

AC 2007-1845: THE ASCE BOK AND ATTITUDES ASSESSMENT

Peter Hoadley, Professor @ VMI

The ASCE BOK and Attitudes Assessment

Abstract

In 2004 ASCE published a report defining the “knowledge, skills and attitudes,” or more broadly, the body of knowledge (BOK), necessary for an individual to enter the professional practice of civil engineering. It has been shown that “attitudes” are important in the effective use of “knowledge” and “skills.” A partial list of these attitudes might include commitment, curiosity, honesty, optimism, persistence, thoroughness and tolerance. The purpose of this paper is to address the “attitudes” portion of the BOK. What is the importance of attitudes in the engineering profession and in other professions as well? If attitudes are included in the BOK then they must be assessed. Knowledge and skills can be objectively measured while attitudes are far more subjective and difficult to assess in a consistent way. Some attitude assessment tools are discussed.

Introduction

In 2004 ASCE published a report defining the “knowledge, skills and attitudes,” or more broadly, the body of knowledge (BOK), necessary for an individual to enter the professional practice of civil engineering.¹ Knowledge means the familiarity with certain facts and natural laws while skill is the ability to use that knowledge. Attitude is “a mental position with regard to a fact or state.”² Defining “knowledge” and “skills” in a BOK seems appropriate and straight forward but there has been much discussion regarding the appropriate inclusion of “attitudes” and, if appropriate, what attitudes should be listed and how are they to be assessed. Is it important for the engineering profession to address the issue of attitudes? Some have suggested it is *abilities* that should be included with *knowledge* and *skills* rather than *attitudes*. What attitudes might be included? Are attitudes important in other professions? How might attitudes be assessed?

The Importance of Attitudes in Engineering Professional Practice

The authors of the first BOK report wrote, “Knowledge and skills are not sufficient to effect a fully functioning professional engineer.”³ Appropriate attitudes are also necessary. Attitudes determine how an engineer uses knowledge and skills and they reflect one’s values and how one perceives and reacts to the world.⁴ Johnston⁵ writes, “An attitude is simply a predisposition to approach or avoid an idea, event, person or object. In other words, it is a tendency to act in one way or another toward an ‘attitude object.’” Attitudes do not exist in a vacuum; they require an object toward which to act. Attitudes can be positive and negative and either might be appropriate given the object toward which the attitude acts.

Several have shown that “attitudes” are important in the effective use of knowledge and skills when accomplishing engineering tasks. Elms noted that “besides having good technical training, a professional engineer has something more which distinguishes him from a technician. The extra quality is a set of attitudes, some of which, holism, realism and flexibility, can be encouraged by university teaching.”⁶ He outlines a way that university faculty could address this topic.

The importance of attitudes has been noted by others. Stouffer writes that a particular set of attitudes are important in effective engineering management.⁷ Kahn writes that the need for managerial effectiveness of manufacturing engineering executives in competitive organizations is becoming more important. One of the objectives of management development is the “inculcation of behavioral change in the manufacturing executives. This change may be in the form of knowledge, skills and attitudes.”⁸ Henshaw surveyed job advertisements for engineering professionals and found that employers wanted applicants with good communication skills, who work well on teams, who possess the ability to relate to people, and who hold positive attitudes.⁹

If attitudes are important to the professional engineer then what attitudes should be considered? It would be difficult to develop an exhaustive list of appropriate attitudes since the list would depend upon the situation and temper of those involved on a given project team. One ASCE committee has suggested that significant attitudes are those supportive of the effective practice of civil engineering.¹⁰ A partial list of those attitudes might include commitment, confidence, consideration of others, curiosity, fairness, high expectations, honesty, integrity, intuition, good judgment, optimism, persistence, positiveness, respect, health self esteem, sensitivity, thoughtfulness, thoroughness and tolerance.¹¹ Some of these attitudes may be similar and some may be easier to measure. For example, it may be easier to measure persistent than healthy self esteem.

The Importance of Attitudes in Other Professions

Other professions recognize the importance of constructive attitudes in the successful completion of a task. Janke speaks to educators in pharmaceutical schools about the importance of attitudes. Educators usually focus on knowledge and skills but should address the teacher’s and the student’s attitudes. Attitudes are malleable and can positively or negatively influence behavior. Attitudes can influence teaching and learning in positive and negative ways; therefore, teachers need to assess their own attitudes and the attitudes of their students so that productive teaching and learning can take place. Students should assess their own attitudes to see if they possess any that might impede learning. Instructors may change instructional material depending on the attitudes of their students.¹²

Morgan, writing of the software business, states that certification based on a generally accepted body of knowledge is needed for clients to trust software professionals and their work. The competencies for software professionals “have been defined as a set of observable performance dimensions, knowledge, attitudes, behavior, collective team, organization capabilities that are linked to high performance.”¹³ It is clear that attitudes are important for the engineering professionals and other professionals as well.

