FORMULATING LEARNING OUTCOMES BASED ON CORE CONCEPTS FOR THE INTRODUCTORY TRANSPORTATION ENGINEERING COURSE

Steven Beyerlein
Professor of Mechanical Engineering, University of Idaho
Moscow, ID 83844
Voice: 208-885-4932
Email: sbeyer@uidaho.edu

Andrea Bill
Associate Researcher, University of Wisconsin Madison
Department of Civil and Environmental Engineering
1415 Engineering Drive, Madison, WI 53706
Voice: 608-890-3425
Email: bill@wisc.edu

Ida van Schalkwyk
Assistant Professor, School of Civil and Construction Engineering, Oregon State University
220 Owen Hall, Corvallis, OR 97331-3212
Voice 541-737-8874
Email: idavan@engr.orst.edu

Kristen L. Sanford Bernhardt
Assistant Professor, Department of Civil and Environmental Engineering, Lafayette College
310 Acopian Engineering Center, Easton, PA 18042
Voice: 610-330-5584
Email: sanfordk@lafayette.edu

Rhonda K. Young
Associate Professor, Dept. of Civil & Architectural Engineering, University of Wyoming
1000 E. University Avenue, Dept. 3295, Laramie, WY 82071
Voice: 307-766-2184
Email: rkyoung@uwyo.edu

Shashi Nambisan
Professor and Director of Center for Transportation Research and Education, Iowa State University
Department of Civil, Construction, & Environmental Engineering
394 Town Engineering, Iowa State University, Ames, IA 50011
Voice: 515-294-5209
Email: shashi@iastate.edu

Rod E. Turochy,, Ph.D., P.E.
Associate Professor, Department of Civil Engineering
238 Harbert Engineering Center, Auburn University, Alabama 36849-5337
Voice: 334-844-6271
Email: rturochy@eng.auburn.edu

Submitted on November 15, 2009 to
Transportation Research Board
89th Annual Meeting
January 10-14, 2010, Washington, DC

ABSTRACT

The introductory transportation engineering course is required in most civil engineering undergraduate programs in the United States and typically occurs during the junior year. As a result of a broad spectrum on possible topics and the lack of national consensus surrounding course content, instructors find the planning and teaching of this course challenging. The need for national coordination and collaboration in designing this course was one of the motivations for the Transportation Education Conference held at Portland State University in June 2009. During this three-day conference, participants shared teaching practices and concerns associated with this course, ultimately underscoring the need to map out general and specific learning outcomes for this course. This paper synthesizes these discussions and describes steps that a subset of conference attendees are following to define a set of core concepts and achievement levels for introductory transportation engineering courses. The approach that has been adopted leverages existing tools such as the American Society of Civil Engineer's Body of Knowledge, the idea of enduring understanding emanating from deep exploration of a manageable set of key concepts, and educational taxonomies to measure mastery of these concepts.

Keywords:

Learning Outcomes, Transportation, Education, Work Force Development, Body of Knowledge

INTRODUCTION

Transportation engineers are required to design, build, maintain, and operate our transportation system. To do this, transportation engineers need a broad background about different elements in this system. The breadth and complexity of the transportation system is one of the aspects that makes a career in transportation appealing, but is also one of the largest challenges in educating the future transportation engineer.

Traditionally, most transportation engineers graduate from undergraduate programs in civil engineering. Within the undergraduate civil engineering curriculum, three-quarters of the programs require one or two transportation engineering courses to introduce civil engineering students to the profession by providing a broad background of the field *(1).* Most often, students do not take these course(s) until the junior year of the program. Elective courses are then used to give students more depth into specific topics within transportation engineering. The challenge is how to adequately represent the transportation engineering profession in a single course in a manner that attracts students to the profession, provides an adequate background for students who go on to practice in the field, and equips students who go on to practice in other areas of civil engineering to work on transportation-related projects.

From the students' perspective, the required transportation course does not follow from a sequential series of foundation courses in transportation. Therefore, students start this course with no prior knowledge of the transportation field other than their own personal experiences. Typical student complaints about the course are that it is simplistic and lacks rigor because of the breadth (as opposed to depth) of the content covered; this perception is exacerbated by the lack of links to previous courses. Some students may also feel that they will not practice in the field so the course is outside their interests.

