of mathematics</u> , including differential equations and numerical methods, to <i>solve civil engineering problems</i> .	Solve problems in mathematics through differential equations and apply this knowledge to the solution of engineering problems.
Natural Sciences	<u>Apply concepts and principles of chemistry, calculus-based physics, and at least one other area of the natural sciences</u> , to <i>solve civil engineering problems</i> .	Solve problems in calculus-based physics, chemistry, and one additional area of natural science and apply this knowledge to the solution of engineering problems.

Defining Entry into the Practice

The Civil Engineering Body of Knowledge defines the knowledge, skills, and attitudes necessary for entry into the practice of civil engineering at a professional level. In BOK2, entry into the practice was defined as becoming a licensed professional engineer. Recognizing that many career paths exist for civil engineers and that all paths do not require licensure, the BOK3 Committee intentionally defined entry into the practice of civil engineering at the professional level as “the point at which a civil engineer is eligible for professional licensure.”

Incorporation of the Affective Domain

A major change in the BOK3, as compared to the BOK2, is the inclusion of the affective domain of Bloom’s Taxonomy in addition to the cognitive domain. The cognitive domain describe the ability to recall knowledge while developing intellectual abilities. The affective domain describes the skills involved in internalizing or developing a sense of value for the human experience. The BOK2 focused on a civil engineer’s cognitive development as evidenced by the action verbs incorporated into the outcome statements. As civil engineers, knowledge and intellectual abilities are critical in addressing civil engineering challenges; however, the BOK3 Committee believed that in order to be successful in achieving the outcome, a civil engineer must also value and appreciate the outcome. Thus, the affective domain was included for the outcomes in the Professional Outcome category plus sustainability. The outcomes described using both the cognitive and affective domains are sustainability, communication, teamwork & leadership, lifelong learning, professional attitudes, professional responsibilities, and ethical responsibilities. In reviewing these outcomes, they could be considered highly personal and likely to vary from one individual to another. As such, they are valued and appreciated.

Pathway to Achievement Redefined

In the BOK2, the paths to fulfillment of the outcomes include a combination of (1) a baccalaureate degree in civil engineering, (2) a master’s degree, or 30 coordinated graduate or upper-level undergraduate semester credits, or equivalent courses providing equal quality or rigor, and (3) appropriate experience based on technical and professional practice guidelines [5]. In BOK3, the typical pathway for fulfilling the outcomes has four components (1) undergraduate education, (2) post-graduate education, (3) mentored experience, and (4) self-development. The significant addition to BOK3 is the addition of self-development. In addition to adoption of the affective domain, the self-development component of the fulfillment pathway encourages civil engineers to personalize and internalize the outcomes of the BOK3 and develop plans to achieve these outcomes.

Methods

Feedback from Civil Engineering department Heads and Chairs was collected using a survey administered on the SurveyMonkey platform. The survey included a short description of the intent of the study, followed by 13 items, described as follows. The first 4 items collected program demographics associated with the respondent’s academic department (public/private, average annual number of civil engineering program graduates, highest degree offered, and the program’s

next scheduled ABET visit). The 5th item queried the respondent's level of knowledge with respect to ASCE's Body of Knowledge. Items 6 and 7 were optional and collected the name of the respondent's academic institution and the respondent's name. Items 8 – 11 were all structured in a similar manner. For those items, a table of BOK3 Outcomes was provided together with descriptions of the expected level of attainment. For example, the Depth in Civil Engineering Area Outcome description was stated at Bloom's Level 2. Respondents were asked to rate the importance of the individual Outcome to civil engineering education (1 – 5 Likert scale ranging from “not important” to “very important”) and ease of implementation into the civil engineering curriculum (1 – 5 Likert scale ranging from “very difficult to incorporate” to “very easy to incorporate”). Outcomes were grouped as Cognitive Domain – Foundational Outcomes (4 total Outcomes), Cognitive Domain – Engineering Fundamentals Outcomes (4 total Outcomes), Cognitive Domain – Technical Outcomes (7 total Outcomes), and Cognitive Domain – Professional Outcomes (6 total Outcomes). Outcome groupings and achievement level descriptions mirror the BOK3 format and definitions. After each Outcome rating, Items 8 – 11 also included an open text box to allow respondents to provide additional comments.

Item 12 provided a list of the 10 ABET Civil Engineering Program Criteria. Respondents were asked to rate the importance of each component to civil engineering education and the ease of implementation into the civil engineering curriculum (using the same 5-point Likert scale as was utilized in Items 8 – 11). An open text box was also provided as part of Item 12. Finally, Item 13 provided one more open text box and encouraged respondents to provide any additional comments related to the importance and/or ease of implementation of the BOK3 Outcomes and/or the ABET Program Criteria.

Survey Distribution

The survey was released on November 7, 2018 and remained open for 62 days. The survey was posted on the Civil Engineering Department Head's Collaborate site (shared discussion board managed by ASCE) and was also sent directly to active civil engineering program department heads. A total of 90 individuals initiated responses, but only 91% provided complete and valid survey responses, resulting in a survey population (n) of 82 responses. The average time spent completing the survey was just over 13 minutes.

Results

Eighty two unique and complete responses were obtained for the survey. ABET identifies a total of 252 accredited civil engineering programs [14]. Representatives of 212 of those programs are connected to the Collaborate system, yielding a survey response rate of approximately 32%.

Approximately 72% (59/82) of the respondents were affiliated with public academic institutions and the remaining (23/82) were affiliated with private academic institutions (see Figure 1). Approximately equal numbers of participants were from institutions with 11 – 30 civil engineering graduates per year up to those with more than 100 students. None of the respondents reported programs with fewer than 11 annual graduates (see Figure 2). A doctoral degree was reported as the highest degree offered in ~83% (68/82) of the respondents' programs, a master degree was reported as the highest in ~10% (8/82), and a bachelor's was reported as the highest in ~7% (6/82)

(see Figure 3). Dates of the respondents' next comprehensive ABET review ranged from 2019 to 2024 (see Figure 4). Only 43 respondents opted to provide the name of their academic institution and only 38 respondents chose to provide their name. This optional information was only used to confirm that multiple entries were not made for individual academic institutions.

All respondents reported having at least some familiarity with the Civil Engineering Body of Knowledge. In addition, ~48% (39/82) reported that they used BOK2 Outcomes to inform parts of their civil engineering program curriculum, while ~11% (9/82) reported that their civil engineering program fully incorporates the BOK2 Outcomes (see Figure 5).

