Promoting the Adoption of Innovative Teaching Practices by Transportation Engineering Faculty in a Workshop

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Introduction

The National Transportation Curriculum Project (NTCP), a consortium of researchers from fifteen colleges and universities, is concerned with the development, dissemination, and widespread adoption of curricular materials and best practices in transportation engineering education [1]. In 2012, the NTCP hosted a two-day Transportation Engineering Education Workshop (TEEW) to facilitate the collaborative development and adoption of active learning and conceptual-assessment exercises for the introduction to transportation engineering class. With this motivation, the workshop provided the opportunity for groups of faculty to develop active learning and conceptual assessment exercises collaboratively in a process scaffolded by short presentations and demonstrations and punctuated by direct feedback by nationally recognized experts in these areas [2]. The workshop's effectiveness was measured by investigating changes in beliefs about the importance of active learning and conceptual assessments, curriculum development networks, and value of the workshop to participants. This paper has been organized in the following sequence: an introduction of the NTCP, followed by a description of the TEEW workshop, an assessment of the workshop's effectiveness, and finally, concludes with the products and impacts of the workshop to date.

The National Transportation Curriculum Project (NTCP)

The NTCP is a collaborative effort of a group of approximately fifteen university transportation engineering educators motivated to advance the goals set during the 2009 Transportation Education Conference [1, 3] (http://www.webs1.uidaho.edu/transportation_education_conference-2009/index.htm). The purpose of the project is to develop a set of activity-based learning curriculum for the introductory course in transportation engineering [3]. With the mission to improve transportation engineering education, to date the project members have developed learning outcomes for the introductory transportation engineering course and a set of associated knowledge tables, which were piloted at three institutions [2]. Following the piloting effort, the NTCP convened the TEEW workshop in order to implement active learning and conceptual assessments by a larger network of transportation faculty members [1]. The specific focus was to (1) develop active learning and conceptual-assessment exercises for the introductory transportation engineering course and (2) form a network of similarly-motivated colleagues (a curriculum-development network) to promote further development, sharing, and adoption of novel materials.

Transportation Engineering Education Workshop (TEEW)

In 2012, the TEEW was convened at the University of Washington, Seattle, WA sponsored by the National Science Foundation (NSF). The goal of the workshop was to provide transportation faculty with a compelling body of evidence that active learning environments are effective for student learning and an opportunity to develop relatively simple materials and strategies to implement active learning in their classroom. The effectiveness of the workshop was measured by investigating changes in faculty beliefs toward active learning and conceptual-assessment

exercises, in the density and connectivity of the curriculum-development network, and in self-reported classroom practice [2].

The following objectives were established in order to address the workshop goal:

1. Change the beliefs of transportation engineering educators regarding the importance of active learning and conceptual assessment exercises in the introduction to transportation engineering class,
2. Facilitate the emergence of a network of transportation engineering educators committed to the collaborative development of improved educational resources for the introduction to transportation engineering class, and
3. Increase the use of active learning and conceptual assessment by transportation engineering educators in the introduction to transportation engineering class.

In this study, active learning exercises are broadly defined as any classroom engagement not categorized as passive learning (i.e., merely listening to a professor speak) [2]. These exercises might include groups of students working together facilitated by the instructor or exercises representing a difficulty beyond that which had been previously encountered in class. Conceptual assessment exercises are broadly defined as any classroom engagement where students are not tasked with the direct application of equations and the calculation of solutions [4, 5].

Workshop Overview

Participants

The workshop brought together 60 professionals from across the country, including 46 engineering faculty members, 9 PhD students, and 5 government engineers from a total of 34 different institutions. The workshop organizing committee was a subset of the NTCP, who recruited participants both personally and through distributing advertisements on numerous listservs, including the civil engineering department heads listserv. To improve diversity, the following characteristics were considered when soliciting participants:

- School type (public & private – community college, 4 year BS-, MS-, & PhD granting)
- Instruction Position (adjuncts, instructors, assistant, associate, & full professors)
- Classroom experience (0-5, 5-10, 10-15, 15-20, 20+)
- Geography (pacific, mountain, central, & eastern)
- Sex & race (men & woman, as diverse as possible)

Activities

The workshop activities were designed to effectively achieve the workshop goal stated in the previous section. The following key points summarize the overall workshop activity.