Abilities and Attitudes in the KSA

Some have suggested that the civil engineering BOK should include *abilities* with *knowledge* and *skills* rather than *attitudes*. Indeed other professions define *abilities* rather than *attitudes* in their respective BOKs. Some examples include Bailey’s discussion of industry perceptions of the knowledge, skills, and *abilities* needed by computer programmers.¹⁴ Many state engineering licensing boards, including California’s, require knowledge and *abilities* for professional engineering applicants.¹⁵ In the definition of a professional engineer, the state of California uses

the term *knowledge* in several contexts, *skill* only once, *ability* only once and never defines requisite *attitudes*.¹⁶ The Oklahoma State website lists requirements for engineering interns including specific “knowledge, skills and *abilities*” including knowledge of basic engineering principles and of specialized subjects such as mathematics, statistics, mechanics, physics and of strength of materials.¹⁷ The website also states that the intern must possess the *ability* to apply engineering principles to practical engineering problems and to express ideas clearly and concisely, both orally and in writing. The Office of Aviation Safety of the National Transportation Safety Board lists required knowledge, skills and abilities for aerospace engineering positions.¹⁸ The US Office of Personnel Management, OPM, states that engineering applicants must possess “the knowledge, skills, and abilities required for professional engineering competence.”¹⁹

Several examples have been listed demonstrating that many in the engineering community define the knowledge, skills and *abilities* necessary for effective professional practice; however, in some cases necessary *attitudes* are also specified. Marshall and Marshall write that the engineering community has a responsibility to produce individuals “with strong moral fiber, a dedication to professional integrity, and the ability to reason soundly.”²⁰ César Quáderas, director of the Electronics Program at ITESM (Institute Tecnológico y de Estudios Superiores de Monterrey) writes that certain values, attitudes and abilities are a priority in the academic training of their students. Essential attitudes include honesty, commitment, a healthy work ethic and respect for others.²¹

Other professions define *attitudes* for effective practice. In the human resource profession, Markman and Beron note that job performance is a function of how well an individual’s *attitudes*, values, knowledge, skills, *abilities*, and personality match the goals of the given organization.²² In a similar way Brkich, et. al., develop a person-to-job scale that provides some measure of degree to which an individual's knowledge, skills, *abilities*, needs and *values* match job requirements. The term “values” may be related to “attitudes.”²³

Some argue that including skill and ability in the BOK definition is redundant but there is some difference between the terms. Skill is “the ability to use one's knowledge effectively and readily in execution or performance.”²⁴ Note that the definition of skill uses the term ability. Ability is “the quality or state of being able.” Skill is ability realized while ability is merely potential skill.

In the health care profession, Hodges, et. al., suggest that the need for a modification of “knowledge, skills and *attitudes*” among primary care physicians towards mental health issues is important.²⁵ Commenting on an article by Ferguson and Armstrong, Freeman describes the growing recognition among many speech and language therapists (SLTs) of the need for more detailed consideration of the knowledge, skills, *attitudes* and values that are brought to our interactions with people with communication disabilities.²⁶ Kaariamen, et. al., analysed differences in health care personnel's knowledge, skills, and *attitudes* in relation to alcohol-related matters. They showed that although discussing alcohol consumption is easy, better motivational skills and more positive *attitudes* are needed in primary, occupational, and specialized health care.²⁷ In psychology, Rodolfa, et. al. present a 3-dimensional competency model delineating the domains of knowledge, skills, and *attitudes* that serve as the foundation required of all psychologists. Several works are cited that list the values, principles, attitudes, knowledge, skills, and *abilities* necessary to effectively deliver psychological services.²⁸

In education, Fullen, et. al., state that the *attitudes* and skills needed by teachers in order to improve their craft include “persistence, understanding of the transfer of training, understanding of the need for theory” and the ability to work well with peers.²⁹ Lennox tried to define the ideal knowledge, skills, and *attitudes* that medical students should have at the end of their undergraduate training.³⁰

The term “attitudes” is used in many professional circles as a part of their respective BOKs or equivalent. ASCE is not outside of professional practice when requiring certain “attitudes” within its BOK.

Assessing Attitudes

One of the concerns when including “attitudes” in the BOK is the difficulty in assessing them in a meaningful way. Knowledge and skills can be objectively measured while attitudes are far more subjective. Even so, attitudes affect behavior and behavior certainly can be measured. Still caution must be exercised because behavior may neither completely nor accurately reflect attitude. It follows that any given measurement of one’s attitude is plagued by a host of uncertainties. For example, the subject, by his own actions and words, may hide his true attitude regarding a particular topic for a host of reasons. An observer may distort an accurate measure of another’s attitudes. An appropriate assessment scheme must be carefully considered.

