Abridgment

Undergraduate Transportation Engineering Education

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A survey of transportation professionals was conducted to determine their views on the contents of a required transportation course in the bachelor of science in civil engineering (BSCE) program. The results are compared with a similar survey of transportation educators. Substantial congruence exists in the views expressed by practitioners and educators. Additional observations and suggestions offered by practitioners to enrich a required course are also presented. It is recommened that topics in transportation engineering receiving a high score from both practitioners and educators be included in a required course in transportation engineering for undergraduates.

A recent nationwide survey of undergraduate civil engineering (CE) programs in this country has revealed that about 86 percent of CE departments teach a required transportation engineering course, representing an average of about 3.5 credit hours *(1)*. Over the years there has been a running debate about what to include in this required course (or courses), because "no two teachers have identical views as to what transportation engineering topics should be taught to aspiring civil engineers" *(2)*.

Most courses in civil engineering are taught using standard textbooks, and transportation is no exception. Although there appears to be a general dissatisfaction with introductory textbooks on transportation, most instructors follow one or more of these texts, supplementing parts of the course with relevant notes. Recently, the author of a transportation textbook conducted a survey of professors teaching transportation to determine the content of the course(s) that should be included as a requirement in a CE curriculum *(2)*.

Although the collective views of transportation educators obtained through this survey have been useful in developing courses, it was believed that similar input from qualified transportation practitioners would further enhance the information available. A telephone survey of 50 transportation professions was, therefore, conducted, and the views of educators and practitioners are compared in this paper followed by a discussion of the survey results.

THE PROBLEM

The multidisciplinary nature of transportation has created several problems in teaching a required course in transportation in the undergraduate CE program. Some of these problems are: lack of suitable, moderately priced, relatively self-contained, introductory textbooks; general deficiency among students in areas such as microeconomics and statistics, which are needed to comprehend transportation problems; lack of understanding of the systems necessary to address socioeconomic issues connected with transportation; lack of appreciation of the multivariable, open-ended, conflict-ridden, value-laden nature of real-world problems; and presentation of the principles of transportation from a modally oriented point of view *(3–5)*.

The questions stemming from these problems are: What constitutes transportation engineering education for an undergraduate CE curriculum? What do employers expect from a CE undergraduate? How should the course be developed so that it addresses the needs of a relatively large number of CE students who in all probability do not foresee the possibility of pursuing further studies in transportation, and at the same time stimulates a relatively small number of students who may develop an active interest in transportation? *(2,3,6)*

BACKGROUND

Although the master's degree is considered by most educators and practitioners as the degree of specialization in transportation, only a small percentage of undergraduates elect to pursue the master of science in civil engineering (MSCE). This is not surprising. When industry pays an individual with a BSCE a starting salary comparable to a Ph.D., it deprives the young engineer of any significant motivation to acquire an advanced degree *(4,6)*.

Proper grounding in the principles of transportation is essential because the entry-level BSCE in federal, state, and local government, as well as in construction, design, and consulting firms may have had only one required course in transportation engineering. The Committee for the Study on Transportation Professional Needs had similar views:

> Some hiring at levels above the entry-level is undoubtedly occurring, but is probably small. The normal practice in most states is to hire relatively inexperienced entry-level engineers, train them in varied activities of the agency and promote them after several years to fill higher staff positions. This not only provides an adequate supply of professionals versed in the methods employed by the agency, but also establishes a career path that encourages loyalty *(7)*.

SURVEY OF PRACTITIONERS

To identify the views of the transportation practitioners, the author selected, at random, 50 professionals in the United States, working for departments of transportation, counties,

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cities, and private firms. The mode-distribution of these professionals was as follows: highways 30; general transport 6; public transport 8; airways, railroads, and seaports 2 each. This distribution matched the ITE membership mode distribution *(8)*. All the practitioners interviewed had acquired an MSCE in transportation after receiving their BSCE. The practitioners were asked to evaluate the importance of 30 topics that could possibly be included in a required course in transportation for CE students. They were also asked to express their views regarding their choice of topics, including general observations and suggestions for improving the quality of CE students.

Each of the topics presented was ranked by the practitioners on a 5-point scale as follows: 1, definitely do not include; 2, probably not include; 3, no opinion; 4, probably include; and 5, definitely include.

Table 1 gives the 30 topics by rank. It also includes as a comparison, the 10 topics that received the highest scores awarded by transportation instructors in Wright's survey *(2)*. Figure 1 is a plot combining the scores given to topics common to practitioners and educators.

DISCUSSION OF SURVEY RESULTS

The 45 degree line shown in Figure 1 represents equal valuing by practitioners and educators. Common topics plotted above the line represent educators assigning a higher score than practitioners for these topics and vice versa. The pattern that appears to emerge is that geometric design of highways, vehicle operating characteristics, highway capacity studies, intersection design, and transportation planning have greater relevance to practitioners versus educators. On the other hand, description of transport systems, traffic flow characteristics, and traffic safety are scored higher by educators versus practitioners. Considering the scale of Figure 1, it is evident that we are essentially dealing with scores of 4.0 and above indicating that these topics are considered essential for inclusion in a required course and that ranking per se has little significance. Also, the fact that the 10 topics receiving the highest scores awarded by educators are common with 13 topics receiving the highest score awarded by practitioners reinforces the belief that there is a high congruence in the expectations of educators and practitioners.