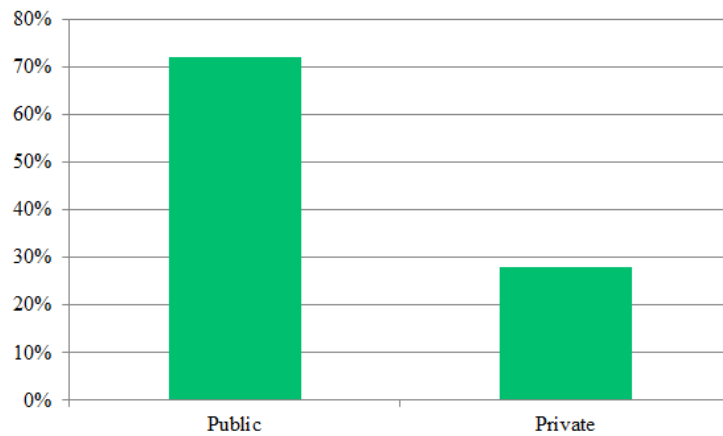


Figure 1. Type of Academic Institution

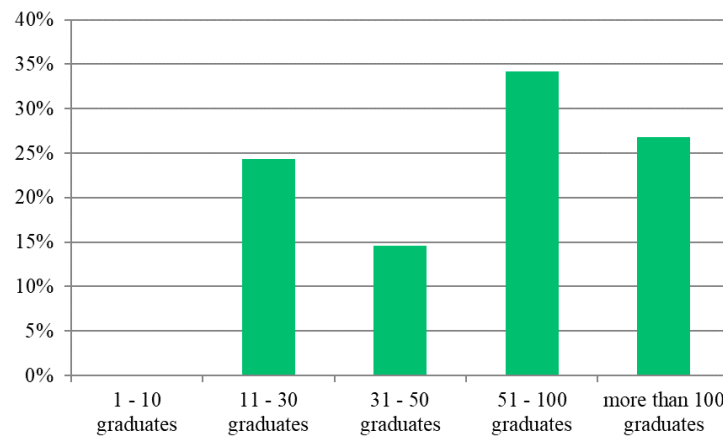


Figure 2. Average Annual Number of Civil Engineering Program Graduates

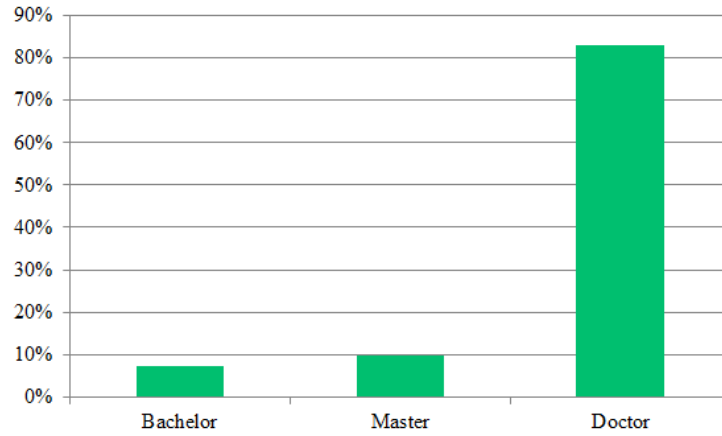


Figure 3. Highest Degree Offered

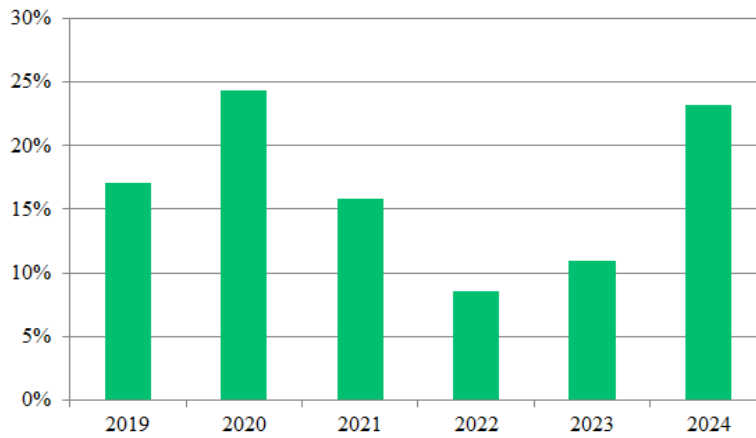


Figure 4. Program's Next Scheduled ABET Visit

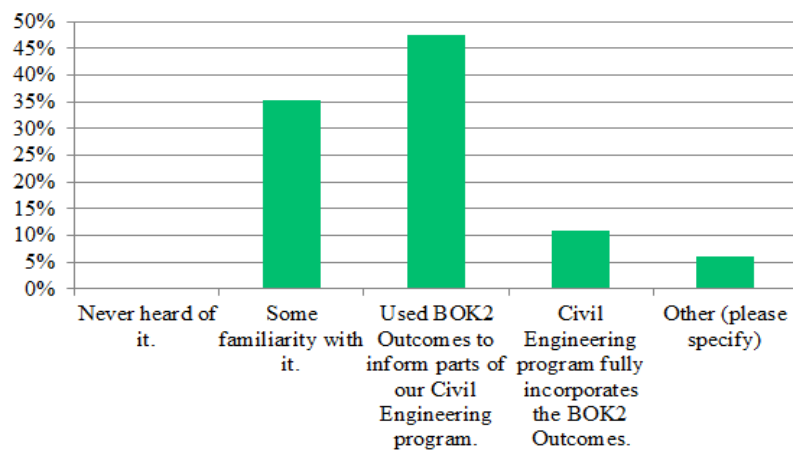


Figure 5. Respondents' Knowledge of ASCE's Body of Knowledge

Summaries of the respondents’ assessments of the importance of individual Outcomes to civil engineering education are shown in Figures 6 to 9. It should be noted that Outcomes were evaluated in their four classifications used in the BOK3. Thus, it is possible that the perceived importance could be influenced by other Outcomes in that same grouping, but it is unlikely that any individual Outcome was influenced by Outcomes beyond that group. For example, the Foundation Outcomes were considered as a group and it is possible that the perceived importance of individual Outcomes within this group may have influenced other rankings within the group.

As shown in Figures 6 to 9, over 50% of the respondents rated mathematics, natural sciences, materials science, engineering mechanics, experiment methods and data analysis, critical thinking and problem solving, design, technical depth, communications, teamwork and leadership, lifelong learning, professional attitudes, professional responsibilities, and ethical responsibilities as being “very important.” The remaining Outcomes included a broader distribution of rankings but as shown in Figures 6 – 9, the level of importance of these outcomes was consistently rated as above “neutral.”