For the instructors' perspective, available textbooks are often viewed as too survey-like, there is a lack of real work problems or case studies available that show the complexity of the field, and there is often not laboratory time or computational facilities available for the course. Like the students, the instructors also find that the course lacks strong connection with previous civil engineering courses the students have taken. It is important to address these challenges since this course serves as a recruitment tool for the profession and for graduate study in the field.

The issues associated with teaching the required transportation engineering course were important factors that led to the organization of the Transportation Education Conference, held in Portland, Oregon on June 22-24, 2009. This conference brought together over 60 people to learn about and discuss issues related to transportation engineering education. One of the main concerns identified in this conference was the lack of guidance regarding the specific learning outcomes expected of the required transportation course. The pressure to include many modes of transportation and potential career paths in the course results in low level learning outcomes for the course. Discussions at the Conference lead the participants to feel that this does not allow the course to show the complexity, challenges, and innovations that make transportation engineering a rewarding career choice. Participants also felt that the interactive workshop environment created at the conference was a valuable asset in tackling this important issue. Therefore a sub-group of conference participants was formed to work on follow-up activities (including the development of another workshop/conference) with the objective of formulating specific learning outcomes that identify core transportation concepts and skills expected of graduates from undergraduate Civil Engineering programs. A companion goal was to define appropriate taxonomies to measure student success in reaching these outcomes.

While there will be a report that summarizes the activities of the Conference, this paper is a progress report that provides a literature review and outlines an implementation plan for generating shared understanding of core concepts and competencies associated with the introductory transportation engineering course.

BACKGROUND

The challenge of attracting students to the transportation profession was researched using the results of a web-based survey of over 1,800 undergraduate civil engineering majors *(2)*. This research effort looked at students' choices and views of the different specializations within civil engineering. The authors concluded that a higher percentage than the current 12 percent of undergraduate civil engineering majors could be attracted to transportation specializations given the views expressed in the survey. The main obstacle appears to be ignorance about rather than opposition to the profession. The key to overcoming this is educating students about the merits of the profession and how the profession can fit well with their goals for their future career. Obviously the required course in transportation engineering can play a major role in achieving this.

The literature documents several efforts to address the topic of developing future transportation professionals. Many of these pertain to undergraduate civil engineering programs. However they also address vocational training programs and graduate programs in engineering. Sources include the proceedings of conferences organized by the Transportation Research Board (TRB) in 1985 &1998, a conference organized by FHWA in 2002, and Special Reports produced by TRB (*3, 4, 5, 6, and 7)*. Similar efforts for transportation planning courses include those by Turnbull *(8)*, Handy et al *(9)*, Krizek and Levinson *(10)*, Freestone et al *(11)*, Zhou and Soot *(11)*, and Zhou and Schweitzer *(12)*. However, it is to be noted that the focus of this paper is on the introductory transportation engineering course.

The issue of content in the introductory transportation engineering course has typically been framed in terms of the skills the professional community wishes to see from new graduates from a civil engineering program. A recent survey of transportation practitioners repeated a survey effort performed in 1986 to see if the priorities in the profession had changed in that 20 year period *(1)*. This survey asked practitioners to prioritize a list of 31 transportation topics by giving each topic a score of 1 to 5 with 5 being the highest importance and 1 the lowest. The paper concluded that topics such as geometric design of highways, highway capacity, and transportation planning remained important when comparing the two survey results and topics such as transportation systems, traffic engineering, and safety have emerged as increasingly important topics. Another important finding from this work is that in Turochy's 2004 survey, 21 of the 31 topics (68 percent) received a score of 3 or above and all but 2 (93 percent) received above the median score of 2.5. This highlights the difficultly that the transportation profession has in deeming topics as low priority, leading many to select breadth over depth in the introductory course. At the same time increased complexity leads some to feel that additional depth in specialized areas in additional to broad knowledge are necessary *(13).*

