MITIGATION OF LANE DEPARTURE CRASHES IN THE PACIFIC NORTHWEST THROUGH COORDINATED OUTREACH
PHASE III

FINAL PROJECT REPORT

by

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16. Abstract

A heavily interactive transportation safety presentation was developed by the research team. The safety presentations focused on local transportation safety issues, using images of locations that students might recognize to help engage students in safety within their communities. Eighteen safety presentations were made to 488 students throughout the Pacific Northwest. After the presentation, students were asked to creatively respond to the prompt, "how do you think we stop crashes?" Students created 408 drawings, wrote 124 narratives, and were interview 4 times about their ideas with researchers. In total 536 individual items were produced by students who participated in the safety presentations. These items were analyzed in the form of word clouds and picture mosaics which were developed on a per state basis and across the Pacific Northwest. Many of the suggestions from students focused on engineering, education or enforcement options to improve issues associated with driver behaviors.

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List of Abbreviations

CalTrans: California Department of Transportation
FHWA: Federal Highway Administration
FMCSA:Federal Motor Carrier Safety Administration
ILCAD: International Level Crossing Awareness Day
NAE: National Academy of Engineering
NSTI: National Summer Transportation Institute
NHTSA: National Highway Transportation Safety Administration
PacTrans: Pacific Northwest Transportation Consortium
PSA: Public Service Announcement

Executive Summary

Engineering education and outreach is a critical component to engaging the public in safety material related to engineering and attracting future engineers to the profession. PacTrans supported a high school and college student Public Service Announcement (PSA) competition in Phase I and II of this outreach project to help engage the Pacific Northwest about lane departure crashes. Phase III expanded on this theme by engaging K-9 students regarding the safety issues associated with crashes. The project team conducted 18 safety presentations to 488 students throughout the Pacific Northwest. The safety presentations focused on local transportation safety issues, using locations that students might recognize to help engage students in safety within their communities. After the presentation, students were asked to creatively respond to the prompt, "How do you think we stop crashes?" Students created drawings, wrote narratives or verbally brainstormed their ideas with researchers. Many of the suggestions from students focused on engineering, education or enforcement options to improve transportation safety. These materials were then combined into a picture mosaic and word cloud to be distributed through various PacTrans communication outlets including the webpage, list serve, and social media accounts.

Chapter 1 Introduction

This technical report summarizes the activities and outcomes of Phase III of a PacTrans outreach project aimed at educating children and young teens about the safety implications of crashes. To educate the community about this significant traffic safety issue, a student competition was created to engage the public, and specifically younger children, about the risks of crashes. Phases I and II of this outreach project involved the planning and implementation of a high school and college student Public Safety Announcement (PSA) competition focused specifically on lane departure crashes. Phase III involved the planning and implementation of outreach activities designed for K-9 students around the broad topic of traffic safety.

1.1 Recap of Phases I and II

Phase I and II of this outreach project were previously documented in the PacTrans Technical Reports entitled *Mitigation of Lane Departure Crashes in the Pacific Northwest through Coordinated Outreach - Phase I* (Hurwitz et al. 2016) and *Mitigation of Lane Departure Crashes in the Pacific Northwest through Coordinated Outreach - Phase II* (Hurwitz et al. 2017). Those reports described the planning and implementation of a PSA competition among high school and college students in the Pacific Northwest by PacTrans partner Universities. The PSA competition sought to bring increased attention the issue of lane departure crashes and expand PacTrans' connection with the regional community.

To solicit a diverse set of PSAs that could be shared through a variety of mediums, the following three components were required for each submission in the competition:

- One video approximately 20 to 30 s in length,
- A series of five Twitter or Instagram posts which can include text, photos, or memes, and

- A poster (2 ft tall x 3 ft long).

The quality of the submissions received was high and numerous materials were generated through the competition that could be used by PacTrans to promote awareness of lane departure crashes. Figures 1-3 show examples of the three types of submissions. The vast majority of the submissions either mentioned or focused on driver distraction as a contributing cause of lane departure crashes. Based on this evident theme, the students who participated in the competition clearly understood that there is a relationship between distracted driving and lane departure crashes.

