Youth Transportation Institute: An Undergraduate Research Initiative to Promote Transportation Engineering

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Abstract – In order to increase the number of practicing transportation engineers in the Southeast Alabama region, a program has been developed by an undergraduate student in the department of Civil Engineering, a participant of the Summer Undergraduate Research Program at the University of South Alabama. The summer research program served two purposes: first, the undergraduate student gained substantial experience in doing research on how to develop instructional components to promote transportation engineering and second, the product of the research: Youth Transportation Institute (YTI). Youth Transportation Institute is an outstanding initiative to introduce middle school and high school students to Civil Engineering disciplines, especially to Transportation Engineering careers. Youth Transportation Institute is expected to attract rising Junior and Senior high school students to help increase the size of workforce within the transportation profession, with preference given to minorities and females. Institute presentations and hands-on examples and challenge activities have been designed to give participants a general overview of transportation engineering as a career. A comprehensive evaluation will be conducted at the end of the Institute to assess if the students enjoyed their experiences, and that they were influenced to consider transportation engineering careers.

Keywords: Transportation Engineering; Engineering Outreach; Middle School; High School.

BACKGROUND

Studies show that fewer students enter into and persist in engineering degree programs than in other programs in the United States [Hossain, 2; Villiers, 3]. This problem is even more pronounced among minorities and students from low-income families. Civil Engineering, like other engineering discipline, is facing similar problem [Elton, 1]. One of the often cited reasons for the shortage of students in engineering programs is the lack of knowledge and exposure to the opportunities in the engineering field [Villiers, 3]. Transportation engineering is a major sub-discipline of civil engineering. This branch of civil engineering is concerned with moving people and goods efficiently, safely, and in a manner conducive to a vibrant community. Transportation engineers specify, design, construct, and maintain transportation infrastructure which includes streets, canals, highways, rail systems, airports, ports, and mass transit. Therefore, for proper functioning of our society, there is a need for more talented and dedicated transportation engineers capable of maintaining our existing transportation infrastructure and designing and building new safe and efficient transportation facilities. Literature shows that there has been a decline in the number of transportation professional s [Wilkes, 4]. This decline can be attributed to the fact that the number of people retiring in this profession is more than the number of young people entering this profession. This paper describes an undergraduate research project that has been initiated at the University of South Alabama to motivate middle and high school students of Southeast Alabama to pursue a future in the transportation engineering profession.

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The civil engineering program at the University of South Alabama (USA), located in Mobile, Alabama, is a major center of quality higher education in civil engineering in the upper Gulf Coast region. This program at the University of South Alabama is the only quality civil engineering program within 150 miles radius of Mobile [Hossain, 2]. If proper initiative is taken, this program can motivate students from the southern part of Alabama, southeastern part of Mississippi, and northwestern part of Florida to pursue career in transportation and other areas of civil engineering. Therefore, it is expected that the Youth Transportation Institute, described in this paper, will be able to develop interest among the young middle and high school students of the upper Gulf Coast region in transportation engineering.

COMPONENTS OF THE PROGRAM

A student's learning can be enhanced significantly by active participation in research activities. The UCUR Summer Undergraduate Research Program at the University of South Alabama provides students an excellent opportunity to become involved in research in their field(s) of interest. This paper describes one such undergraduate research project that was conducted to develop an outreach program for Transportation Engineering- The Youth Transportation Institute. The primary objective of the Youth Transportation Institute is to attract students in the surrounding area to transportation engineering profession. In an attempt to effectively address the area's youth, the proposed transportation program is designed to accommodate students from both middle schools and high schools in the Greater Mobile area. Although the program is developed for middle and high school students in general, participation of minority and female students is going to be more encouraged. The program has a separate component for middle school and high school students, and each component consists of presentations followed by activities.

Middle School Component Presentations

The following presentations have been designed to target younger audiences:

- Traffic/road signs
- Overview of transportation design and urban planning
- Transportation-Opoly board game

The traffic and road sign presentation discusses commonly used traffic symbols and their history. Specifically, the discussion covers how transportation engineers decide when and where to place a road sign, the meaning of the colors of road signs, and how the reflective material on signs is developed. At the end of the lecture, the students will break into groups and make traffic signs of their own using given poster boards and markers.