One of the concerns of conference attendees is the difficulty in getting faculty members to agree on course outlines and syllabi. Faculty preferences and prejudices notwithstanding, different institutions have also different missions and different stakeholders. At the aforementioned Transportation Education Conference, an attempt was made to determine instructor priorities, with respect to course topics, for the first course on transportation engineering. Forty-three of the conference attendees participated in a survey that included 34 potential course topics. Each topic was to be ranked on a scale of 1 to 5 with 5 being the highest importance and 1 the lowest, in a manner similar to the survey of practitioners conducted in 2004. The top 20 of these topics, along with mean scores and standard deviations based on the 43 survey responses, is shown in Table 1. The survey was intended to simply reflect whether a given course topic should be included but not necessarily the extent, or depth, of the topic coverage.

TABLE 1: Survey of Transportation Engineering Topics at the Transportation Education Conference, Portland, OR (June 22-24, 2009)

Topic	Mean	Standard Deviation
Geometric Design of Highways	4.67	0.81
Traffic Flow Characteristics	4.49	0.83
Description of Transportation Systems	4.40	0.98
Driver Behavior	4.33	0.94
Highway Capacity Studies	4.33	0.87
Traffic Safety	4.28	0.98
Traffic Control Devices (also Traffic Signals)	4.26	1.11
Intersection Design	4.10	0.93
Transportation Planning	4.05	1.09
Land Use/Transportation Interaction	3.83	0.96
Traffic Impact Assessment	3.81	0.94
Intelligent Transportation Systems	3.77	0.81
Transportation Systems Management	3.65	0.97
Statistics Applied to Transportation	3.60	1.18
Mass Transit (also Public Transportation)	3.53	1.01
Evaluation Techniques	3.44	1.08
Human Powered Transportation (also Ped / Bike)	3.43	1.11
Operational Characteristics of Modes	3.42	1.01
Economics of Transportation	3.40	0.90
Vehicle Operating Characteristics	3.37	1.23

In addition, departments at institutions with predominantly undergraduate focus and smaller departments at all types of institutions have different resources in terms of faculty, space, and equipment. The setting (large city or small town) of an institution and its student body composition can also be a factor in determining course content. Given the variety of institutions and curricula, it may be more appropriate to define a minimum set of core transportation-related concepts that a typical undergraduate civil engineering graduate would be expected to master and a second set of optional concepts that presumably could be incorporated for alignment with the transportation engineering focus at different institutions.

BODY OF KNOWLEDGE

The framework of a "body of knowledge" is one way to organize ideas about what someone in a profession should know and be able to do. Several engineering professional societies are developing such a framework for their own disciplines, including the American Academy of Environmental Engineers *(14)* and the American Society of Mechanical Engineers (ASME) *(15).* The American Society of Civil Engineers (ASCE) recently published the second edition of its Body of Knowledge (BOK2) *(16),* and an Engineering Management Body of Knowledge has been developed jointly by several professional organizations *(17).* Over 300 papers of the American Society for Engineering Education (ASEE) conference proceedings since 1996 using the term in the context of a variety of disciplines, including electrical engineering and industrial engineering; clearly, there is substantial interest in a wide variety of engineering fields.

The civil engineering BOK2 is particularly relevant because many transportation engineers are graduates of civil engineering programs. In 1998, ASCE initially adopted Policy Statement 465, which "... supports the attainment of a Body of Knowledge (BOK) for entry into the practice of civil engineering at the professional level" *(18).* In response, the Committee on Academic Prerequisites for Professional Practice (CAP^3) was formed to establish what this body of knowledge should include. The first edition was released in 2004, and a second edition in 2008. Major changes included expanding the number of expected outcomes from 15 to 24 and adopting Bloom's Taxonomy to express these in measurable ways.

Bloom's Taxonomy refers to a classification of educational goals and objectives developed by Benjamin Bloom along with other psychologists and educators after discussions at the 1948 Convention of the American Psychological Association. Bloom’s Taxonomy includes three domains of the cognitive, affective, and psychomotor (*19*). For engineering education, including transportation, the cognitive domain is of prime focus. Figure 1 depicts the hierarchical nature of Bloom’s Taxonomy. The cognitive domain includes six levels:

1. Remember (to recall previous information)
2. Comprehend (to grasp the meaning of the material)
3. Apply (to use learned material in new and concrete situations)
4. Analyze (to break down material into component parts so that its organizational structure may be understood)
5. Synthesize (to put parts together to form a new whole)
6. Evaluate (to judge the value of material for a given purpose).