Figure 1 High School Level Video Screenshot

Figure 2 High School Level Social Media Post

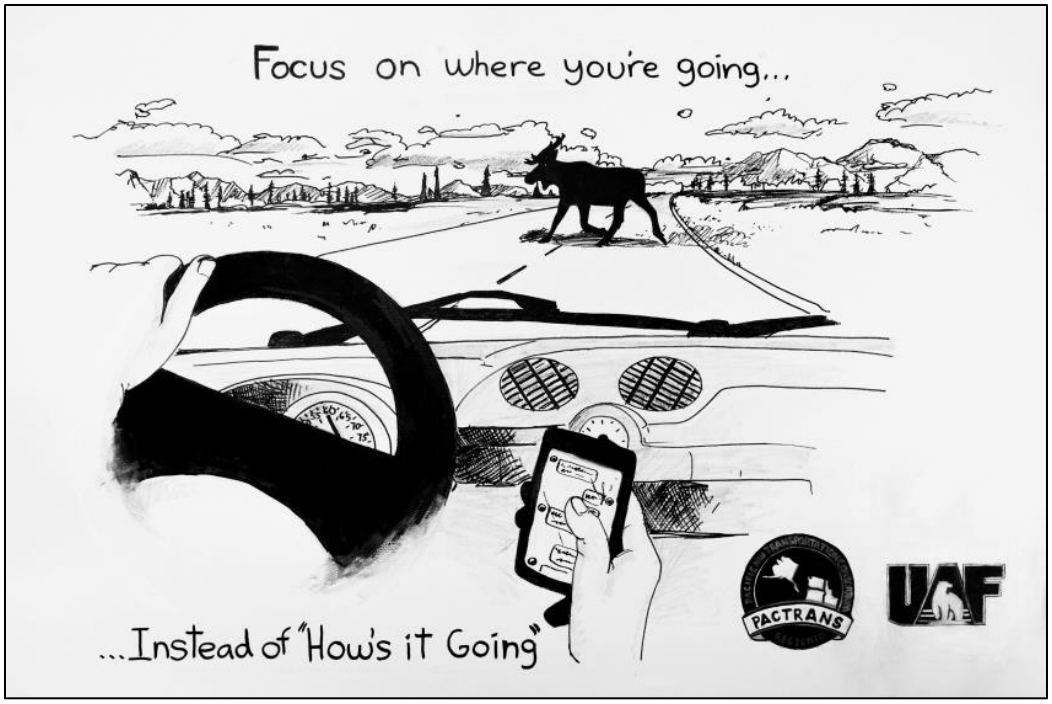


Figure 3 College Level Poster

In total, there were 13 entries for the competition. At most, three winners from each geographical area (Alaska, Idaho, Oregon, and Washington) and each competition level (high school and college) were selected for awards. Some areas, such as the Oregon and Alaska high school competitions, received no entries. The lack of entries across the competitions was potentially due to 1) a limited number of effective advertising and marketing strategies; 2) insufficient incentives for students to participate in the project considering the amount of deliverables required; 3) a technical malfunction with the submission website that may have excluded entries with large file sizes. The lessons learned from the Phase II PSA competition were carried forward to the K-9 outreach efforts in Phase III.

Chapter 2 Literature Review

Phase III of this PacTrans outreach project aimed at educating children and young teens about the safety implications of crashes and how to prevent them, from a transportation engineering perspective. Previous phases of this project focused specifically on roadway departure crashes. These crashes are an important subset of crashes, comprising more than half of all traffic fatalities that occur in the United States (FHWA 2016). Phase III of this project simplifies this topic for younger children to improve their understanding two questions: 1) What causes a car crash? and 2) Knowing what causes crashes, how can they be prevented?

These topics of engineering education and transportation safety outreach were explored in the current literature and are summarized in the following sections.

2.1 Engineering Education and Outreach

Engineering outreach is a critical component of successfully attracting future engineers. One of the significant issues facing transportation engineering in the U.S. is maintaining a full and competent workforce to meet the future demands of the transportation system. To recruit the transportation professionals of the future, different target areas have been identified: 1) attracting K-12 students to transportation engineering through outreach and 2) attracting current college students to transportation engineering through their coursework (Nezamuddin et al. 2014). The National Academy of Engineering (NAE) identifies many major benefits to bringing engineering education to K-12 students, including increasing awareness of engineering and the work of engineers, interest in pursuing an engineering career, and understanding of engineering design (NAE 2009).

One of the most significant outreach efforts to K-12 students in the U.S. is called the National Summer Transportation Institute (NSTI), funded by the Federal Highway Administration (FHWA). Educational institutions are invited to apply for funding to host two to three weeks of outreach programs where K-12 students can interact with transportation engineering students and professors while completing hands-on activities geared towards piquing young student's interest in transportation engineering (Nezamuddin et al. 2014). As of 2012, more than 65 colleges and universities have hosted an outreach program and over 8,000 middle school or high school students have participated (FHWA 2012). This example is one of the few large-scale opportunities. On a smaller scale, many other engineering outreach programs have been implemented that require less funding and time but still make an impact on K-12 students (Hurwitz et al. 2016, Ivey et al. 2012, Jeffers et al. 2004).

