2015

STRIDE | Southeastern Transportation Research, Innovation, Development and Education Center

Final Report

UF Workforce Development Efforts (Year 2)

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ABSRACT

Workforce development activities aim to attract new entrants into the transportation field and improve the skills of the existing workforce to effectively address today's transportation system challenges. The University of Florida Transportation Institute (UFTI) participated in four planned K-12 outreach activities for STRIDE, as well as several other activities as outlined:

LEGO® Robot Vehicle Lesson Plans for Secondary Education: UFTI used the "Introduction to Transportation" curriculum developed at UF for students at a Girl Scout summer camp. A second set of updated robots was purchased and a new limited curriculum was developed for fourth and fifth graders, which includes building of the robot which serves the intelligent vehicles of the future curriculum. In all robotic workshops, students learned various fundamentals of Transportation Engineering and how the use of advanced technology is integral to solving current and future transportation problems. They also learned how much transportation affects the quality of life in our society.

Transportation Career Day: Designed to introduce high school-aged students to transportation careers, the events featured presentations, lab tours, and a hands-on traffic simulation exercise.

Family Engineering Events: UFTI hosted an informal engineering education program at local elementary schools to team up children aged 7-12 and their parents or caregivers to experience fun, hands-on engineering activities. Parents and caregivers can positively influence attitudes about engineering and encourage consideration of a possible career in engineering by showing interest in and willingness to explore such engineering activities.

In addition to the programs planned for STRIDE, UFTI participated in outreach with assistance from university student chapter members and through local partnerships. Students provided a booth at the College of Engineering's Engineering Fair, and hosted workshops providing hands-on engineering activities at a local middle school afterschool program and church education fair.

SIMCity: UFTI develop and piloted transportation specific modules for middle school-aged students utilizing the video game SimCity (www.simcity.com) to foster interest in the transportation profession as a career choice.

Project funds provided mostly equipment to support the STRIDE University of Florida workforce development efforts. A small amount of staff salaries were charged to this project.

The Council of University Transportation Centers held a National Transportation Workforce Summit April 24-26, 2012. Gerhard Salinger from the National Science Foundation stated, "Rather than developing a course for railroads or any of the modes...we can take a math problem and teach people mathematics in the context of a transportation problem. And then do a bit more exploration about transportation so students get the idea." (1) UFTI aims to expose children to transportation through exploration and activities that already interest them.

EXECUTIVE SUMMARY

A National Workforce Summit, sponsored by FHWA, Federal Transit Administration and Research and Special Programs Administration, was held in May 2002 to coordinate an initiative to preserve and advance the U.S. transportation system. The summit members outlined three critical areas that need to be addressed:

1. Ensuring that young people are attracted to the transportation jobs of the future;
2. Ensuring that workers are using the latest technologies and practices to improve transportation; and
3. Developing partnerships throughout the transportation and education communities to "institutionalize" transportation workforce development. (2)

Summit participants emphasized the need to expose students to transportation early and often, by making it applicable to coursework at hand. This need has been the key focus of UFTI's approach to K-12 workforce development. The UFTI addresses each of the above critical issues with its K-12 workforce development efforts outlined in the following report. The programs developed and implemented through this project expose children to careers in transportation by partnering with science teachers, university engineering student chapter members, Girl Scout troops, and coordinators at afterschool programs, and local churches.

Increasing career awareness among the next generation requires a comprehensive approach, from industry partners to parents and neighborhood leaders. Developing tools to educate parents, teachers, and school counselors about transportation career opportunities allows children and young adults to learn about transportation in both the classroom and at home. (2)

During the second year from November 1, 2013 to January 31, 2015, the UFTI STRIDE K-12 workforce development programs exposed 623 elementary, middle and high school students to careers in transportation with fourteen organized events utilizing a variety of activities including robots, PowerPoint presentations, videos, hands-on activities, panel discussions, lab tours and computer simulation.