The 24 ASCE BOK2 outcomes are divided into three groups - foundational, technical, and professional. Within these groups, the level of Bloom's Taxonomy to which the outcome should be achieved is specified, as is how it should be fulfilled. That is, it is recognized that a bachelors degree alone is insufficient to fully prepare a student for practice as a professional. On-the-job experience and additional education beyond the bachelors degree are required, and the BOK2 specifies the level of achievement for each outcome that is to be fulfilled through the bachelor's degree, additional education, or professional experience.

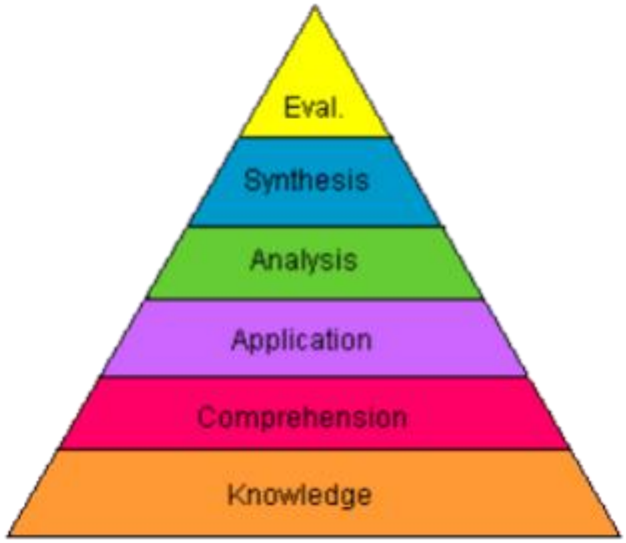

Figure 1 Bloom's Taxonomy (*20*)

For example, four foundational outcome areas are mathematics, natural sciences, humanities, and social sciences; all four are expected to be achieved at the third level of Bloom's Taxonomy (Application) at the undergraduate level. The outcome for mathematics is "Solve problems in mathematics through differential equations and apply this knowledge to the solution of engineering problems." On the other hand, technical outcomes such as risk, uncertainty, and project management are expected to be achieved through Application at the undergraduate level and through Analysis as a result of experience. Other technical outcomes are only expected at the Knowledge and Comprehension levels. It is expected that higher levels in technical specializations will be achieved through graduate education and experience. Bloom's Taxonomy provides a generic approach for educators to develop course content and evaluation systems.

As part of the development of course content, lesson plans and evaluation approaches, faculty in civil engineering also use the Accreditation Board for Engineering and Technology (ABET) requirements to tailor content to meet the needs of students and industry. ABET specifies 11 program outcomes that students must demonstrate (*21*):

1. an ability to apply knowledge of mathematics, science, and engineering
2. an ability to design and conduct experiments, as well as to analyze and interpret data
3. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. an ability to function on multidisciplinary teams
5. an ability to identify, formulate, and solve engineering problems
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively
8. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
9. a recognition of the need for, and an ability to engage in life-long learning
10. a knowledge of contemporary issues

11. an ability to use the techniques skills, and modern engineering tools necessary for engineering practice.

In addition to these eleven outcomes, civil engineering programs must meet civil engineering program specific criteria. These criteria are determined by the American Society of Civil Engineers, and there is therefore a relationship between the BOK and the program criteria. In fact, Appendix H of the BOK2 document maps the relationship among accreditation criteria and the two published editions of the BOK.

Another approach to identifying what students ought to know involves the articulation of a set of core concepts. Core concepts are important for students to grasp what the discipline is about and the fundamental or central thoughts. Such core concepts have not been developed at a national level to coordinate teaching efforts for the introductory transportation engineering course that is part of the civil engineering undergraduate curriculum. Other divisions of engineering already defined some core concept for their area. For example, Wikipedia describes the core concepts for mechanical engineering to be mechanics, kinematics, thermodynamics, fluid mechanics, and energy *(22).* Six consortiums in North Dakota met to come up with overarching concepts between automated manufacturing, science technologies, engineering, and information/communication technology. The results of their work are presented in Table 2.