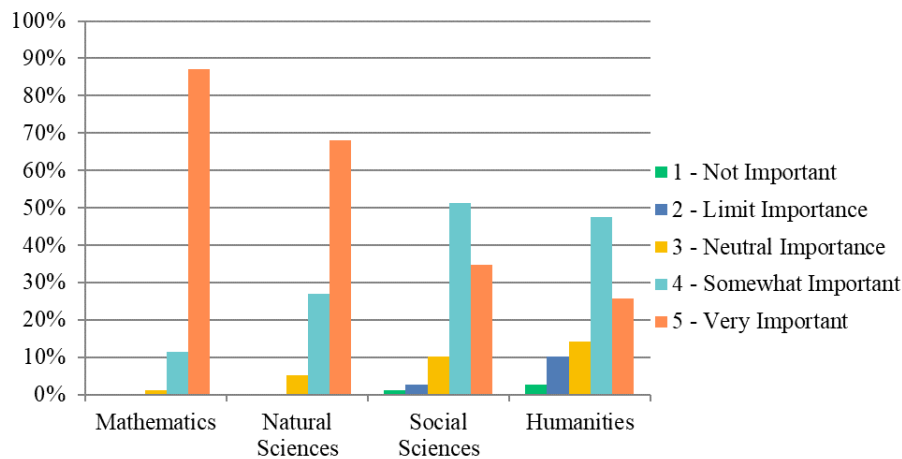


Figure 6. Foundational Outcomes - Importance to Civil Engineering Education

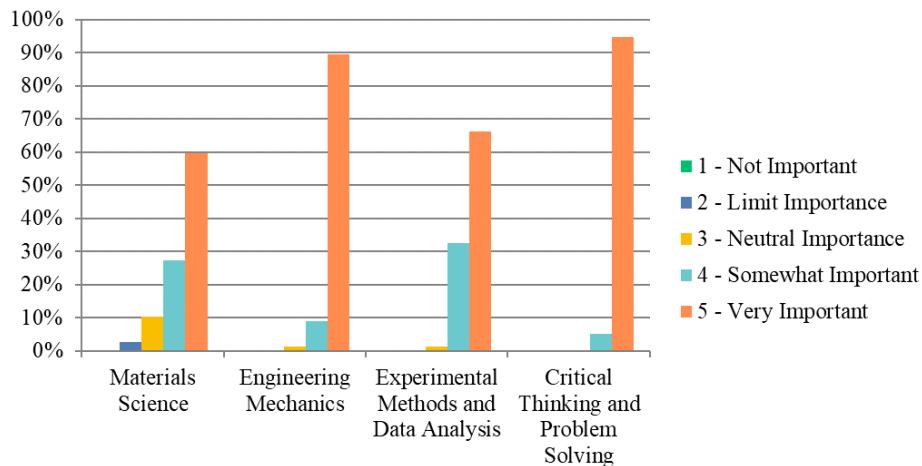


Figure 7. Engineering Fundamentals Outcomes - Importance to Civil Engineering Education

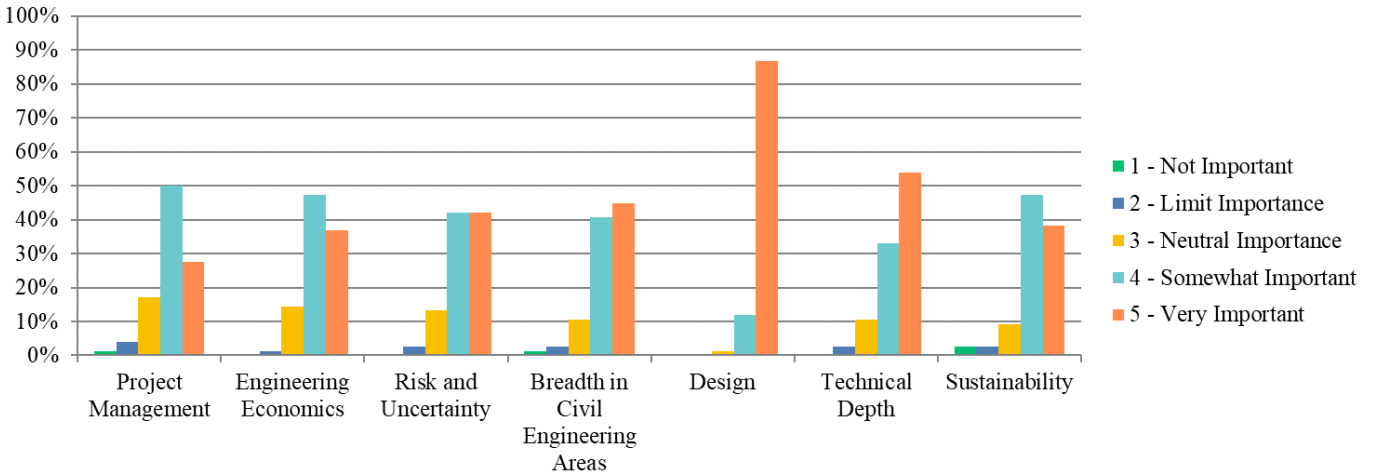


Figure 8. Technical Outcomes - Importance to Civil Engineering Education

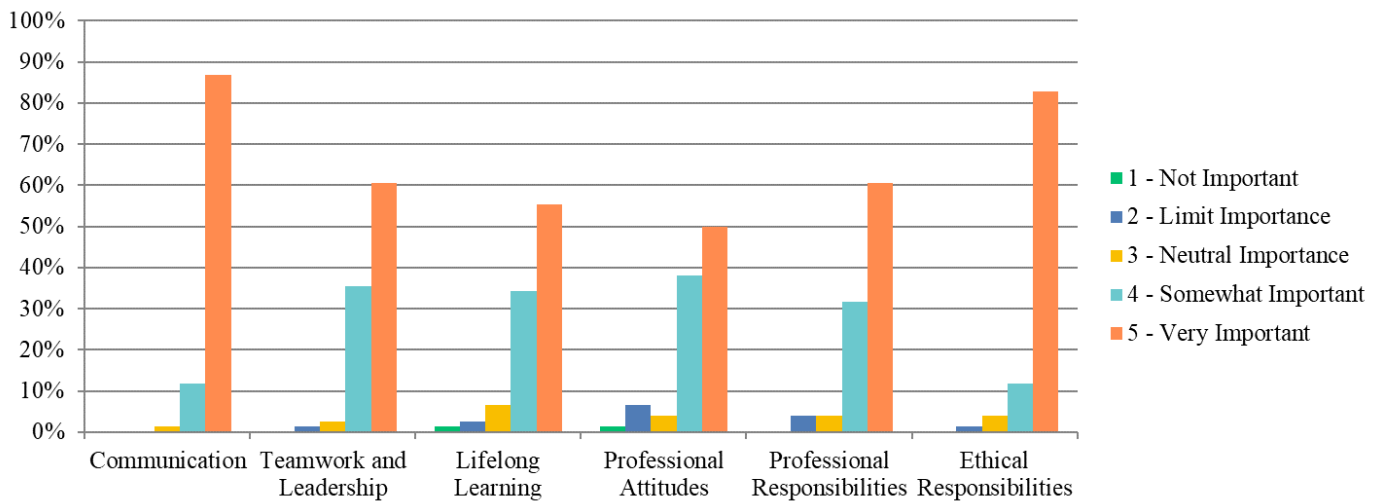


Figure 9. Professional Outcomes - Importance to Civil Engineering Education

A summary of all Outcomes, shown in Figure 10, includes the average of all respondents' ratings of the Outcomes' importance to civil engineering education. Critical thinking was rated highest overall (4.95/5.00), while humanities was rated lowest overall (3.83/5.00) with respect to importance to civil engineering education. With the exception of Project Management and Humanities, the importance of all outcomes was rated as being at least "somewhat important" (4.00/5.00).