Even if children exposed to careers in transportation do not choose engineering as a career, the programs are still successful in exposing kids to elements of transportation that should equip them to make better decisions in the future about transportation needs in their community.

According to Toole and Martin, "The next generation of transportation professionals is sitting in our classrooms today. It is not too early to consider what will affect their choices and how we need to support them in their development." (3)

CHAPTER 1 BACKGROUND

PROBLEM STATEMENT

Urban and rural areas continue to see traffic growth, increasing the need for more transportation engineers. As Baby Boomers retire, the profession is losing over half of the state agency transportation engineers and many more local agency professionals. The *TRB Special Report 275—The Workforce Challenge* reviews some of the transportation workforce needs. (2) This shortage has increased demand on universities to work harder at recruiting more and brighter students to the field.

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2. Ensuring that workers are using the latest technologies and practices to improve transportation; and
3. Developing partnerships throughout the transportation and education communities to "institutionalize" transportation workforce development. (2)

The University of Florida Transportation Institute (UFTI) workforce development efforts covered in this report for period November 1, 2013 to January 31, 2015 address each of these three critical issues. According to Toole and Martin, "The next generation of transportation professionals is sitting in our classrooms today. It is not too early to consider what will affect their choices and how we need to support them in their development." (3)

RESEARCH OBJECTIVES

The objectives of the workforce development effort are to conduct outreach programs and document reporting metrics outlined in the STRIDE prospectus, including Transportation Career Day, Family Engineering, SimCity, and LEGO Robotic Vehicle Lesson Plans for Secondary Education. Documentation metrics include:

- Number of events organized
- Number of participants in K-12 events
- Number of schools visited
- Number of contact hours
- Number of participant hours
- Number of K-12 lesson plans developed

Project funds provide for equipment to support the STRIDE UFTI workforce development efforts. A small amount of staff salaries were charged to this project.

SCOPE OF STUDY

The following workforce development activities were planned and conducted with several other activities added when appropriate:

LEGO® Robot Vehicle Lesson Plans for Secondary Education: UFTI used the "Introduction to Transportation" curriculum developed at UF for students at a Girl Scout summer camp. A second set of updated robots was purchased and a new limited curriculum was developed for fourth and fifth graders, which includes building of the robot which serves the intelligent vehicles of the future curriculum. In all robotic workshops, students learned various fundamentals of Transportation Engineering and how the use of advanced technology is integral to solving current and future transportation problems. They also learned how much transportation affects the quality of life in our society.

Transportation Career Day: Designed to introduce high school-aged students to transportation careers, the events featured presentations, lab tours, and a hands-on traffic simulation exercise.

Family Engineering Events: UFTI hosted an informal engineering education program at local elementary schools to team up children aged 7-12 and their parents or caregivers to experience fun, hands-on engineering activities. Parents and caregivers can positively influence attitudes about engineering and encourage consideration of a possible career in engineering by showing interest in and willingness to explore such engineering activities.

In addition to the programs planned for STRIDE, UFTI participated in outreach with assistance from university student chapter members and through local partnerships. Students provided a booth at the College of Engineering's Engineering Fair, and hosted workshops providing hands-on engineering activities at a local middle school afterschool program and church education fair.

SIMCity: UFTI developed and piloted transportation specific modules for middle school-aged students utilizing the video game SimCity (www.simcity.com) to foster interest in the transportation profession as a career choice.

CHAPTER 2 RESEARCH APPROACH

TASKS

LEGO® Robot Vehicle Lesson Plans for Secondary Education: UFTI used the "Introduction to Transportation" curriculum for two workshops at Camp Kateri, a Girl Scout summer program. Twenty-eight middle school girls participated in the two and one half-hour workshops. UFTI instructors, Leslie Washburn and Morgan Witter, guided the Girl Scouts through modules intended to teach students how an intelligent vehicle can help mitigate congestion by using sensors and computer programming. Exercises included programming the intelligent vehicle to move, follow a route, detect and pull over for an emergency vehicle, and detect and brake for pedestrians. Participants also learned the extent to which transportation affects the quality of life in our society. The goal of the workshops was to explore the exciting field of transportation engineering and encourage girls to pursue this field as a career.