Phase III of this project focuses on younger students, specifically in the K-9 range. Younger students often struggle to conceptualize and describe the work of engineers. Capobianco et al. (2011) asked elementary students across the Midwestern United States to draw an engineer and then selected participants to interview to understand their thoughts. Many students conceptualized an engineer as a mechanic, laborer, or technician that used tools or vehicles, indicating that they were unaware of the work of engineers. Using a similar procedure, Fralick et al. (2009) demonstrated middle school students also have difficulty understanding the roles of engineers. This lack of understanding has been identified as one of the primary factors for students shying away from engineering, making it critically important to address (Jeffers et al. 2004).

There are also other advantages to focusing on younger students. Engineering education outreach programs that target high school age kids typically only reaffirm students that are already

interested in engineering. By addressing a younger demographic, there is greater potential for students to try more difficult math, science and engineering classes as they get older, placing them on an easier path to becoming an engineer (Jeffers et al. 2004). This can also be especially important for recruiting minorities and women to the engineering profession (Demetry et al. 2009; Anderson-Rowland et al. 1999)

However, not all engineering outreach approaches are equally effective. The type of outreach can also be a pivotal factor in whether or not students become engaged and interested in the engineering profession. Effective outreach to young students involves engaging, hands-on activities. Students often do not realize the importance of creativity in engineering (NAE 2009), making it important for engineering outreach activities to tap into students' creativity. One popular model for introducing elementary students to engineering is called Engineering is Elementary (Cunningham and Hester 2007). The five-step process focuses on students brainstorming ideas and planning solutions through a creative medium, like drawing a diagram. This emphasis on engaging students through creative and hand-on problem solving is a key approach to successful engineering outreach.

Another aspect to engaging students in engineering is conveying the importance of the work. Research has shown that students are more attracted to professions where the societal impact of the work is clearly understood (Ivey et al. 2012). However, most teens and adults do not associate engineering with rewarding work or having a positive effect on the world (NAE 2009). Phase III of this project engages young students with transportation safety material in a creative way to help them understand how to be safer as they navigate transportation facilities and how to envision even safer facilities, demonstrating how critical the profession of transportation engineering is to society.

2.2 Transportation Safety Student Contest

In conjunction with educating students about transportation engineering, Phase III also teaches students important safety information. The opportunity to target younger, future drivers could result in the greatest impact. Young drivers (ages 16-19) are at the highest risk for motor vehicle crashes. In 2013, there were 2,163 teens killed and more than 240,000 injured in vehicle crashes (CDC 2015). Teaching children and young teens the importance of safety in transportation could help reduce this risk. Since the members of this group will comprise the travelling public for the longest amount of time, engaging children and young teens could have the largest benefits in long-term behavior shifts. Therefore, transportation safety competitions that target younger groups may result in more significant longitudinal benefits than those that target other segments of the population.

One of the ultimate goals of transportation safety competitions and public service announcements (PSAs) is to change the behavior of the public. NHTSA understands the importance of a well-coordinated PSA campaign in transportation safety, stating that the most successful past campaigns have included the combination of advertisement and enforcement (NHTSA 2016).

One such form of advertising for public safety announcements includes materials created by students through competitions. The USDOT's Federal Motor Carrier Safety Administration (FMCSA) has implemented a student competition designed around the slogan "Be Ready. Be Buckled". They state that artistic competitions can be a fun, creative way to teach students important safety lessons (FMCSA 2016).

Figure 4 Winning Artwork for 2016 "Be Ready, Be Buckled" Contest

(Jessica Hong, FMSCA 2016)

Similar contests have also been held by the International Level Crossing Awareness Day (2014), the California Department of Transportation (CalTrans) (2007) and in Phase II of this PacTrans Outreach project. These types of PSA campaigns can be effective at 1) teaching students important safety concepts during the creation of the materials and 2) educating the public during the distribution of the materials created by students.

Chapter 3 Methodology

To help disseminate information about traffic safety to K-9 students across the Pacific Northwest, three universities (Oregon State University, University of Idaho, and University of Washington) coordinated outreach activities. Activities were conducted in Idaho, Oregon and Washington. Each university contributed to the development of an interactive activity that focused broadly on the topic of transportation safety and presented to K-9 students (Figures 5 through 7).