- During the workshop, nationally recognized experts presented mini-lectures to participants to provide evidence of the efficacy of active and conceptual learning.

- Those mini-lectures were interspersed between working sessions in which participants formed small teams to develop ranking tasks and learning activities. Teams focused on the content areas of transportation planning, design, operations, and safety. The purpose of those working session was to provide participants with the opportunity to collaboratively apply the new knowledge acquired and to develop networks of educators with similar interests.
- During the workshop, participants developed drafts of 108 ranking tasks and other learning activities based on the NTCP learning outcomes and knowledge tables [1].
- The crafted drafts were recorded by hand on large pads of paper, which were digitized and transcribed into .docx files for dissemination to all of the conference participants and other interested parties through the NTCP website (http://nationaltransportationcurriculumproject.wordpress.com/).
- To date, 60 ranking tasks have been finalized. These ranking tasks include contents on traffic operations topics, such as the fundamental diagram of traffic flow, time-space diagrams, cycle length, and delay; and design topics, such as stopping-sight distance on isolated vertical and horizontal curves, the alignment of horizontal curves in sequence, and vehicle cornering [2].
- In addition to the NTCP website, the developed materials were also disseminated through the Institute of Transport Engineers (ITE) Education Council in the form of presentations at the mid-year and annual meetings, newsletter articles, and in a presentation and conference paper presented at the 2013 American Society for Engineering Education (ASEE) annual meeting [2, 6].
- The workshop organizers also accumulated data on participant beliefs about active learning, their current application of active learning exercises in their courses, and connectivity with other workshop participants.

Assessment of workshop effectiveness

The impact of the workshop on participants was assessed with reflective open-ended survey questions. For that purpose, three surveys were developed and administered in sequence to collect information on participants' belief of active learning and conceptual assessment exercises, the extent they are connected to curriculum development network, and the influence of the workshop on participants' classroom practice. To accumulate data on each category, surveys were administered at the beginning of the conference on the first day, at the end of the conference on the last day, and six months later, which were respectively titled as pre-, post-, and follow-up surveys.

Results and Summary

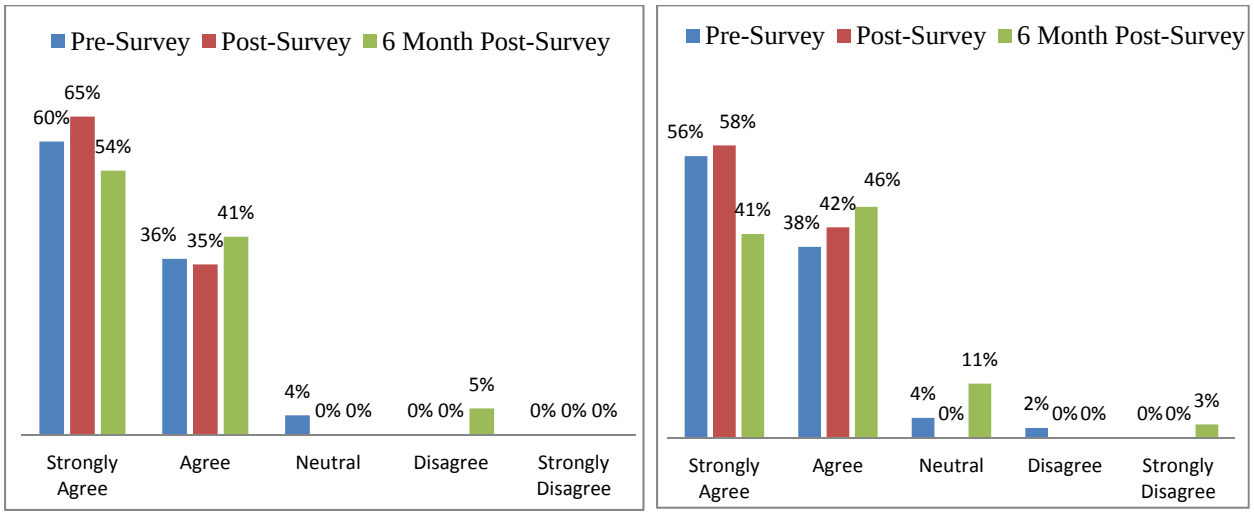
This section includes results found by analyzing in the pre-, post-, and follow-up survey responses described in previous section.

