Computation for Active Transportation

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Abstract

There was a time when almost half of K-8 students walked or rode their bike to school, but today only 13% of students do. Research shows, though, that students who participate in one of these forms of active transportation do better in school. At the same time, increasing the number of students who walk or bike to school decreases car traffic in front of schools, which leads to improved traffic safety, better air quality, and lower transportation costs for parents. In Summer 2015, my students and I worked with local advocates and city officials to identify ways to make it easier for more students in Claremont to walk and bike to school. In this project, I propose a summer student project to turn those preliminary results into one or more systems that can be put into practice in public schools. If successful, our work this summer will result in two tools: one that can be used to help schools identify and organize groups of students who want to walk to school together, and one that can be used with student groups to provide hands-on experience analyzing the factors that contribute to air pollution.

Starting Date, Duration, and Location of Proposed Research

This research will be conducted over a period of ten weeks beginning May 16, 2016 at HMC.

Proposed Research

A generation ago nearly half of K-8th grade students walked or biked to school; today the national average is just thirteen percent [2]. Some school districts rely heavily on school buses to transport students. Bus transportation costs districts nearly a thousand dollars per student per year [4]. Other districts, including Claremont Unified School District, do not provide school buses except in the case of students with disabilities; in those districts, the vast majority of students travel to and from school in private automobiles, passing the cost of transportation to families. The resulting traffic contributes to morning traffic congestion, which in turn contributes to more dangerous streets and decreased air quality.

Increasing the number of children who walk or bike to school has benefits in terms of health (active transportation options like walking or biking give students a built-in opportunity for physical activity), cost (either in terms of district expense for school buses or in terms of family expense for private vehicle trips), safety (fewer cars in front of schools means fewer opportunities for pedestrian-vehicle collisions) and environmental quality (as a result of decreased vehicle emissions). Programs that have attempted to increase the number of students who use these active transportation options have identified several specific parental concerns that must be addressed before students are likely to walk or bike to school. In particular, parents report transportation decisions being most strongly affected by their concerns for safety and convenience [3]. Safety concerns have been addressed in some cities with walking school buses, in which groups of students walk together with one or more adults [6]. In most schools, these programs are small and volunteer-driven. Groups of parents coordinate to identify a convenient location for their children to meet, and then the parents take turns walking the children to school in the morning [5].

Last year, I worked with two students on my Computing for Active Transporation project. They worked on two tasks, and this proposal aims to extend both of them.

Walking School Bus Routing

My Rasmussen Scholar from last year, Alyssa Kubota, focused on exploring routing algorithms for identifying groups of students who should walk to school togther, and for finding the best meeting spot for those students. She considered several different ways that student routes could be determined. For example, one of her models minimized the total distance that each student would have to walk, including the distance from their home to the meeting point as well as the distance from the meeting point to the school. Another model considered the driving time for parents who wanted to drop their children off at a meeting point, on their way to the freeway, under the hypothesis that this might provide the most accurate quantification of parents' perceptions of the convenience of a walking school bus program. Alyssa then provided a careful analysis of the trade-offs between the different models.

This summer, I would like to work with a student to develop an interface based on Alyssa's routing work. We will work with parents, teachers, and administrators from Claremont Unified School District to find the best way to bring Alyssa's theory into a working system, with the goal of deploying the system in at least one school in the fall of 2016.

Air Quality Sensor for School Science Projects

The other student I hired for the active transporation project last summer followed open-source plans to develop an Arduino-based air quality sensor. He was able to develop a working prototype with some of the air quality sensors, but was not able to get the last couple of sensors working. This summer, I would like to work with a student to review the plans and make changes so that the sensor is more reliable, and easier to build. Then we will begin work on a mobile application that can interact with the air quality sensor. Our eventual goal is to build a system that will allow school groups to define and run their own experiments related to air quality. For example, a class might ask questions like: * How does location (e.g. near Foothill compared to several blocks away) affect air quality? * How does time of day affect air quality in front of our school? * How does day of the week affect air quality in front of our school?

Our hope is that by getting students to think about these questions, we will also be able to get them to think about ways that their own transportation choices might affect the quality of the air in their environment.

Summer 2016

This summer, I would like to hire two student researchers to continue the work started in 2015. I am seeking funding for one of those students through this proposal, with the second student being supported through my start-up fund. I have advertised this position on a funding-contingent basis through the computer science department's summer research application, and already have a number of interested students. I plan to interview interested students in the coming weeks.

Significance of the Project for Environmental Quality

Despite strict standards for air quality, the Los Angeles area to continues to struggle to reduce the rate of ozone and particulates in the air. In 2014, the city ranked in the top five cities in the country for rates of both types of pollution [1]. One of the major sources of air pollution is private automobiles, which emit pollutants and contribute to traffic congestion. In particular, this project aims to reduce traffic congestion in the areas directly surrounding schools by reducing the number of students who travel to and from school in private automobiles.

Educational Value

Computer science students can struggle to see the direct connection of their field of study to social and environmental issues. The student who works on this project will have the opportunity to work on a technical project with a clear environmental benefit. In addition to implementing algorithms, they will get to talk with non-technical domain experts who might use the algorithms they are developing, and will gain an appreciation for the non-technical constraints on a system that is used in the real world. They may find, for example, that parents are not open to participating in a program if they perceive that it is less time efficient for them than dropping their children off at school directly, even if our models show that the walking school bus would increase the efficiency of their morning.

Feasibility

Both of the pieces of this project are extensions of work that was started last summer, and there are clear and achievable improvements to be made on both. In the time since my proposal this time last year, I have joined the Claremont Bicycle Pedestrian Advisory Committee, which gives me a chance once a month to get feedback on my projects from a Clarmeont city traffic engineer, a member of the Claremont Rotary group (who frequently supports programs in the Claremont schools to encourage active transportation), a former middle school science teacher, and several eager volunteers. I have also discussed this work with the principal of Sycamore Elementary School, the closest school in Claremont to Harvey Mudd's Campus. She is very eager to see our programs implemented in her school, and I expect her to be an ongoing source of valuable feedback to the students on the project.

Budget

This proposal is for one student. I am planning to hire a second student for this project through start-up funds, so that the student will have a research partner to work with.

Item	Cost
Student Stipend	$5,000
Faculty Stipend	$1,000
Total	$6,000

References

[1] American Lung Association. State of the air 2014. `http://www.stateoftheair.org/2014/assets/ALA-SOTA-2014-Full.pdf`.

[2] Feet First. Safe routes to school: Discover your world. `http://www.feetfirst.org`. Accessed: 2015-02-08.

[3] N. C. McDonald and A. E. Aalborg. Why parents drive children to school: Implications for safe routes to school programs. *Journal of the American Planning Association*, 75(3):331–342, 2009.

[4] National Center for Education Statistics. Fast facts: Transportation. `http://nces.ed.gov/fastfacts/display.asp?id=67`. Accessed: 2015-02-08.

[5] National Center for Safe Routes to School. Starting a walking school bus. `http://walkingschoolbus.org`. Accessed: 2015-02-06.

[6] C. E. Staunton, D. Hubsmith, and W. Kallins. Promoting safe walking and biking to school: The marin county success story. *American Journal of Public Health*, 93(9):1431–1434, 2015/02/06 2003.