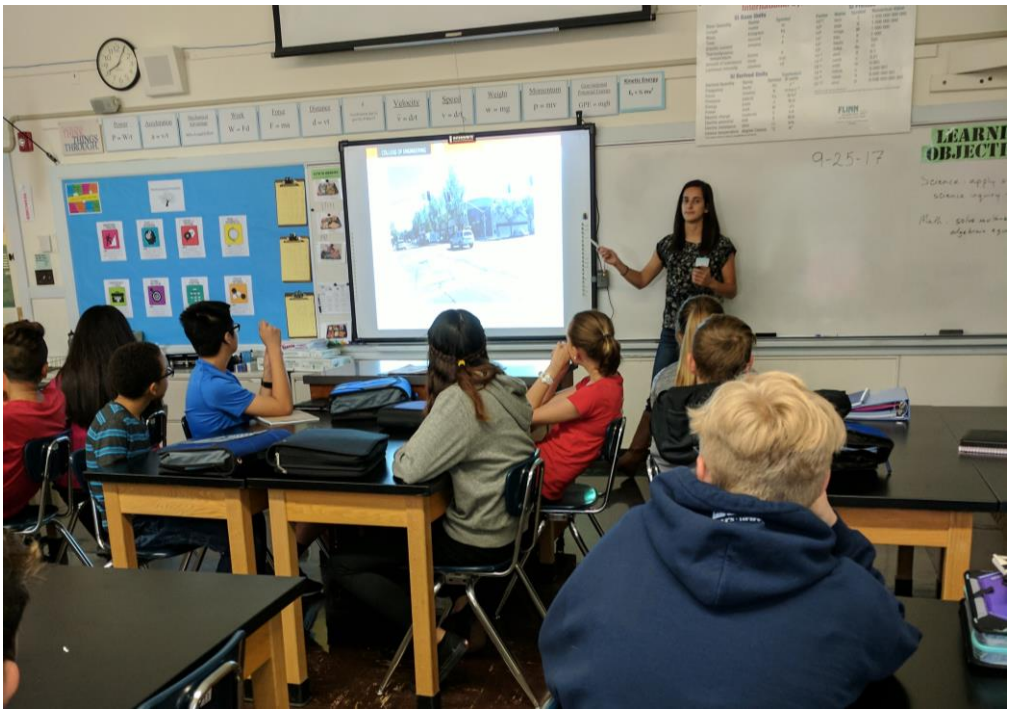


Figure 5 Oregon State University Team Presenting to Students

Figure 6 University of Idaho Team Presenting to Students

Figure 7 University of Washington Team Presenting to Students

While the outreach activities conducted by each university was slightly different, each typically included three main elements:

1) a short introduction into transportation engineering and transportation safety,
2) an interactive presentation for students to identify unsafe transportation behavior, situations or infrastructure, and
3) an activity to allow students to respond to the presentation and provide ideas to improve transportation safety.

The first part of the outreach activities focused on introducing students to transportation safety and engineering. As discussed in Chapter 2 of this report, the importance of introducing students to a variety of engineering disciplines at a young age cannot be overstated. Students were also introduced to key safety concepts, to allow them to respond in a more meaningful way to the second portion of the outreach activity.

The second portion of the presentation was designed to be interactive, to allow students to engage with the material. Students were presented with pictures of unsafe behavior, situations or infrastructure related to transportation, like the example shown in Figure 7. These photographs were collected through field observations near the locations of the student participants, to demonstrate scenarios and situations that the students may be more familiar with. The scenarios that the photos demonstrated included:

- Distracted and inattentive driving (texting while driving),
- Ignoring traffic control devices (red-light running and stop-sign running)
- Limited intersection sight distance,
- At-grade railroad crossing conflicts, and
- Bicycle-vehicle conflicts.

Students were then asked to identify what was unsafe about the scenario and discuss with the presenters what would make the scenario safer.

Figure 8 Example Scenario of Unsafe Behavior - Red Light Running

After the interactive presentation, students were provided with materials to creatively express their thoughts on transportation safety. The students were prompted with the question "How do you think we can stop crashes?" and asked to respond by either drawing a picture, recording a verbal response, or making a written response (as shown in Figures 8 and 9). In most cases, students had the freedom to choose between the three different mediums to creatively and comfortably express their thoughts on transportation safety and engineering. In some instances, the project team finished the activity with a short debrief to discuss the ideas students came up with or any questions they had.