The transportation design and urban planning presentation is designed to provide young audiences an overview of the engineering designs transportation engineers are involved in. Also, this presentation gives them a general idea of the urban planning processes. Using aerial photos of the downtown area of Mobile, Alabama, students observe how roads, bridges, and overpasses are woven into the surrounding city. In short, this presentation shows the middle school students how transportation engineers cater to the community they serve and facilitates the city's operations. At the end of this presentation students will be asked to develop mall cities with efficient transportation network using an urban planning simulation program called SimCity. This activity is described later in this paper.

The final presentation introduces middle school students to the "Transportation-OPOLY" board game, a product of the undergraduate research described in this paper. "Transportation-OPOLY" board game introduces players to the various systems that transportation engineers deal with regularly. The game is described in detail later in this paper.

High School Component Presentations

The following presentations have been designed to target high school students:

- Job opportunities within transportation engineering
- Highway design

- Bridge design
- Transportation materials
- Crash statistics/driver safety

Transportation engineers are civil engineers who design highways, airports, railway, bus systems, etc. They work for governmental agencies; for consulting firms that troubleshoot for the government; and for private firms that produce materials and equipment used in transportation. Transportation engineers are also teachers and researchers at colleges and universities. Some transportation engineers design roads, while some transportation engineers deal with traffic patterns. Engineers also supervise the construction or repair of transportation systems. Municipal, county, or state officials hire transportation engineers to develop new transportation systems or to find alternative routes to relieve congestion on existing highways. Sometimes the engineers draw up plans for new multilane highways to be built in places where only local roads exist. The youth transportation program provides the high school student participants opportunity to meet local transportation professionals. The participants learn from them about local transportation projects and job that are locally available for transportation engineers.

The highway design presentation informs the students about the various aspects of the layout and geometric design of highways. The students learn about the history and scope of the United States interstate system. Additionally, the students learn how highways are laid out using a variety of geometric forms such as tangents, horizontal curves and vertical curves. The young participants also learn about the makeup of roadway cross-section: sub-grade, sub-base, base and wearing surface. After the presentation, students take part in an activity that involves them in building road cross-sections in the lab as described later in this paper.

Bridge design presentation introduces different types of bridges and discusses factors considered in the selection of each type. Also, it gives a general overview of the major factors that influence the design of a bridge. After the presentation, each participant gets a taste of designing a very simple bridge using the "West-Point Bridge Designer" software.

Transportation materials presentation for high school students discusses the properties and use of transportation materials. Such materials include: concrete, asphalt, wood and steel. Following the presentation, students take part in the compressive strength testing of concrete.

The teen crash statistics presentation is geared towards preventing accidents through awareness. This lecture focuses on vehicle accident facts for the state of Alabama. Three main topics discussed are the number, types, and causes of accidents. Also, this presentation discusses preventative measures that drivers can take to avoid getting into an automobile accident. The students also watch a video about driver safety and road barriers which is followed by a question and answer session.

PROGRAM ACTIVITIES

The Youth Transportation Program consists of various hands-on interactive activities for the participants. This section briefly describes the activities mentioned in the previous section.

Urban Planning Exercise Using "SimCity"

After attending the presentation on transportation design and urban planning, the young participants will have an opportunity to develop their own city using the "Sim City" computer program. The "Sim City" is an excellent computer simulation software that allows users to create their own cities from scratch. The software is suitable for upper elementary school students and above. The participants of the Youth Transportation Institute will create virtual cities that they control on a landscape generated by the computer. In the city, the participants will create residential, industrial, and commercial zones at suitable locations for the inhabitants (Sims) to live, work and shop/ conduct business respectively. Also, they have to create roads to connect the different zones together so that the inhabitants (Sims) can travel between work, shopping or home. This activity will provide the participants an appreciation of the urban planning process. Figure 1 shows a virtual city created by the "Sim City" program.

Figure 1. Development of a city using the "SimCity" computer program.

"Transportation-OPOLY" Game

The Transportation-OPOLY board game was designed to actively engage the middle school students and introduce them to the various systems that transportation engineers deal with regularly. Like the popular Monopoly game, the Transportation -OPOLY game board consists of thirty two spaces containing twenty-eight infrastructure entities or activities (such as highway design, airport design, road maintenance, and traffic control), and the four corner squares: Start, Stop: Loose a turn, and two chance spaces for sharing informative questions and answers. The game shown in Figure 2 is designed for two to five players. The instructions for the game are provided on the board as can be seen in Figure 2b. Basically, each player is "hired" as a transportation engineer, and his or her goal is to collect the transportation needs for his or her city. At the beginning of the game each player is given a card with five properties listed on it that must be collected with the fund provided to him or her. The player to collect all the properties listed on their card first wins.