Faculty Beliefs

The educational belief questions were designed around three concepts: 1) active learning and conceptual assessment exercises are an important part of lecture, 2) active learning and

conceptual assessment exercises improve student learning, and 3) all instructors should implement active learning and conceptual exercises.

Figures 1-3 demonstrate the survey responses on these three perceptions during the pre-, post-, and follow-up survey periods. As shown in Figure 1, participants strongly agreed (range of 41% to 65%) or agreed (range of 35% to 46%) with the idea that active learning and conceptual assessment exercises are an important part of lecture. Figure 2 shows a similar pattern about the idea that active learning and conceptual assessment exercises improve student learning (with 50% to 67% strongly agreeing and 30% to 44% agreeing). However, as observed in Figure 3, a larger percentage of responses to participant beliefs that all instructors should implement active and conceptual learning activities in the classroom were neutral or even disagreed, particularly in the 6-month post-survey.



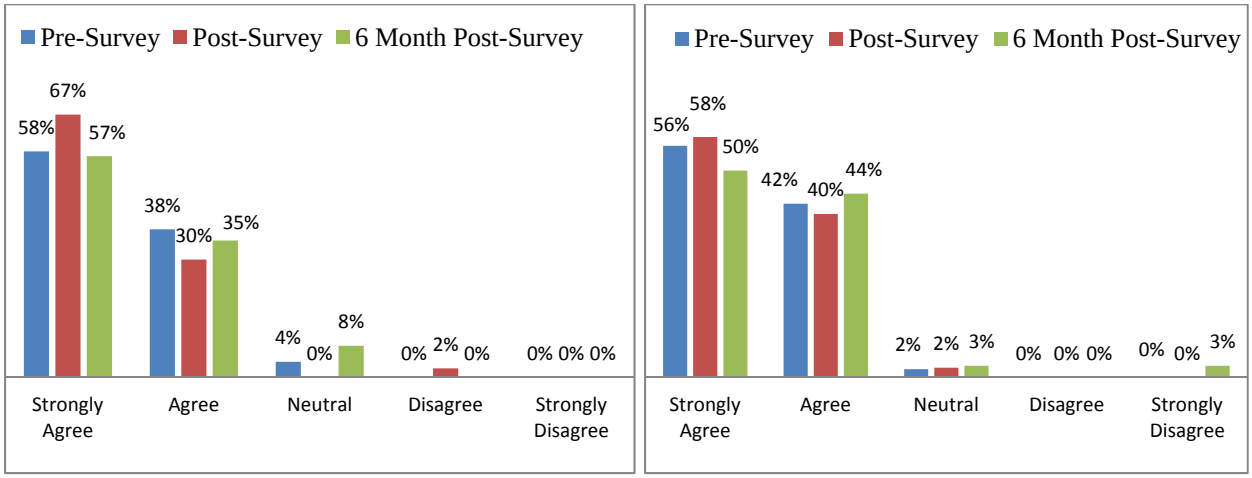
(a) (b)

Figure 1: Changes in participant beliefs that active learning and conceptual exercises are an important part of a lecture period: (a) active-learning exercises; (b) conceptual exercises

Although there are extensive evidence supporting the value of active learning and the link between beliefs and practices, no survey scales were found on teacher beliefs about active learning [2]. Therefore, the beliefs survey responses utilized the 5-point Likert Scale, which were then transformed into numerical values with "Strongly Agree" responses given a value of 5 and "Strongly Disagree" given a value of 1., When comparing the results of the pre- and post-surveys, the responses were higher (i.e., more favorable) in the post–survey when compared to the pre-survey, except the question that asked whether conceptual exercises should be implemented by all instructors. For this question, the average was slightly lower when all observations were included and slightly higher when only the paired observations were analyzed. However, comparison of the pre- and follow-up surveys responses produced a different result, where responses to all six results were lower in the follow-up survey compared to pre-survey.