TABLE 2: Core Concepts for Mechanical Engineering

Knowledge and Skills	Basic Core Concepts
Academics	Applies Math, Applied Science
Communications	Communication Skills
Problem Solving and Critical Thinking	Problem Solving, Troubleshooting
Information Technology Applications Systems	Creativity
Safety, Health, and Environmental	Safety
Leadership and Teamwork	Teamwork, Adaptability, Flexibility
Ethics and Legal Responsibilities	Work Ethic
Employability and Career Development	Job Information
Technical Skills	Trade Skills, Research Skills, Measurement

In thinking about core competencies it is helpful to parse these out into categories that inform instruction, rather than just give this as a flat list. An effective way to classify knowledge items for a course is as follows:

- concepts - learning based on definitions, diagrams, and models
- processes - learning based on methodologies (i.e. information processing, design, teamwork, communication)
- tools - learning surrounding forms/templates, software, and lab equipment
- contexts - learning situated in various environments (i.e. rural highways, urban highways, multi-modal configurations, DOT office, consulting firm)
- ways of being - attitudes and values surrounding learning

The core concept framework has been applied to transportation (*1, 2, 3, 4, 5, 6, and 7)*. One such example is an effort within the field of highway safety. In 2003, a subcommittee was formed through the Transportation Research Board to emphasize and address the lack of training and core competencies for highway safety professionals. *Research Results Digest 302* outlines the current highway safety educational opportunities that exist through different universities degree and certification programs, government training courses, and other independent training courses. The authors then recommended five core competencies that would provide the basic level of knowledge for highway safety professionals. Each core competency has specific learning objectives. The five core competencies are as follows: *(23)*

1. Understand the management of highway safety as a complex multidisciplinary system.
2. Understand and be able to explain the history of highway safety and the institutional settings in which safety management decisions are made.
3. Understand the origins and characteristics of traffic safety data and information systems to support decisions using a data-driven approach in managing highway safety.
4. Demonstrate the knowledge and skills to assess factors contributing to highway crashes, injuries, and fatalities, identify potential countermeasures linked to the contributing factors, applying countermeasures to user groups or sites with promise of crash and injury reduction, and implement and evaluate the effectiveness of the countermeasures.
5. Be able to develop, implement and manage a highway safety management program.

As a whole, the ASCE BOK2 and the core competencies framework provide a place of departure for establishing a robust and transferable set of core concepts for civil engineering undergraduates with respect to transportation.

WORK PLAN

The preceding sections outline the need for widely regarded core concepts and learning objectives for the introductory transportation engineering course as well as a framework for organizing these. This section outlines a tentative work plan by the sub-group focusing on the introductory transportation engineering course that emerged out of the June 2009 Transportation Education Conference. The ultimate goal of this sub-group is to prepare materials and plan a workshop/conference that will bring people together transportation educators and practitioners to classify candidate concepts and achievement levels for the introduction to transportation course. The workshop/conference will take place in August 2010 in conjunction with the ITE 2010 Annual Meeting. The work plan includes distributing participant invitations through a variety of organizations such as TRB, ASEE, and ITE. By doing this, the hope is to have an audience representing the entire field of transportation engineering to vet the candidate outcomes. The facilitation plan includes orientation about backward course design (11), identification of a small set of central ideas and learning outcomes for the introduction to transportation course, analysis and prioritization of supporting knowledge elements, and assignment of threshold levels in Bloom's Taxonomy required realize the desired learning outcomes. It is anticipated that the methodology used could be easily applied to follow-on transportation courses as well as engineering courses in general.

Figure 2 summarizes the past, present and future activities identified in the work plan.