Roadway Cross-section Lab Exercise

Following the highway design presentation, the participants will take part in a laboratory activity to build a roadway cross-section. A typical roadway cross-section consists of several layers: (i) soil sub-grade layer; (ii) gravel sub-base layer; (iii) base layer made of finer gravel or stones; and (iv) asphalt concrete wearing surface layer. The participants will be broken into groups. Each group will build a roadway cross-section in a plexiglass box as shown in Figure 3 using the materials provided to them.

(a)

(b)

Figure 2. The Transportation-OPOLY game: (a) The Transportation-OPOLY board; and (b) close up of the left corner of the board.

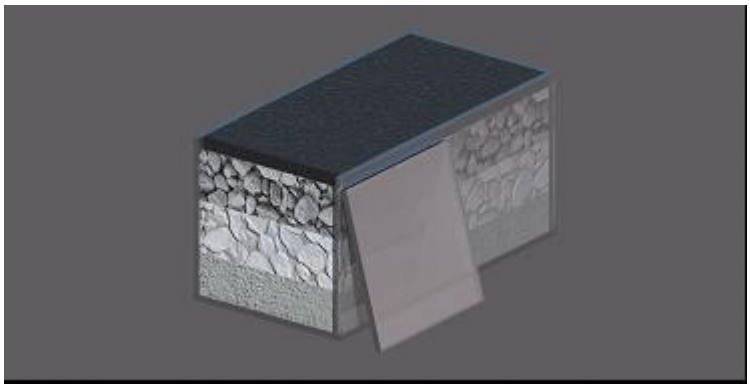

Figure 3: Roadway cross-section laboratory activity.

Simple Bridge Design Using "West Point Bridge Designer"

After the bridge design presentation, the participants will design their own simple bridge using the "West Point Bridge Designer". Each of them will be given a file containing a simple steel bridge between two banks of a river. The participants will be asked to perform optimization of the bridge using the program for a given overall load. Optimization will be done by varying the following parameters:

i) material (carbon steel, high strength low alloy steel, etc.),

ii) cross section (solid or hollow), and

iii) cross section size

They will be able to use the program to calculate overall cost of the bridge. The participant with a bridge that costs the least and can withstand the given overall load will receive an award.

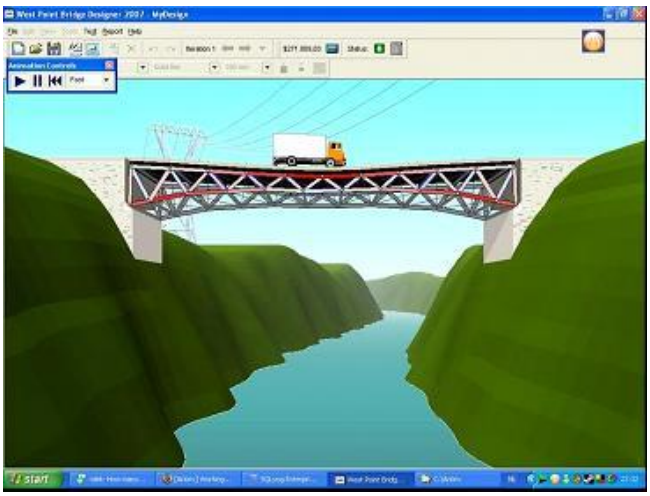

Figure 4: Bridge design using "West Point Bridge Designer".

Concrete Cylinder Breaking Lab

One of the major properties of a civil engineering material is its strength. For concrete structures, compressive strength is the most commonly used design parameter. The compressive strength of concrete is measured by subjecting a concrete cylinder under axial compression in a compression testing machine. From the maximum load before failure, the compressive strength is calculated. Following the transportation materials presentation, the participants of the Youth Transportation Institute will move to the materials laboratory. In the materials laboratory, after a brief demonstration, each participant will be allowed to break a concrete cylinder in a compression machine and asked to calculate the strength.

Figure 5: Compressive strength test of concrete.