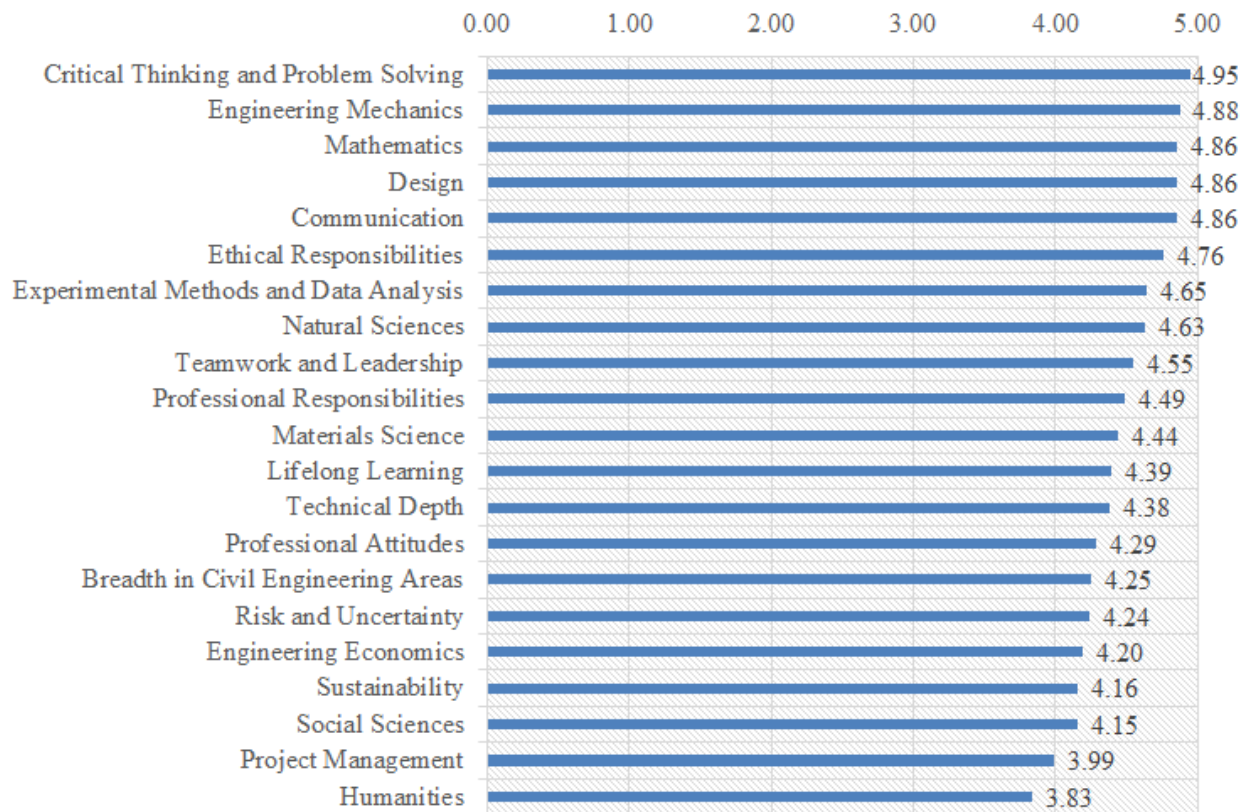


Figure 10. Summary of All Outcomes - Importance to Civil Engineering Education

Survey questions also addressed the ease of implementation of each outcome into the civil engineering curriculum. More than 50% of respondents indicated that mathematics, natural sciences, and engineering mechanics would be “very easy to incorporate” in their civil engineering curriculum, as shown in Figures 11 to 14.

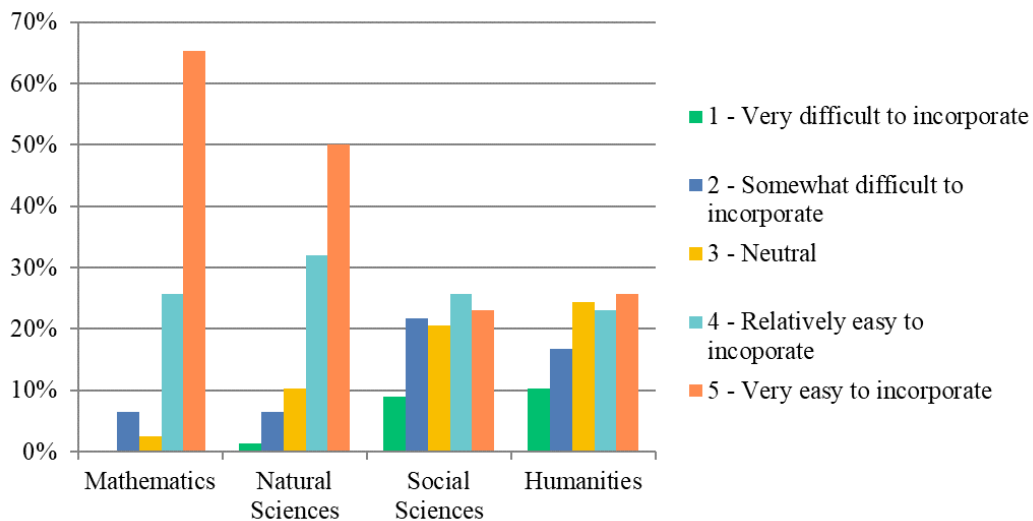


Figure 11. Foundational Outcomes - Ease of Implementation into Civil Engineering Curriculum