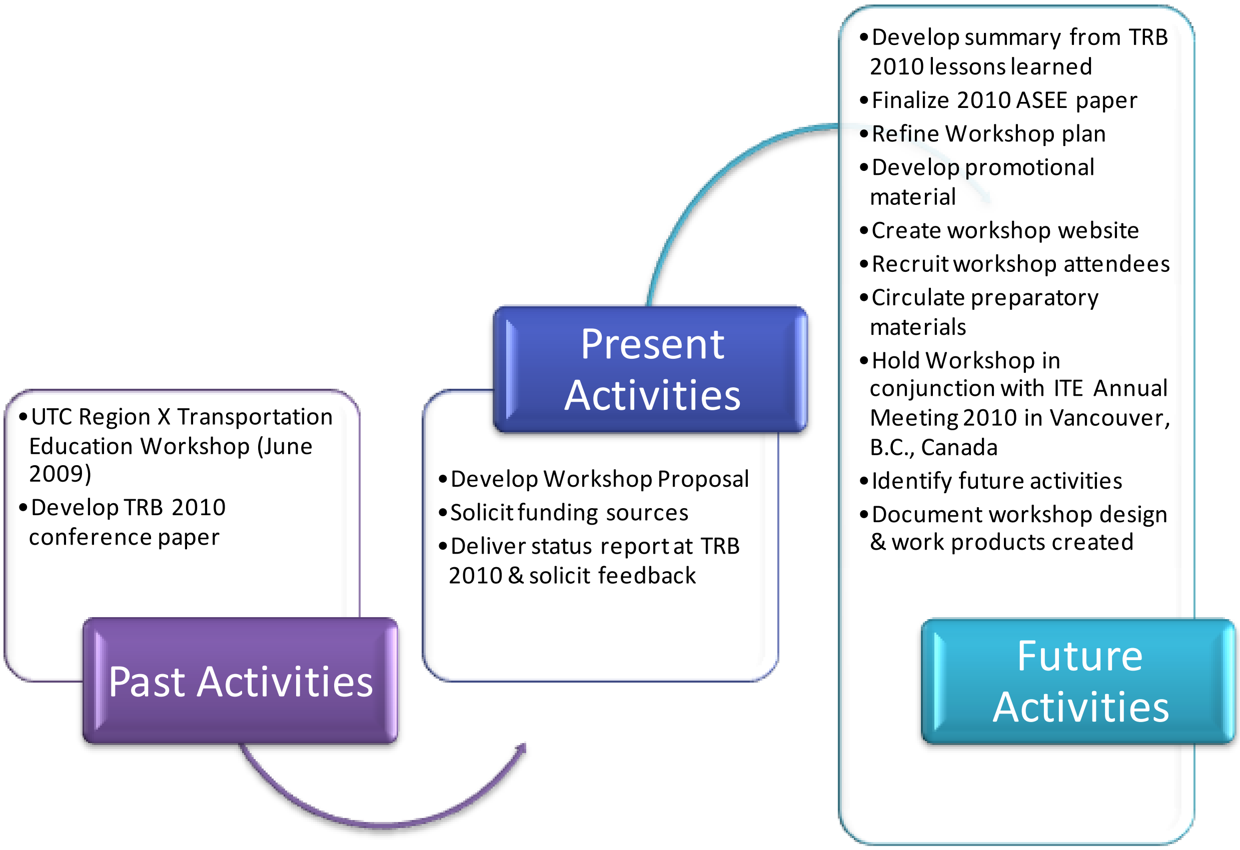

Figure 2 Work Plan

Past Activities (Prior to November, 2009)

During the UTC Region X – Transportation Education Workshop (June 2009) participants:

- Compared and contrasted different undergraduate transportation programs within Civil Engineering across the country
- Analyzed rankings of different transportation topics derived from practitioner and educator surveys over the last 20 years
- Reviewed principles of backward curriculum design by Wiggins & McTighe *(24)*
- Engaged in a group experience classifying knowledge within a course for (a) enduring understanding, (b) important to know, and (c) items for awareness exposure
- Formed a subgroup to design and realize a national workshop to establish program level learning outcomes for undergraduate transportation education course

The subgroup of participants of the Region X – Transportation Education Workshop (June 2009) identified the development of a TRB paper as a key element in the success of identifying core concepts and formulating learning outcomes for transportation engineering courses. Such a paper will serve as a white paper to the education community, allow for broader discussion and input, and elevate the need for collaboration in course design. The group agreed that the paper would ideally be presented at the TRB Annual Meeting in 2010 and that it would include the following elements:

- Articulate purpose and motivation for this work.
- Review literature on past program and course development efforts.
- Propose a framework for crafting learning outcomes grounded in educational theory.
- Outline work needed for a successful curricular workshop at the 2010 ITE Annual Meeting.