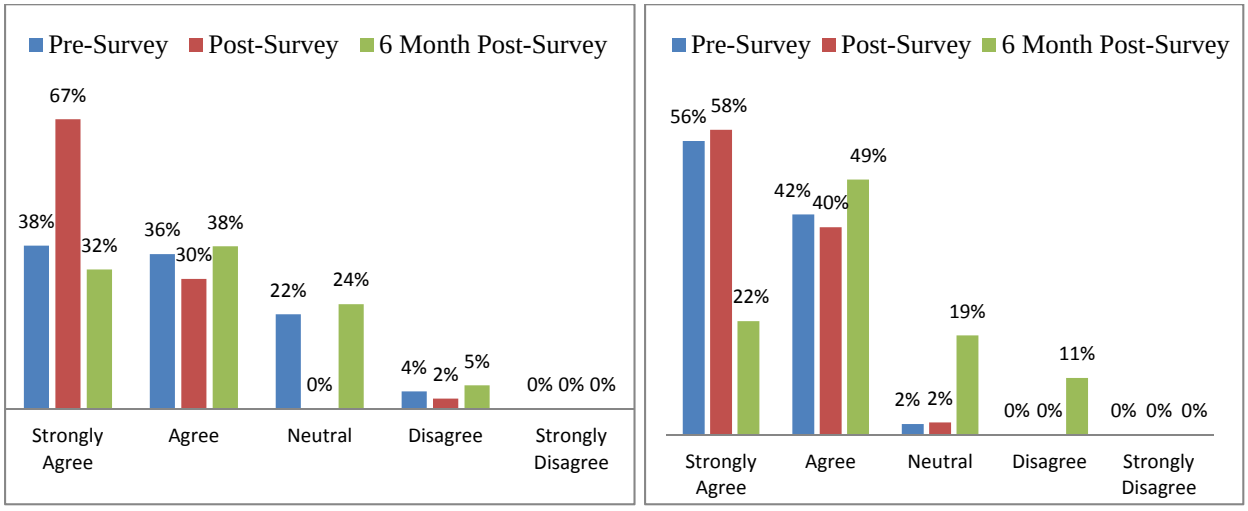
The immediately positive shifts in participant beliefs about the importance of active learning and conceptual exercises with declines during the follow-up period indicates participants' enthusiasm for active and conceptual learning to improve student learning. However, implementing these techniques in the real world might be significantly more challenging than

developing them in a supportive environment, which may have depressed the follow-up survey results [2].



(a) (b)

Figure 2: Changes in participant beliefs that active learning and conceptual exercises improve student understanding: (a) active-learning exercises; (b) conceptual exercises



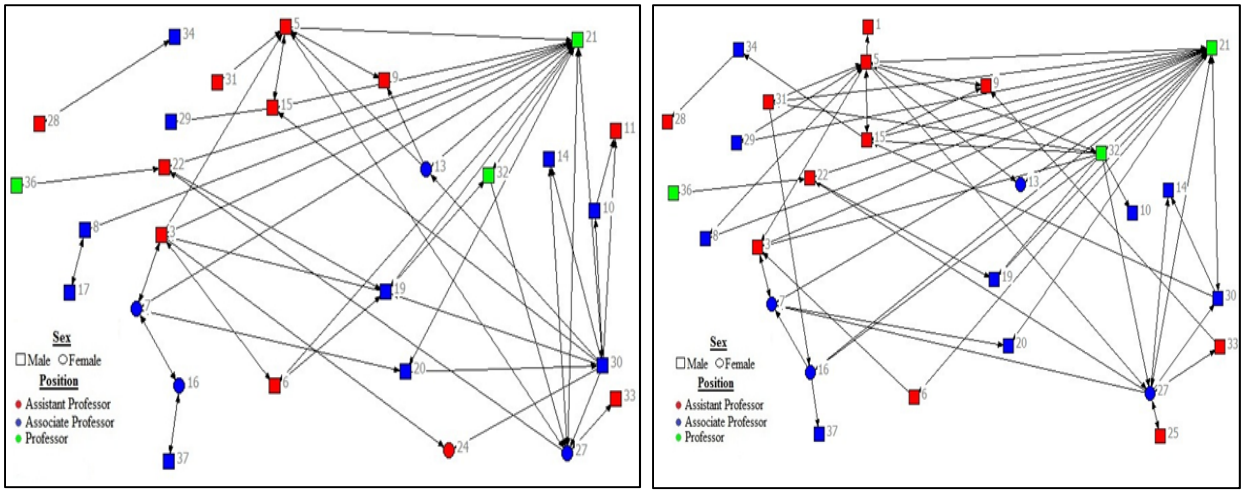
(a) (b)