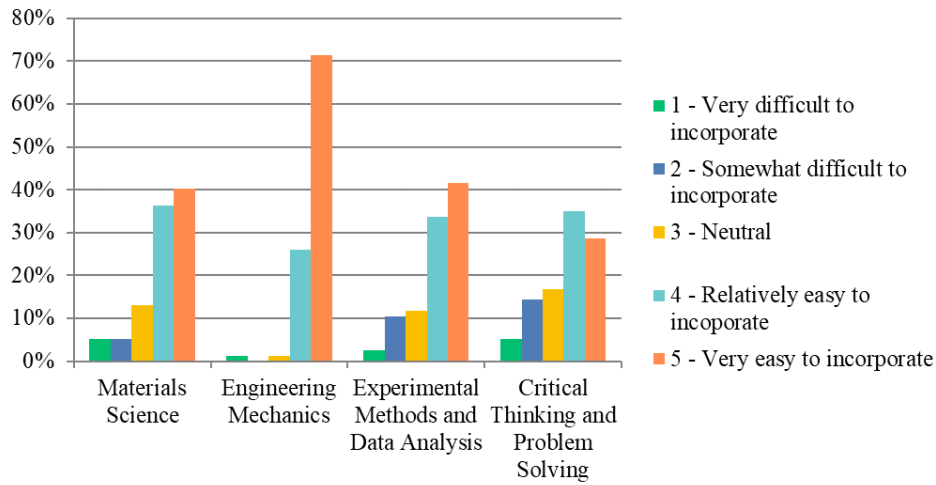


Figure 12. Engineering Fundamentals Outcomes - Ease of Implementation into Civil Engineering Curriculum

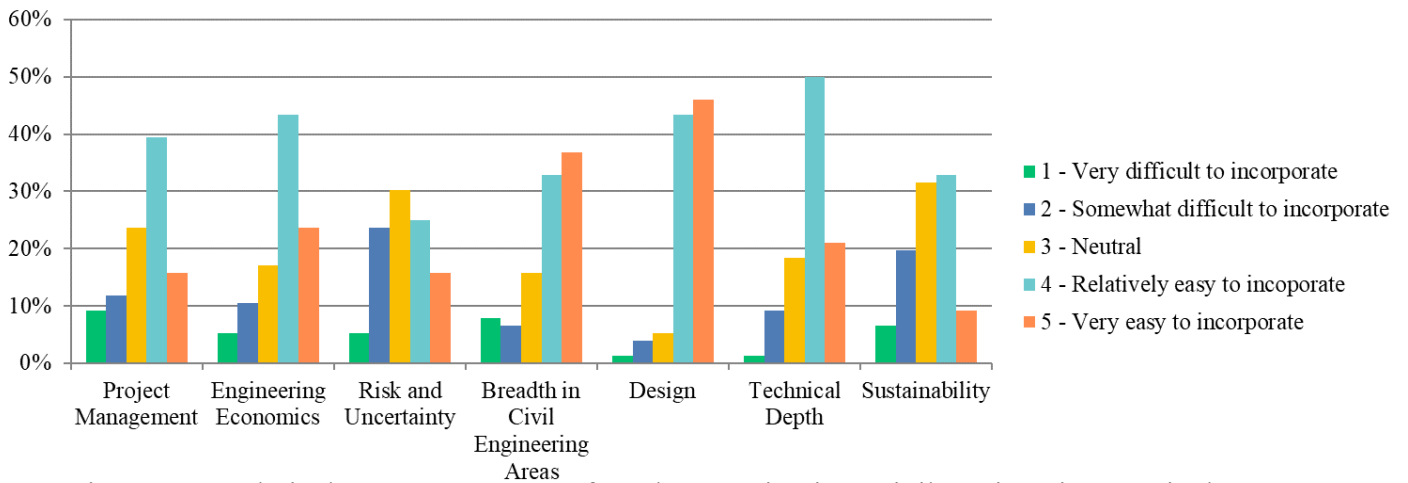


Figure 13. Technical Outcomes - Ease of Implementation into Civil Engineering Curriculum

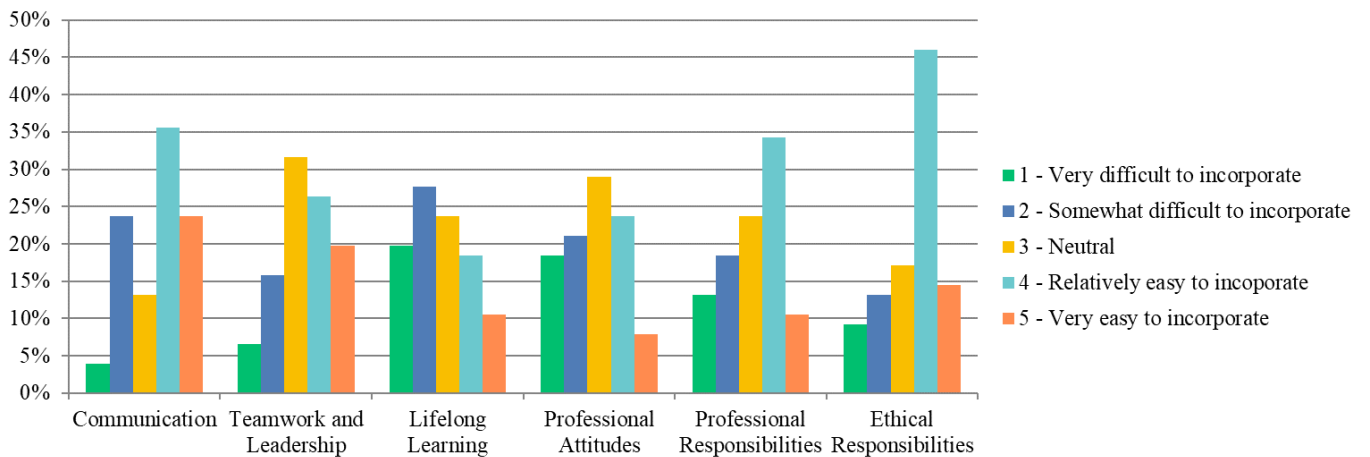


Figure 14. Professional Outcomes - Ease of Implementation into Civil Engineering Curriculum

A summary of all Outcomes, shown in Figure 15, includes the average of all respondents' ratings of the Outcomes' ease of implementation into the civil engineering curriculum. Engineering mechanics was rated highest overall (4.66/5.00), while Lifelong Learning was rated lowest overall (2.82/5.00) with respect to ease of implementation. With the exception of professional attitudes and lifelong learning, all other outcomes were rated at a level of neutral or higher (easier) with respect to ease of implementation into the curriculum. These results may indicate areas where ASCE can provide support to civil engineering department heads and faculty wishing to incorporate the BOK3 outcomes into their curricula.