A second set of robots were purchased in order to address the demand for a workshop for elementary school children to design and build a robot. The new set is the next generation of the LEGO robots the EV3. Since it is not feasible for the middle school program to rebuild each robot before class, the first set will continue to be utilized as pre-built robots.

A pilot workshop was held with seven students on the UF campus. Utilizing building instructions and program tutorials provided, UFTI was able to determine how difficult it was for fourth and fifth graders to build and program the robots. With lessons learned, it is intended to find additional funding to develop a complete curriculum for introducing transportation and engineering to elementary students using the LEGO EV3.

A portable demonstration table for the LEGO® Robots was constructed and utilized during the pilot workshop and is intended for future use at student workshops, conference demonstrations and community events.

See Table 3-1 for further details on dates, locations, and participant numbers.

Transportation Career Day: UFTI held three events focused on introducing high school students to careers in transportation. Utilizing the traffic simulation exercises developed in 2013, a workshop was held where eleven students participated in the hands-on exercises. Two signal lab tours were conducted which included a demonstration of a signal control cabinet and city video traffic control system. Thirty-two students from the Center for Precollegiate Education and Training Junior Science, Engineering and Humanities Symposium participated in the tours.

The traffic simulation exercise used CORSIM (CORridor SIMulation), a microscopic traffic simulation software package for signal systems, highway systems, freeway systems, or combined signal, highway and freeway systems.

The first part of the simulation workshop covered the basics of signal timing and phasing through building a single isolated and pre-timed intersection within CORSIM. Workshop

participants created nodes and links for the intersection and entered the inputs needed such as volumes, link lengths, and free-flow speeds, as well as others. They began by selecting a timing plan for their signal that they thought would yield the best operations. Participants were required to determine the necessary yellow and all-red times for each phase of their signal phasing plan using the provided equations. Once they selected their timing plan, a CORSIM simulation was run to determine if their timing plan was adequate or needed to be improved. Participants were encouraged to obtain the best possible outputs (i.e., minimized delay) by adjusting their timing plan as needed. After the participants obtained what they felt was their best plan, UF students showed their own best timing plans along with the results from their own simulations which helped participants gain a better understanding of which inputs influence the operation of transportation systems and how traffic signals affect these operations.

In the second part of the simulation workshop, participants focused on coordinated signalized intersections using a CORSIM file containing three signalized intersections. Participants tried to select offsets and modify existing green times and cycle lengths to best improve the existing network. The amount of time needed to travel from one intersection to another based on the free-flow speed and link lengths was calculated to help determine offset values for each signal.

See Table 3-2 for further details on dates, locations, and participant numbers.

Family Engineering Events: UFTI hosted an informal engineering education program at local elementary schools for elementary-aged children and their families to participate in fun, hands-on engineering activities. The activities highlighted several engineering disciplines, such as building a cantilever out of dominos, pushing a LEGO® brick into various earth samples to evaluate the best materials to use for foundations and playground coverings, and matching cards of products with the engineer who designed that product. Family Engineering activities are designed to engage children aged 7-12 and their parents or caregivers in actively working together as a team. Parents and caregivers can positively influence a child's attitude about engineering and encourage their children to consider a possible career in engineering by showing interest in and willingness to explore such activities.

UFTI teamed with the Women Transportation Seminar (WTS), Institute of Transportation Engineers (ITE) and the American Society of Civil Engineers (ASCE) Student Chapters at UF to host six Family Engineering Events. Student volunteer efforts included manning a large booth at a school carnival, offering engineering activities to children in afterschool programs, and setting up multiple activity stations in school cafeterias for whole-family participation.