Current Activities (November – January 2010)

Draft a workshop proposal that includes the following elements:

- Workshop goals – achieve consensus on core transportation learning outcomes and associated taxonomies/rubrics for measuring success with Civil Engineering (CE) undergraduates
- Stakeholder identification – CE faculty, department administrators, state and federal government professionals in transportation, consultants, ABET evaluators
- Workshop design – organize background materials, define presentation needs, small group activities, large group reports, real-time recording of results, and post-processing needed to meet workshop goals
- Facilitation planning – identify facilitation team, bring together 30-40 stakeholders for two days sometime in 2010 to propose and vet ideas about core competencies as well as metrics, subgroup meets for an additional day to distill findings for circulation among wider transportation community for validation

Solicit sources for workshop funding. These sources may include:

- UTC directors
- DOT staff
- NSF officers

Present status report at the TRB 2010 Annual Meeting and solicit feedback from academics and practitioners attending the meeting and from relevant TRB committees.

Future Activities (February 2010 onwards)

At this point the sub-group sees the need to pursue the following activities:

- Develop a summary of lessons learned from the feedback received at the TRB 2010 Annual Meeting.
- Finalize 2010 ASEE paper that updates curriculum development methods, presents work products from the TRB workshop, and captures important lessons learned that should ITE workshop planning.
- Refine ITE workshop plan based on TRB feedback.
- Create promotional materials for recruiting stakeholders.
- Design workshop website.
- Recruit workshop attendees.
- Circulate preparatory materials and assignments to attendees.

- Hold workshop in conjunction with the Institute of Transportation Engineers Annual Meeting. The meeting will take place August 8-11, 2010 in Vancouver, British Columbia, Canada
- Identify future activities based on findings from the ITE workshop
- Document workshop design and work products created at the ITE workshop through TRB and ASEE papers.

CONCLUSIONS AND RECOMMENDATIONS

Transportation education is a broad and complex field. As teachers, there is consensus that it is necessary to teach the key concepts to make students competitive and competent in today's workforce. However, there is not broad-based agreement on what are these key concepts. Backward course design (11) as well as guidance from professional societies (17) and accrediting organizations (22) can be used to distill a concise and meaningful set of learning outcomes for the introduction to transportation engineering course

Preliminary work products and a plan for a 30 to 40 person workshop at the 2010 ITE Annual Conference in August, 2009, will be reviewed by a focus group ahead of the 2010 TRB meeting. Upon completion of the August 2010 workshop, the working group represented by the authors of this paper, intends to fully document the process used for course design, report consensus on essential and optional learning outcomes for the first transportation engineering course, and supply preliminary rubrics based on Bloom's Taxonomy for gauging achievement of these outcomes. The working group recognizes that curriculum design and delivery is an ongoing process.

While the August 2010 workshop is targeted towards the development of a set of vetted learning outcomes, it is understood that the underlying core concepts and supporting pedagogies will need to be updated in response to classroom feedback as well as evolution in the field of transportation engineering itself. One of the most important impacts of this course development effort may be a community of transportation educators who actively share course designs, curriculum materials, teaching methods, and assessment instruments.