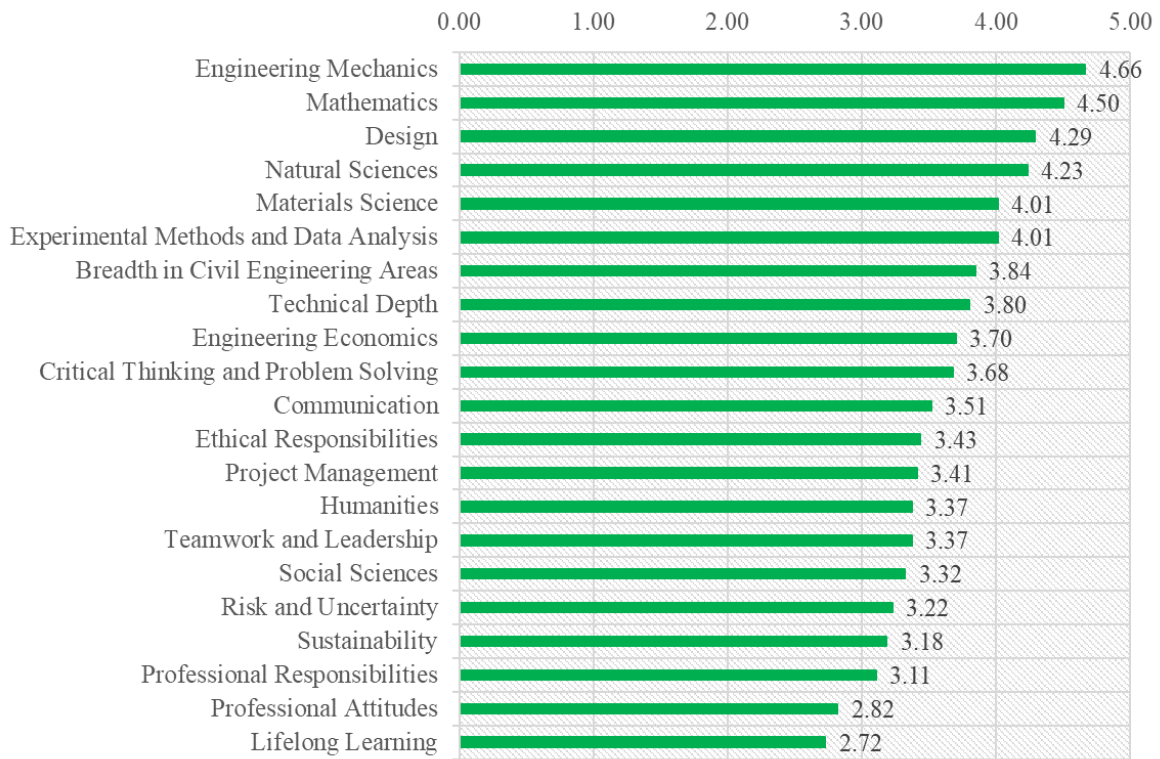


Figure 15. Summary of All Outcomes - Ease of Implementation into Civil Engineering Curriculum

Department heads' ratings of the individual components of the Civil Engineering Program Criteria are shown in Figures 16 and 17. More than 40% of the respondents rated 8 of the 10 Program Criteria as "very important." The average rating for importance to civil engineering education ranged from a low of 3.87/5.00 ("at least one additional area of basic science") to a high of 4.58/5.00 (preparation of graduates to apply mathematics). On average, all components had a rating of the level of importance above "neutral," with all but two components being rated as "somewhat" or "very" important.