SUMMARY OF VIEWS EXPRESSED BY PRACTITIONERS

Conversations with practitioners interviewed in the telephone survey resulted in the following general observations, views, and suggestions with respect to enriching a required course in transportation.

- Students should be given the opportunity to tackle open-ended problems, defending their solutions or conclusions with short narratives.

TABLE 1 TRANSPORTATION TOPICS

Topic	Practitioners (N = 50)			Educators (N = 51)		
	Score	SD	Rank	Score	SD	Rank
Geometric Design of Highways	4.80	0.63	1	4.62	–	2
Vehicle Operating Characteristics	4.72	0.72	2	4.34	0.77	5
Highway Capacity Studies	4.69	0.68	3	4.28	0.99	6
Intersection Design	4.58	0.90	4	4.00	–	8
Transportation Planning	4.44	1.33	5	3.96	–	9
Traffic Control Devices	4.32	1.20	6	4.38	0.96	4
Economics of Transportation	4.20	1.35	7	–	–	
Land Use/Transportation Interaction	4.18	1.45	8	–	–	
Evaluation Techniques	4.13	1.02	9	3.90	–	10
Transportation System Management	4.06	1.40	10	–	1.36	
Description of Transport Systems	4.04	0.80	11	4.72	0.57	1
Traffic Flow Characteristics	4.04	0.94	12	4.54	0.79	3
Traffic Safety	4.00	0.73	13	4.22	0.89	7
Contracting Procedures	3.92	1.20	14	2.30	–	–
Specifications	3.80	1.31	15	–	–	–
Operational Characteristics of Modes	3.80	1.37	16	–	–	–
Mass Transit	3.79	1.35	17	–	–	–
Airport Planning	3.63	1.50	18	–	–	–
Human Powered Transport	3.50	1.41	19	–	–	–
History and Development of Transportation	3.41	1.11	20	–	–	–
Earthwork Operations	3.40	1.39	21	2.28	1.49	–
Transportation Materials	3.27	1.15	22	–	1.46	–
Pavement Management	2.90	1.15	23	–	1.37	–
Construction Procedures	2.68	1.04	24	–	1.37	–
Transportation Legislation	2.54	1.98	25	–	0.73	–
Pipelines	2.42	1.29	26	–	–	–
Statistics Applied to Transportation	2.40	1.10	27	–	–	–
Maintenance of Facilities	2.31	1.37	28	–	1.34	–
Belt Conveyors	2.30	1.40	29	2.08	–	–
Ports and Harbors	2.28	1.39	30	2.12	1.46	–

Note: SD indicates standard deviation.

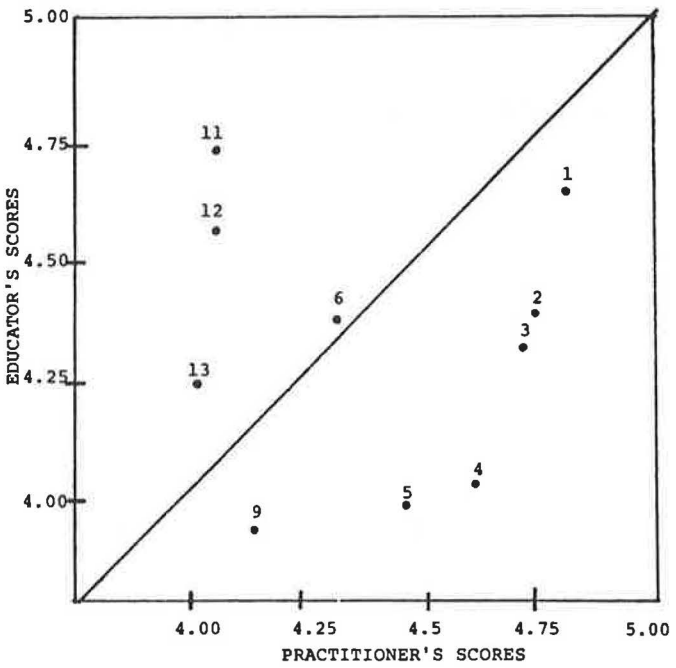

FIGURE 1 Comparison of scores.

- Students should be given every opportunity to tackle real-life problems. This could be in the form of one or more projects done individually or in a group. The group project idea should be encouraged because it provides students with a realistic experience in team dynamics. Assessing individual effort from team performance should not prove a menacing problem if proper peer assessment techniques are used *(9)*. If possible, a practitioner should be asked to help in the assessment.
- The ability to solve problems with incomplete or redundant data should be impressed on students through appropriate examples and class assignments.
- The fundamental principles underlying transportation should be emphasized.
- To do justice to such topics as pavement design, construction methods, maintenance of facilities, and so forth, it would be best to address these topics in courses other than the required course.
- Where possible, between 10 to 15 percent of the course should be taught by instructors actively collaborating with practitioners.

RECOMMENDATIONS AND CONCLUSIONS

On the basis of the data presented, it is recommended that

1. A required course(s) in transportation engineering in the BSCE program cover all or most of the topics receiving a score of 4.0 or more as given in Table 1.
2. The proportion of time devoted to each topic and the sequence in which these topics are addressed be left to the discretion of individual instructors.
3. Cognizance be given to the suggestions made by practitioners.
4. The basic principles of transportation be emphasized, if necessary, through one mode of transportation.

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