It was the intention of the author to define an assessment program that would effectively measure appropriate attitudes in the licensure applicant. After some study it was evident that this was not possible in this exercise. What follows are descriptions of a few assessment schemes. Their possible use in the problem at hand is a discussion that must come later.

Perhaps the simplest way to measure the attitudes of a licensure applicant would be through an assessment by a supervising professional engineer. The state of California requires four references that must rate an engineering applicant’s technical competency, judgment and integrity among other characteristics.³¹ In North Carolina references must rate an applicant’s integrity and ethical behavior³² and in Oklahoma applicants must be technically competent and of good character as attested by at least five references.³³

Thurstone was one of the pioneers in the measurement of attitudes. He wrote that attitudes are a “complex affair” and one must take care in assessing them.³⁴ Thurstone’s methods for measuring attitudes used a simple agree/disagree scale. This approach involves two main stages. The first is to develop a large number of attitude statements regarding a topic. Subjects are then asked to rate how they agree or disagree with the attitude statements.³⁵

The example below only presents two attitude statements regarding cultural considerations in engineering design. The Thurstone method requires multiple attitude statements before an accurate measure of one’s attitude can be obtained.

Example 1. Thurstone Scale

“Cultural considerations should not be considered in an engineering design.”

1	2	3	4	5	6	7
Agree						Disagree

“Cultural considerations are important in construction management.”

1	2	3	4	5	6	7
Agree						Disagree

The Semantic-Differential method of measuring attitudes devised by Osgood consists of a topic and a set of bipolar scales, for example, exciting to dull.³⁶ The subject has to indicate the direction and intensity of an attitude towards a given topic.

The example shown below includes a statement and a series of scales. The subject rates their response to the statement on several scales. The design of the statement and the scales is important in the accurate assessment of attitude.

Example 3. Semantic Differences

“Overseas engineering projects should consider cultural differences.”

1	2	3	4	5	6	7
Good						Bad
1	2	3	4	5	6	7
Fair						Unfair
1	2	3	4	5	6	7
Valuable						Worthless
1	2	3	4	5	6	7
Necessary						Unnecessary

The assessment of attitudes has been a long study in several professions. For example, the topic of teacher’s and student’s attitudes has long been a study in the education profession.³⁷ Even though this section did not define a possible assessment scheme, it is clear that attempts have been made to address the issue; therefore, it is entirely appropriate for the engineering profession to do the same.

Summary

A body of knowledge for any profession certainly includes knowledge and skills. Since attitudes affect how the knowledge and skills are used in the outworking of the profession it is appropriate for a BOK to include attitudes. Attitudes are specified in many professions and the assessment of attitudes has long been a study in those professions. More study is necessary to develop assessment tools that might best serve the engineering profession.

References

- ¹ ASCE, “*Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future*”, Prepared by the BOK Committee of the Committee on Academic Prerequisites for Professional Practice, January 12, 2004.
- ² Merriam-Webster’s Online Dictionary, <http://www.m-w.com/>.
- ³ See Ref. 1, p. 33.
- ⁴ See Ref. 1.
- ⁵ Johnston, H., “*Shaping Beliefs and Attitudes: A Handbook of Attitude Change Strategies*,” <http://www.principalspartnership.com/AttitudeHandbookforUPWebs.htm> , 2001.