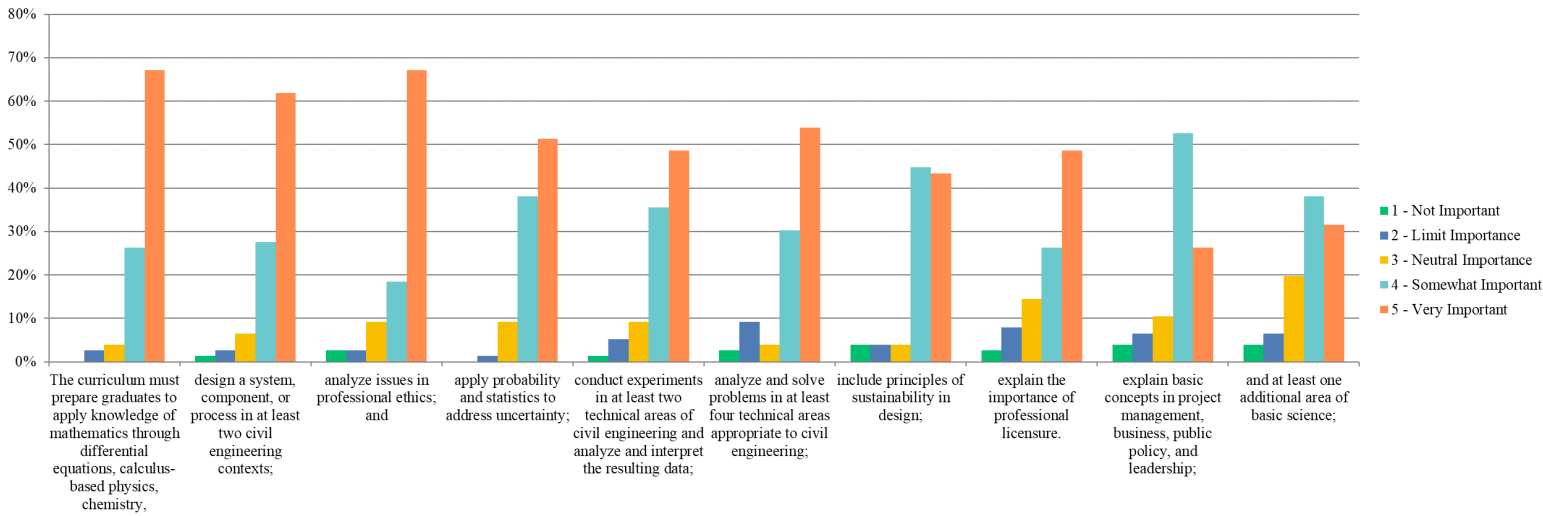


Figure 16. ABET Program Criteria - Importance to Civil Engineering Education

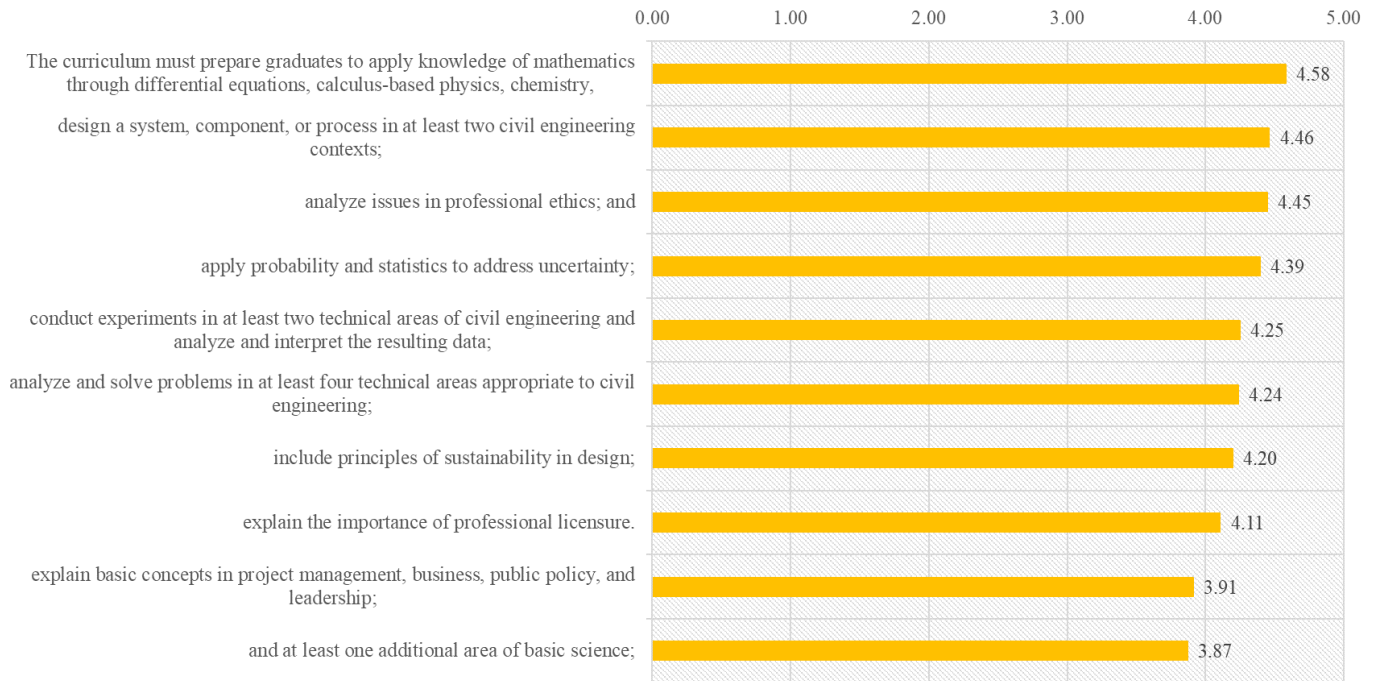


Figure 17. Summary of ABET Program Criteria - Importance to Civil Engineering Education

Although the respondents generally provided high ratings on the importance of components included in the Civil Engineering Program Criteria, the ease with which those components are implemented into the curricula are rated slightly lower, as shown in Figures 18 and 19. The ratings range from a low of 2.97/5.00 (explain basic concepts in project management, business) to a high

of 4.55/5.00 (preparation of graduates to apply mathematics). Notably, the preparation of graduates to apply mathematics criteria was rated as high for both importance and ease of implementation. Despite being commonly cited as an area of concern among department heads, over 75% of respondents rated the breadth component (“apply knowledge in four areas”) and the requirement of an additional area of basic science as being relatively or very easy to incorporate into the curriculum.