See Table 3-3 for further details on dates, locations, and participant numbers.

Engineering Fair: In addition to the outreach programs designated in the STRIDE prospectus, UFTI gained assistance from undergraduate and graduate student volunteers to host a booth at the College of Engineering, Engineering Fair. The Engineering Fair brought hundreds of K-12 students to a large ballroom where various student chapters provided displays and hands-on activities for the students to learn about various engineering fields.

STRIDE efforts organized the booth by providing the activities and materials. UF students set up a real life traffic signal controller to visually demonstrate signal timing and progression at

intersections. Participants were allowed to interact with the signals and choose when to change the signal indications from green to red. Attendees were also encouraged to build a LEGO® car and race it against their peers. This activity introduced participants to the concepts of air resistance, center of gravity, momentum, and the impact of the incline plane on LEGO® car speed. Volunteers interacted with approximately 150 children who visited the booth during the events.

See Table 3-4 for further details on dates, locations, and participant numbers.

SIMCity: Building on the educational benefits of computer games, which are becoming increasingly popular as a teaching tool, UFTI developed a 9-week class for middle school aged students using the computer game SimCity (simcity.com). The class aims to foster interest in the transportation profession as a career choice, with each 45-minute module designed to instill participants with the planning and engineering concepts involved in this profession, such as design, materials, traffic mitigation, and budget management.

Participants spend the first five weeks learning from tutorials included in the SimCity software. At the end of each of these initial sessions, the students completed a short questionnaire developed by UFTI to measure knowledge transfer. Participants spent the remaining five weeks competing to build the most successful city based on instructor-established criteria.

Two UFTI instructors piloted this course at Jordan Glen School in Archer, Florida. This location proved ideal for the pilot because of its unique afternoon elective schedule where students can select from a variety of courses. The students worked in pairs and worked together to learn the best way to build their ideal city. They were exposed to computers, mathematics, urban and regional planning, and civil and transportation engineering.

See Table 3-5 for further details on dates, locations, and participant numbers.

Chapter 3 FINDINGS AND APPLICATIONS

The following tables provide the dates, locations, and number of K-12 student participants for each event for period of November 1, 2013 to January 31, 2015.

Table 3-1. LEGO® Robot Vehicle Lesson Plans for Secondary Education

Date of Event	Event	Location	Participants	Contact Hours	Participant Hours
6/24/2014	Girl Scouts	Camp Kateri	14	2.5	35
6/25/2014	Girl Scouts	Camp Kateri	14	2.5	35
12/13/2014	LEGO EV3 Pilot	UF Campus	7	6	42
Total			**35**	**11**	**112**

Table 3-2. Transportation Career Day

Date of Event	Event	Location	Participants	Contact Hours	Participant Hours
1/26/2014	Traffic Simulation Workshop	UF Campus	11	2	22
1/27/2014	Traffic Lab Tour	UF Campus	6	1	6
1/26/2015	Traffic Lab Tour	UF Campus	21	1	21
Total			**38**	**4**	**49**

Table 3-3. Family Engineering Events

Date of Event	Event	Location	Participants	Contact Hours	Participant Hours
10/28/2013	ASCE Student Chapter	Lincoln Middle afterschool	40	2	*80
11/4/2013	ASCE Student Chapter	Lincoln Middle afterschool	40	2	80
11/11/2013	ASCE Student Chapter	Lincoln Middle afterschool	40	2	80
3/13/2014	Family Engineering Night	Kimball Wiles Elementary	158	2	316
1/12/2014	Monteocha Education Fair	Rural church	18	2	36
10/3/2014	PK Yonge Carnival	PK Yonge Research School	85	2	**14
Total			**381**	**12**	**606**

*The first event at Lincoln Middle School was not reported in the last report even though it was conducted in October of 2013 and therefore is added to this report.
**Note: The time participants spent at the table at the PK Yonge carnival varied and participant hours are estimated based on an average of 10 minutes for each student.