-
- ⁶ Elms, D. G., "Steps Beyond Technique – Education for Professional Attitude," *Civ.Eng.Syst.*, 2(1), 55-59, 1985.
- ⁷ Stouffer, W. B., Russell, J. S., and Oliva, M. G., "Making the strange familiar: Creativity and the future of engineering education," Proceedings of the ASEE 2004 Annual Conference, American Society for Engineering, Washington, DC 20036, United States, Salt Lake City, UT, United States, 9315-9327.
- ⁸ Khan, H., "Correlates of engineering and management effectiveness: design of a strategic university curriculum for corporate engineering executive development (SUCCEED) program." Proceedings of the 1996 26th Annual Conference on Frontiers in Education, Part 2 (of 3), IEEE, Nov 6-9 1996, Piscataway, NJ, USA, Salt Lake City, UT, USA, 886-890.
- ⁹ Henshaw, R., "Survey of professional engineering job advertisements," International Mechanical Engineering Congress and Exhibition, 1991.
- ¹⁰ ASCE, "Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future," 2nd Edition, Prepared by the BOK Committee of the Committee on Academic Prerequisites for Professional Practice, Expected publication date: February 2008.
- ¹¹ See Ref. 1.
- ¹² Janke, Kristin Kari, Accreditation Council for Pharmacy Education webpage, <http://www.acpe-accredit.org/scholar05/Breeze/AssessingAttitudes/index.html>.
- ¹³ 48 Morgan, Jeanette Nasem, "Why the software industry needs a good ghostbuster," *Commun ACM*, V48(8), 2005.
- ¹⁴ Bailey, J.L. and Stefaniak, G., "Industry perceptions of the knowledge, skills, and abilities needed by computer programmers," Proceedings of the 2001 ACM SIGCPR Conference on Computer Personnel Research, 2001, italics mine.
- ¹⁵ California Board for Professional Engineers and Land Surveyors, "PROFESSIONAL ENGINEERS ACT," January 1, 2007, italics mine, , http://www.dca.ca.gov/pels/e_plppe.pdf.
- ¹⁶ California Board for Professional Engineers and Land Surveyors, "PROFESSIONAL ENGINEERS ACT," January 1, 2007, italics mine, , http://www.dca.ca.gov/pels/e_plppe.pdf.
- ¹⁷ Oklahoma State Board of Licensure for Professional Engineers & Land Surveyors webpage, <http://www.pels.state.ok.us/>, italics mine.
- ¹⁸ Office of Aviation Safety of the National Transportation Safety Board, <http://www.nts.gov/vacancies/descriptions/AeroEngPowerplants.doc>.
- ¹⁹ US Office of Personnel Management, OPM, <http://www.opm.gov/qualifications/SEC-IV/B/GS0800/0800.htm>, italics mine.
- ²⁰ Marshall and Marshall, "Facilitating the Development of Student's Personal Ethics in Cultivating Professional Ethics in Engineering Classrooms," Proceedings of the 2005 ASEE Annual Conference and Exposition, June 2005, pp. 6323-6330.
- ²¹ Quádernas, César, "Improving Academic Performance Through Typifying Electronics Engineers," Proceedings, Frontiers in Education Conference, IEEE, 2000.
- ²² Markman, G.D., "Person-entrepreneurship fit: why some people are more successful as entrepreneurs than others," *Human Resource Management Review*, V13(2), 2003.
- ²³ Brkich, M., Jeffs, D. and Carless, SA, "A global self-report measure of person-job fit," *European Journal of Psychological Assessment*, V18(1), 2002.
- ²⁴ See Ref. 2.
- ²⁵ Hodges, B., Inch, C. and Silver, I., "Improving the Psychiatric Knowledge, Skills and Attitudes of Primary Care Physicians," *American Journal of Psychiatry*, V158, October, 2001.
- ²⁶ Freeman, M. "SLT talk and practice *knowledge*: A response to Ferguson and Armstrong," *International Journal of Language & Communication Disorders*, V39(4), 2004.
- ²⁷ Kääriäinen, J., Sillanauke, P. Poutanen, Pauli and Seppä, K., "Opinions on alcohol-related issues among *professionals* in primary, occupational, and specialized health care," *Alcohol and Alcoholism*, V36(2), 2001.
- ²⁸ Rodolfa, et. al., "A Cube Model for Competency Development: Implications for Psychology Educators and Regulators," *Professional Psychology: Research and Practice*, V36(4), 2005.
- ²⁹ Fullen, M.G., Joyce, B and Showers, B., *Student Achievement through Staff Development*, 3rd Edition, 2002
- ³⁰ Lennox, N. and Diggins, J., "*Knowledge, skills and attitudes: Medical schools' coverage of an ideal curriculum on intellectual disability*," *Journal of Intellectual & Developmental Disability*, V24(4), 1999.
- ³¹ California Board for Professional Engineers and Land Surveyors, PE application, http://www.dca.ca.gov/pels/a_appinstpe.htm.

³² North Carolina Board of Examiners For Engineers and Surveyors website, <http://www.ncbels.org/reg-pe.htm>

³³ Oklahoma State Board of Licensure for Professional Engineers & Land Surveyors webpage, <http://www.pels.state.ok.us/>.

³⁴ Thurstone, L.L. (1928), "Attitudes Can Be Measured." American Journal of Sociology 33, : 529-554.

³⁵ Roberts, J.S., Laughlin, J.E. and Wedell, D.H., "Comparative Validity of the Likert and Thurstone Approaches to Attitude Measurement," ETS Report, 1997.

³⁶ Osgood, C.E., Suci, G.J., and Tannenbaum, P.H., "The measurement of meaning," Urbana: University of Illinois Press, 1957.

³⁷ Karavas-Doukas, E., "Using attitude scales to investigate teachers' attitudes to the communicative approach, ELT Journal, V50(3), 1996.