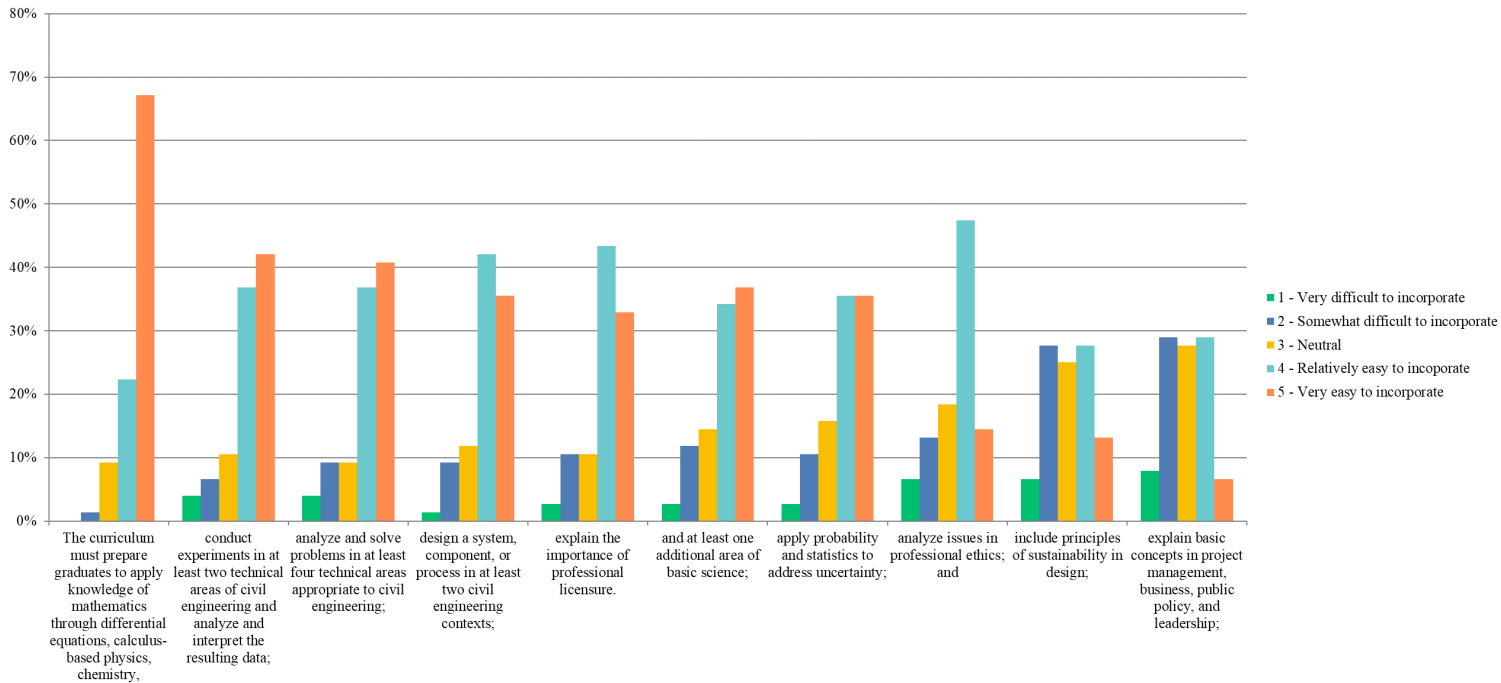


Figure 18. ABET Program Criteria - Ease of Implementation

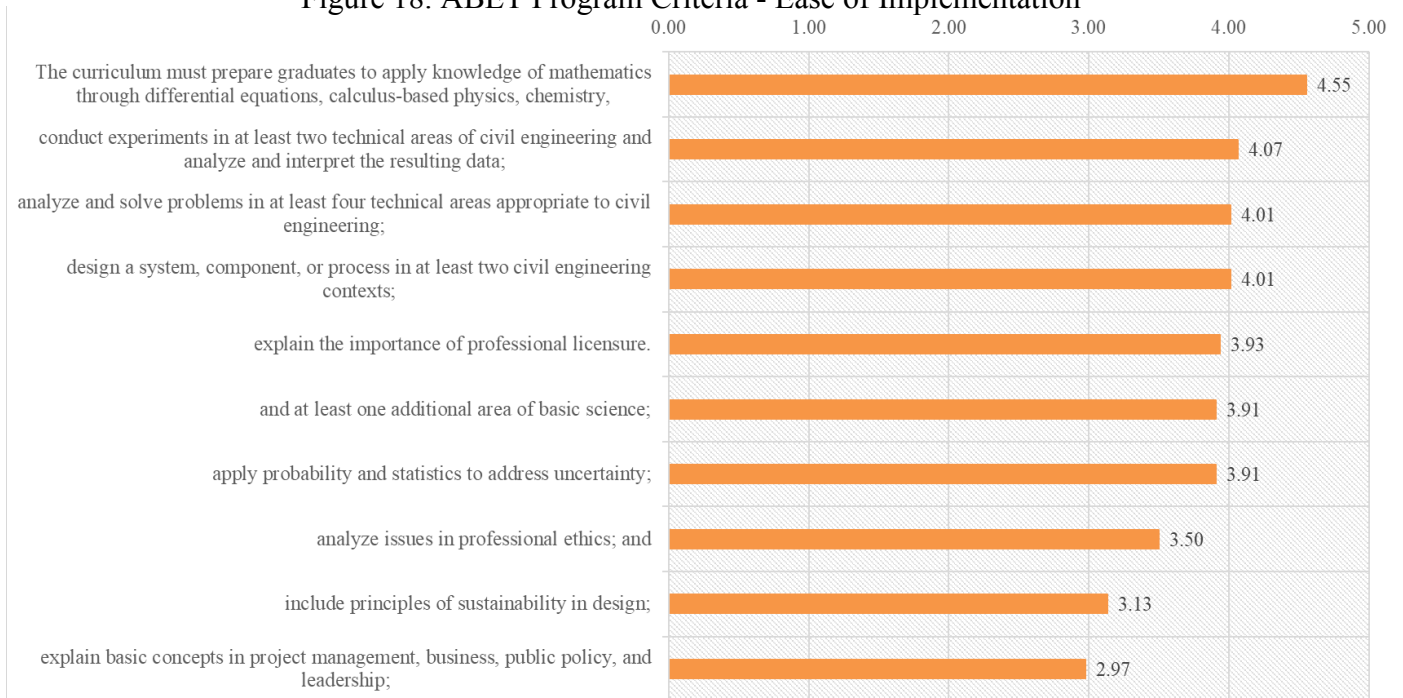


Figure 19. Summary of ABET Program Criteria - Ease of Implementation

In their survey of Civil Engineering Department Heads in 2014, Estes, et al [15] compiled responses on whether a component of the CEPC was acceptable, and the level of curricular change required. In that study, the components addressing “sustainability” and “applying probability and risk to address uncertainty” were considered to be the least acceptable and to require more effort than others to incorporate into the curriculum. Comparing results obtained in the present study to those presented by Estes et al, the difficulty of including sustainability into the curriculum appears to persist, as shown in Figure 19. Familiarity with principles of sustainability is increasing and many programs use sustainability as a distinctive feature. However, observations presented in this paper reveal potential areas in which an exchange of ideas can support faculty members’ efforts to adapt curricula and address the changing needs of the civil engineering profession.

Summary

Following the established 8 year cycle, the ASCE Committee on Accreditation will soon convene a Task Committee to review, and if needed, revise the Civil Engineering Program Criteria. The CEPC has been influenced by prior versions of the CE BOK and thus it is likely that the recently completed BOK3 will influence future CEPC content. Civil Engineering Department Heads and Chairs play a key role in ensuring that the Civil Engineering program criteria are met in their programs, and thus, their perspectives are relevant to shaping the next edition of the CEPC. The purpose of this study was to survey the ASCE Department Head community to capture the perspectives of civil engineering educators as they relate to the BOK3 and CEPC. Respondents provided feedback on the importance of the BOK3 outcomes and components of the CEPC to civil engineering education and the ease of implementing each into their civil engineering curricula.

Analysis of results indicates that leaders of Civil Engineering Departments consider the BOK3 outcomes and components of the CEPC as being important to the civil engineering education, including the importance of design, breadth in the discipline (4 areas of CE), and components that were added to address the ASCE Strategic Priorities (sustainability, risk, uncertainty). Given these study results, it appears that programs have adapted to the CEPC components and that the components are accepted.

Generally, the Foundational, Engineering Fundamental and Technical Outcomes of the BOK3 were identified as being very easy to relatively easy to incorporate into a civil engineering curriculum. The Professional Outcomes, more specifically, lifelong learning, professional attitudes and professional responsibilities were perceived as being more difficult to incorporate into a civil engineering curriculum compared to other outcomes. The reason for the difficulty in incorporating lifelong learning, professional attitudes and professional responsibilities may be due to the level of faculty comfort or familiarity with the material and opportunities to include the material in a class or to add a class to the curriculum.

Prior to the recent changes made to ABET EAC Criteria 3 and 5, lifelong learning was included among the Criterion 3 outcomes, more specifically, Outcome (i) (i.e., students must have “a recognition of the need for, and an ability to engage in lifelong learning”) (ABET, 2017). Lifelong learning is now incorporated in the new 2019-2020 ABET Criterion 3 outcome (7) (i.e., “an ability

to acquire and apply new knowledge as needed, using appropriate learning strategies”) (ABET, 2018). Despite existing as an ABET Criterion 3 outcome for over 20 years, addressing lifelong learning as an outcome still appears to pose a challenge for some programs. Some programs may benefit from guidance on measuring students’ ability to demonstrate lifelong learning skills.

The American Society of Civil Engineers (ASCE) and the American Society for Engineering Education (ASEE) can help address concerns about the difficulty of incorporating outcomes into civil engineering programs by providing more guidance in the CEPC Commentary and by facilitating exchanges of ideas about areas that are perceived to be more difficult to implement. Programs that have successfully incorporated these outcomes in their civil engineering curriculum could be invited to share their successes with other programs at the ASCE Annual Department Heads Conference or to present papers at ASEE conferences.

Data and information provided within this paper can help inform future revisions to the CEPC. More importantly, information related to the importance of the BOK3 outcomes provides baseline data for use in the next review of the Civil Engineering Body of Knowledge.

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