Table 3-4. Engineering Fair

Date of Event	Location	Participants	Contact Hours	Participant Hours
2/18/2014	UF Campus	150	8	25
Total		**150**	**8**	**25**

Note: The time participants spent at the table varied and participant hours are estimated based on an average of 10 minutes for each student.

Table 3-5. SIMCity

Date of Event	Location	Participants	Contact Hours	Participant Hours
8/11/2014 – 11/14/2014	Jordan Glen School	19	6.75	128
Total		**19**	**6.75**	**128**

STRIDE Performance Metrics

- Number of events organized 14
- Number of participants in K-12 events 623
- Number of schools visited 4
- Number of contact hours 41.75
- Number of participant hours 920

Note: While four schools were visited, many more students from other schools were reached at events where students came to the university campus for engineering fairs, career days, and several Florida counties were represented by the girls participating at Camp Kateri.

- Number of K-12 lesson plans developed 2

Note: See Appendix A for worksheets and competition rubric developed for SimCity.

Chapter 4 Conclusions, Recommendations, and Suggested Research

Conclusions and Recommendations

The UFTI K-12 workforce development program will continue to strive to follow the action items outlined as follows in the 2012 National Transportation Workforce Summit in order to achieve the goal of reaching out to the future transportation workforce:

- "Build on existing outreach programs, activities, and publications
- Develop tools to educate parents, teachers, and school counselors about the industry
- Create a Web portal identifying educational opportunities, curricular, and extracurricular transportation activities, industry internships, and career profiles
- Address transportation opportunities in STEM courses beginning in elementary school
- Work with parents, politicians and neighborhoods to reinforce the importance and relevance of transportation to youth" (1)

The LEGO® Robot Vehicle Lesson Plans for Secondary Education curriculum is available for download and has been downloaded by 93 different individuals as of the end of January 2015.

Suggested Research

The LEGO® Robot Vehicle Lesson Plans for Secondary Education course could be expanded to include "Building Your Intelligent Vehicle," "Picking Up and Delivering Cargo," "Delivery Truck Plan a Route," and a "Competition Module." With these new lessons, the course could run as a weekly after school program for a semester, or as a two-day summer camp. Lesson plans could be tailored for a younger audience or for high school students.

Lessons learned from the preliminary pilot workshop of the LEGO EV3 with elementary students could be utilized to develop step by step transportation related program tutorials.

The Family Engineering program could be expanded to more elementary schools in the area, while the Transportation Career Day program could try different days of the week during the year to accommodate high school students' busy schedules.

The SimCity program was a success. The transportation related worksheets and competition rubric developed should be disseminated at meetings, conferences and expanded to local schools.

Continued effort should be made through presentation at local, regional, and national levels to disseminate all of these programs and the associated findings and curriculum. Opportunities to work with additional school districts should also be explored.

REFERENCES

1. Council of University Transportation Centers. “National Transportation Workforce Summit Summary of Results.” April 24-26, 2012

2. Transportation Research Board (TRB). “The Workforce Challenge: Recruiting, Training and Retaining Qualified Workers for Transportation and Transit Agencies.” TRB Special Report 275 (2003).

3. Joseph S. Toole & Clark C. Martin. “Developing Tomorrow’s Transportation Workforce.” ITE Journal, March 2004, p 26-30. 99

Appendix A

SimCity Tutorial Questionnaire

Getting Started Tutorial 1

1. What can you do in mayor mode?

    a. Manage city zoning
    b. Manage transportation networks
    c. Design power systems
    d. Design water systems
    e. Select civic buildings
    f. All of the above

2. What type of power source did you use to power the residential zoning area of your city?
    a. Wind
    b. Gas
    c. Coal
    d. Oil
    e. Solar
    f. Nuclear

3. Industrial zoning areas are placed away from residential zoning to prevent pollution where people live.
    a. True
    b. False

