STREET: Where Simulation Meets Reality

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Simulations and games are receiving increasing attention in teaching in higher education. In this context, we developed a series of simulation modules (STREET) in transportation engineering education and applied them in teaching undergraduate and graduate transportation courses at the University of Minnesota. After several years, we contend that they represent an effective pedagogical tool in transportation education. In this chapter we describe our motivation for this work, the program's development process, dissemination and impacts, and our future work.

Motivation

As simulations and games have been increasingly assimilated in classroom teaching for a variety of disciplines, transportation-related courses are still mostly taught with the chalk-and-talk lectures and paper-and-pencil problem solving method [1, 2]. Unlike some other areas of engineering, it is difficult to do traditional laboratory work in transportation, and agencies are rightly reluctant to allow students to affect live traffic or test new road or transit route configurations. There exists a wide gap between understanding new transportation knowledge from the classroom and applying it in a real environment for learners. Therefore, we developed STREET (Simulating Transportation for Realistic Engineering Education and Training) to fill this gap by allowing students to apply new knowledge in a simplified, low-cost and risk-free environment through simulations. These simulations actively engage students in the learning process, where students can take the initiative to set up the experiment, propose their hypotheses and strategies, and test these hypotheses by themselves or working in groups in silica. These simulation modules are particularly useful for applied subjects in transportation such as traffic signal design and transportation infrastructure planning.

Funding and the development process

Led by Professors Henry Liu and David Levinson at the University of Minnesota, the STREET Program was funded by the National Science Foundation's Division of Undergraduate Education with match support from the ITS Institute at the University of Minnesota, and seed grants from the former Digital Media Center at UMN. This program developed web-based simulation modules to improve undergraduate teaching in transportation engineering to create an "active textbook" [3]. Several other modules are applied in graduate-level transportation courses at the University of Minnesota. The program currently consists of nine online simulation modules, with each module focusing on a particular subject (Table 1). The subjects include: roadway design, signalized intersection simulation, travel demand and assignment, road network design, retail location choice, origin-destination estimation, and the growth of transportation infrastructure.

Specifically, we create an assignment for each simulation module which can be found on each module's webpage. In these assignments, students are required to play designated scenarios as well as scenarios they propose on their own. Their final product is a report summarizing findings from the investigated scenarios. To facilitate teaching, we further provide online students' background survey and evaluate survey for each simulation module, based on which instructors can assess its effectiveness.

A remarkable feature of the development process is the integration of research and teaching. Some simulation modules are derived from the researchers' existing research projects which engender opportunities for match

funding. The modules are tested and evaluated in the course offerings of the Civil Engineering program at the University of Minnesota.

Table 1 Simulation modules in the STREET Program

Name	Topic
ROAD (Roadway Online Application for Design)	Roadway geometric design
OASIS (Online Application for Signalized Intersection Simulation)	The control logic of an actuated signal controller
ADAM (Agent-based Demand and Assignment Model)	Travel patterns on a road network
SONG (Simulation of Network Growth)	Transportation network growth
SAND (Simulation and Analysis of Network Design)	Transportation network design
SOFT (Simulation of Freeway Traffic)	Traffic flow theory
CLUSTER (Clustered Locations of Urban Services, Transport, and Economic Resources)	Retail location choice
ABODE (Agent Based Model of Origin Destination Estimation)	Matching origins and destinations using employment job search method
ANGIE (Agent-based Network Growth model with Incremental Evolution)	The growth of road networks and the Minneapolis Skyway network

Dissemination and impacts

We share the produced program with the civil engineering education community in the US and around the world. The simulation modules are web-based and are open sourced. The source code, surveys, and related papers are available for download here. In addition to the University of Minnesota, faculty members from 17 universities have integrated STREET modules into their curricula. To further disseminate it to the general public, we have demonstrated the program in different exhibitions such as the Minnesota State Fair and Academic Technology Showcase at the University of Minnesota.

Applying the simulation modules in transportation courses at the University of Minnesota also spawned publications. Six research papers on using simulations in transportation education have been published or presented at the Transportation Research Board Annual Meetings. A full list of papers can be found here. Our research results indicate that such modules not only improve students' understanding of critical concepts in transportation, but also enhance their interest in the subjects they study. For example, after playing the CLUSTER simulation module, students are asked to write upon how transportation cost, demand, and supply would influence retail location choice, the theory of which has been taught in lectures. Students' feedback reveals that their understanding and interest in this topic has been deepened with the aid of visuals and fun game process. Overall, we find that the STREET Program well complements traditional classroom teaching.

Future work

Our future work will take several directions. We will continue to develop online simulation modules related with ongoing research projects and further evaluate their efficacy in lab teaching. It is of interest to use the modules or derivatives for other educational purposes. Examples include educating the general public on traffic and planning and integrating modules into high school extracurricular activities to attract students into the transportation field. This calls for collaborative work with public agencies, schools, and private sectors.

References

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