Figure 3: Changes in participant beliefs that all instructors should implement active learning and conceptual exercises in their lectures: (a) active-learning exercises; (b) conceptual exercises

Curriculum-Development Networks

Social-network analysis was conducted to assess participants' level of connection with other workshop participants prior to the workshop and the change in their network connectivity during the workshop follow-up period. Figure 4 depicts the curriculum-development network that was developed accounting for the sex and institutional positions of the faculty participants. The links

represent a sharing of curriculum materials; an arrow pointing away from a node indicates that materials were provided by a participant, whereas an arrow pointing toward a node indicates that a participant received materials.



(a) (b)

Figure 4: Curriculum-development network among conference participants: (a) pre-existing network; (b) network six months later

In order to further describe the change over time in the overall networks, inclusiveness and network density were calculated. Inclusiveness refers to the number of points that are included within the various connected parts of the network, and the network density describes the general level of linkage among the points in a graph [2]. As shown in Table 1, a 24.0% increase in network inclusiveness and a 280.0% increase in network density were observed between the conference participants in the pre- and follow-up survey.

Table 1: Change in Network Density and Connectivity

Measures	Pre-Survey	Follow-up Survey	Delta
Inclusiveness	0.76	1.0	0.24
Density	0.05	0.19	0.14

Value of Workshop

Participants reported increased confidence implementing active learning in the classroom, a strong awareness that they needed to do more active learning, and, in some cases, increased implementation. Conference participants reported that they learned more about the importance and development of active learning and conceptual exercises and developed network ties to facilitate future development and implementation. The follow-up survey indicated that 90% of participants responded that the conference had an influence on changing their teaching practices, 67% said they both designed and used new active-learning exercises, 52% said they designed new conceptual-learning exercises, and 65% said they used conceptual-learning exercises.

Workshop products

An archive of draft ranking tasks and learning activities crafted during the workshop has been developed, which is available on the conference website (http://nationaltransportationcurriculumproject.wordpress.com/home/nsf-workshop/). The following papers have also been published as an outcome of the TEEW workshop:

1. Sanford Bernhardt, K., Hurwitz, D., Young, R., Bill, A., Brown, S., Heaslip, K., Kyte, M., Swake, J., & Turochy, R. (2013*) A Model for Collaborative Curriculum design in Transportation Engineering Education*. 120th ASEE Annual Conference & Exposition Conference Compendium.
2. Hurwitz, D., Swake, J., Brown, S., Young, R., Heaslip, K., Sanford Bernhardt, K., Turochy, R. (to be submitted 4/2013) Influence of Collaborative Curriculum Design on Educational Beliefs, Communities of Practitioners, and Classroom Practice in Transportation Engineering Education. American Society of Civil Engineers: Journal of Professional Issues in Engineering Education and Practice.

Conclusion

The TEEW described in this research presents a model of a professional development workshop, which demonstrated that collaborative development of active learning activities and conceptual assessment exercises could contribute to positive improvements in faculty beliefs, curriculum development networks, and classroom practice. Results of this research effort suggest the rationale for adoption of active learning and conceptual exercises in the introduction to transportation engineering class and building a curriculum development network that can contribute to improved education learning and student retention. The model proposed and tested through this workshop can be adapted by other engineering disciplines for the purpose of improving adoption rates of the best engineering education practices and to develop better teaching materials.

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