4. The City Planner:
    a. Advises the City Mayor
    b. Provides tips on building cities
    c. Helps the Mayor become popular
    d. Advises the Mayor to run an efficient city
    e. All of the above

Exit and Play the Game

SimCity Tutorial Questionnaire

Terraforming Tutorial 2

1. Terraforming is the act of shaping landscaping.
   a. True
   b. False

2. Erosion is caused by
   a. Wind.
   b. Water.
   c. Glaciers.
   d. All of the above.

3. What kind of wild animals did you create?

---

4. To continue to play this landscape click here.

5. Using the create Fauna button, add woodland animals and horses.
   What type of animal is created with woodland animals?

---

6. Try a volcano, a UFO attack and more!
7. Exit the city without saving.

Open Berlin Region and Konradshohe Knut and try the God features on an urban city.

   a. Click top left button (looks like the world)
   b. Click load region
   c. Select Berlin
   d. Click on Konradshohe Knut

SimCity Tutorial Questionnaire

Making Money Tutorial 3

1. What is the number one reason new Mayors fail?
   a. Abducted by aliens
   b. Bankruptcy
   c. Move to another city
   d. Illness

2. You should place your first small fire station before your first fire.
   a. True
   b. False

3. How does a city get its income/money?
   a. Donations
   b. US Government
   c. Taxes

4. A successful budget requires
   a. Making local funding match your needs.
   b. Avoid building structures until you need them.
   c. Taxes as your main source of income.
   d. All of the above.

Try playing this city and building it up to 20,000 Sims! (Hint: start by zoning some more residential zones.)

SimCity Tutorial Questionnaire

Big City Tutorial 4

1. What service is not needed by a city to be a desirable place to live?
   a. Schools
   b. Hospitals
   c. Trains
   d. Parks
   e. Police station

2. High density areas require water.
   a. True
   b. False

3. How much does a water pump cost?
   a. $1,100
   b. $1,200
   c. $1,300
   d. $1,400

4. What is the monthly cost of a large medical center?
   a. $1,000
   b. $1,100
   c. $1,200
   d. $1,300

5. Which of the following tips is not needed to build a successful city?
   a. Build high rise apartments
   b. Build out before you try and build up
   c. Parks, schools, and hospitals will improve desirability
   d. Provide water to get larger buildings
   e. Educated Sims will bring in better paying businesses

   Continue playing this city and see if you can get some high density development.

   Can you make more of the city more desirable to live?

SimCity Tutorial Questionnaire

Rush Hour Tutorial 5

1. Using the Road Query button, how many routes are going through the congested road between the residential and industrial zones?

   _____

2. An elevated rail station costs
   a. $300.
   b. $500.
   c. $700.
   d. $1,000.

3. Toll booths are not good for traffic congestion but great for subsidizing (paying for) transportation needs.
   a. True
   b. False

4. Which is cheaper to build?
   a. Ferry and ferry station
   b. Bridge

Continue playing this city and try driving the ferry

Try driving the fire truck. Can you spray the water hose?

Jordan Glen Virtual City Competition Criteria

	Fair 1	Good 2	Excellent 3
City Plan			
1. Development - use of residential, commercial and industrial	Missing zones, levels low	Not all levels developed	Development in all zones
2. City Plan - city is well thought out	Some evidence of plan	Evidence of clear plan	Well executed plan
3. Transportation Plan - ease of moving about	Some evidence of plan	Evidence of clear plan	Well executed plan
Basic Services			
1. Population	5,000 - 14,999	15,000 - 49,999	50,000+
2. Utilities	Some power and water, 50%-90%	Adequate power and water 90%-95%	Complete power and water >95%
3. Public Transportation	One or more systems built	Sims using at least one public system	Sims using two or more public systems
Budget			
1. Budget Management	In the red - expenses > income, some funds in savings	In the black - expenses and income closely balance	In the black - income > expenses