REFERENCES

1. Turochy, R.E. (2006) Determining the Content of the First course in Transportation Engineering. *Journal of Professional Issues in Engineering Education and Practice*. July 2006, pg. 200-203. American Society of Civil Engineers.
2. Agrawal, A.W. and J. Dill. (2008) To Be a Transportation Engineer or Not? How Civil Engineering Students Choose a Specialization. *Transportation Research Record 2046*. Transportation Research Board of the National Academies.
3. Transportation Research Board (1985). Transportation Professionals: Future Needs and Opportunities, Special Report 207, TRB, National Research Council, Washington, D.C.
4. Transportation Research Board (1985). Transportation Education and Training: Meeting the Challenges, Proceedings of the Conference on Surface Transportation Education and Training, Special Report 210, TRB, National Research Council, Washington, D.C.
5. Transportation Research Board (1998). Intermodal Transportation Education and Training. Conference Proceedings 17, TRB, National Research Council, Washington, D.C.
6. FHWA (2002). National Transportation Workforce Summit: Summary of Proceedings, US Department of Transportation, Washington, D.C. May.
7. Transportation Research Board (2003). The Workforce Challenge: Recruiting, Training and Retaining Qualified Workers for Transportation and Transit Agencies. Special Report 275, TRB, National Research Council, National Academies, Washington, D.C.

8. Turnbull, K. F. (1995). Transportation Planning Education in Urban and Regional Planning Graduate Programs. Transportation Research Record No. 1498, TRB, National Research Council, Washington, D.C., pp 57-64.
9. Handy, S, L. Weston, J. Song, K. Maria, and D. Lane, (2002), Education of Transportation Planning Professionals. Transportation Research Record No. 1812, TRB, National Research Council, Washington, D.C., pp 151-160.
10. Krizek, K. and D. Levinson (2005). Teaching Integrated Land Use-Transportation Planning: Topics, Readings, Strategies. Journal of Planning Education and Research, Vol. 24, pp 304-316.
11. Wiggins, G. and J. McTighe (2005) *Understanding by Design*, Prentice Hall, pp.201,
12. Zhou, J. and S. Soot (2006). Nationwide Survey of Transportation Planning Courses: Introduction, Findings, and Recommendations. Journal of the Transportation Research Board, No. 1956, TRB, National Research Council, Washington, D.C., pp 175-183
13. Zhou, J. and L. Schweitzer (2009). Transportation Planning Education in the United States: Literature Reviews, Course Survey, and Findings. Journal of the Transportation Research Board, No. 2109, TRB, National Research Council, Washington, D.C., pp 1-11.
14. Sussman, J.M. Educating the New Transportation Professional. *ITS Quarterly*. ITS America, Summer 1995.
15. Reinhart, D. (2008) Developing a Body of Knowledge for Environmental Engineering. *Proceedings of the 2008 American Society for Engineering Education Annual Conference & Exposition*.
16. Laity, W. et al. (2004) A Vision of the Future of Mechanical Engineering Education, a report of the ASME Council on Education. American Society of Mechanical Engineers, http://files.asme.org/asmeorg/Education/College/ME/7782.pdf
17. American Society of Civil Engineers. (2008) *Civil Engineering Body of Knowledge for the 21st Century, 2nd Edition*. Accessed at http://www.asce.org/professional/educ/bok2.cfm
18. Engineering Management Certification International. (2009) *What is the EMC-BOK?* Accessed at http://www.engineeringcertification.org/About/EMCBOK.cfm
19. http://www.asce.org/pressroom/news/policy_details.cfm?hdlid=15
20. Forehand, Mary. (2005) *Bloom's Taxonomy: Origninal and Revised.* E-Book: Learning, Teaching, and Technology. Accessed at http://eit.tamu.edu/JJ/DE/BloomsTaxonomy.pdf
21. Overbaugh, R.C. and L. Schultz. *Bloom's Taxonomy.* Accessed at http://www.odu.edu/educ/roverbau/Bloom/blooms_taxonomy.htm
22. ABET. (2007) *Criteria for Accrediting Engineering Programs.* Accessed at http://www.abet.org/Linked%20Documents-UPDATE/Criteria%20and%20PP/E001%2008-09%20EAC%20Criteria%2012-04-07.pdf
23. Wikipedia. (2009) *Mechanical Engineering.* Accessed at http://en.wikipedia.org/wiki/Mechanical_engineering
24. National Cooperative Highway Research Program. (2006) Core Competencies for Highway Safety Professionals. *Research Results Digest 302*. Accessed at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_302.pdf