RECRUITING PARTICIPANTS

The Youth Transportation Institute will be offered free of charge to the students. It will be advertised as a great opportunity to learn about interesting careers in the transportation engineering profession. Principals of middle schools and high schools will be contacted in and around Mobile County, Alabama asking for nominations for up to 5 students to participate in the Youth Transportation Institute. They will receive a brochure containing general information about the institute, transportation career opportunities and the activities the students will be engaged in. Students who have the potential and genuine interest will be given priorities. The goal is to recruit approximately 25 students from middle school and approximately 25 rising high school juniors and seniors for the institute. During recruiting visits to the participating schools, the students will receive a welcoming letter containing information about the institute and a registration form.

ASSESSMENT OF THE PROGRAM

In order to assess the effectiveness of the youth program discussed in this paper, a survey has been designed for middle school and high school students. The survey is expected to provide assessment related to their interpretations of the demonstrations and activities, their demographic backgrounds, their intentions for pursuing transportation engineering in the future, as well as whether this program influenced their impressions of the transportation engineering profession. The survey is presented in Table 1.

Table 1. Survey Instrument for Assessing the Effectiveness of the Youth Transportation Institute

Enclosed please find the Transportation Engineering Experience Survey. It should only take about 5 minutes for students to complete, and will provide us with important information about your levels of engagement and integration at the Youth Transportation Institute. This is an important part of our program assessment and we appreciate your help in this process.

For questions 1-5, on a scale of 1 to 5, how would you rate your experience in this transportation institute program?

1 means strongly agree

2 means agree

3 means neither agree nor disagree

4 means disagree

5 means strongly disagree

1. Transportation Institute was fun __1 __2 __3 __4
2. I know more about transportation engineering __1 __2 __3 __4
3. I know more about civil engineering __1 __2 __3 __4
4. This program made me want to go to college __1 __2 __3 __4
5. This program made me more interested in transportation engineering __1 __2 __3 __4
6. What grade are you in: ____
7. Your gender: __ male __female
8. Your race: __African American __ Asian__Hispanic __White __ Other

EXPECTED RESULTS

A possible outcome of this initiative could be an increase in the general transportation knowledge of the public. This could potentially increase road safety and might decrease the number of accident-related deaths per year. Furthermore, the program might also cause a greater number of Mobile's graduating seniors to attend the University of South Alabama and thereby increase the number of college-educated Mobile residents. Because of the technical nature of transportation engineering, an elevated interest in other technical areas such as mathematics and physics could result. Ideally however, the program will enlarge the size of the University of South Alabama's transportation engineering program as well as the general number of students pursuing transportation engineering as a career.

CONCLUSIONS

The Youth Transportation Program developed at the University of South Alabama is expected to be an effective instrument for demonstrating the different aspects of Transportation Engineering among the middle and high school students. Although the program is developed for middle and high school students in general, participation of minority and female students is going to be more encouraged. The activities are designed to be fun-filled and interesting and should be able to capture the attention of the students. This program is going to be used as an educational outreach activity to introduce the transportation engineering profession.

A survey has been instrumented to assess the effectiveness of the program. The survey will be conducted at the end of the program among the students who participated. In general, the activities designed for the Youth Transportation Institute are very much adaptable for use in engineering educational outreach for a wide variety of audiences. These activities should generate enhanced appreciation of engineering, especially transportation engineering among students and help them to relate real life situations through this educational program.

REFERENCES

[1] Elton, D. J., Hanson, J. L., and Shannon, D. M., "Soils Magic: Bringing Civil Engineering to the K-12 Classroom", Journal of Professional Issues in Engineering Education and Practice, 132:2, ASCE, April, 2006.

[2] Hossain, A.B., White, K., "Introducing Civil Engineering Undergraduates to the Premature Cracking of Concrete Bridge Decks", Proceedings of the 2007 ASEE Annual Conference and Exposition, June, 2007.

[3] Villiers, C., Shelby G., Lyra L., Kathy D., Lee D. "Fostering Excellence in High School Students Exposed to Applied Mathematics and SAT Prep Summer Program". Proceedings of the 2010 ASEE Annual Conference and Exposition, June, 2010.

[4] Wilkes, M.B., Turner, D.S., and Anderson, W.T., University Transportation center of Alabama (UTCA) Report No. 09108, Advanced transportation Institute 2009, The University of Alabama, Tuscaloosa, AL, 2009.

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Sarah Brown

Sarah Brown is a former undergraduate student of civil engineering at the University of South Alabama. Sarah received her BS in Civil Engineering in 2010. She worked in the UCUR summer research project to organize the ideas about the different activities for the middle school and high school students.