Figure 9 Student Choosing a Written Response

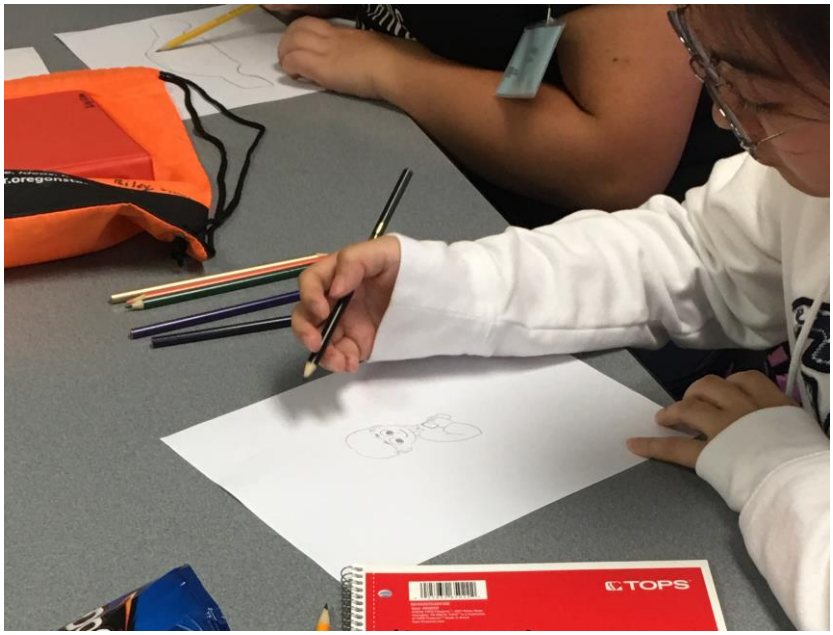


Figure 10 Student Choosing to Draw a Response

Chapter 4 Results

In total, 18 presentations were conducted by the university teams. 488 students ranging from second grade to ninth grade participated in the outreach activities. Table 1 below breaks down the number of presentations and the student demographics for each university.

Table 1 Presentations per University

University	Number of Presentations	Number of Students	Grade Range
Oregon State University	7	203	4^{th}-8^{th}
University of Idaho	9	211	2^{nd}-9^{th}
University of Washington	2	74	6^{th}-8^{th}
Total	18	488	2^{nd}-9^{th}

To help engage students in the material, the students responded to the presentation by producing a drawing, a written response, or a verbal response. The following table summarizes the total number of responses that were collected from students, based on university and artistic medium.

Table 2 Student Responses per University

University	Drawings	Written Response	Verbal Response	Total
Oregon State University	163	110	2	275
University of Idaho	169	0	0	169
University of Washington	76	14	2	92
Total	408	124	4	536

While students expressed themselves through different mediums, similar themes appeared throughout the responses. Many of the responses could be categorized by the three "E's" of transportation safety: education, engineering, and enforcement (Brookshire 2016). Transportation professionals commonly refer to the "3 E" model when identifying potential solutions to a safety problem. "Education" refers to a variety of approaches that are intended to raise the awareness and compliance of drivers, bicyclists, and pedestrians on safety issues and behaviors to improve safety. "Engineering" encompasses changes to the physical environment to improve safety and access. "Enforcement" refers to methods to increase compliance with laws and regulations. While there are other "E's" that are considered in some models (i.e. emergency response, emerging technologies, engagement, evaluation, equity, etc.), the three themes of education, engineering, and enforcement are used in the following sections to help categorize student responses.

4.1 Education

For many students, education was identified as an important way to prevent crashes, especially crashes caused by improper driver behavior. Many students mentioned both intoxicated driving and distracted driving as areas for increased public education. In Figure 10, a student calls out drunk driving as a dangerous behavior.

Figure 11 Student Drawing of Drunk Drawing

When driver distraction was mentioned, several students focused on cell phone usage. One student wrote that people should, "put phones on 'do not disturb', delay notifications or shut off phones in general" when operating a vehicle. In Figure 11, a student depicts both drivers and pedestrians who are distracted by their handheld devices, indicating the importance of educating the public on the implications of both distracted driving and walking. Students also recognized the importance of not using a phone or wearing headphones while biking. Radios were another example that students identified as a potential source of distraction, which could be remediated through education. Education was identified as a potential solution to many issues with one student writing that people should utilize driver education programs, saying that those programs, "are supposed to teach you the rules of driving".

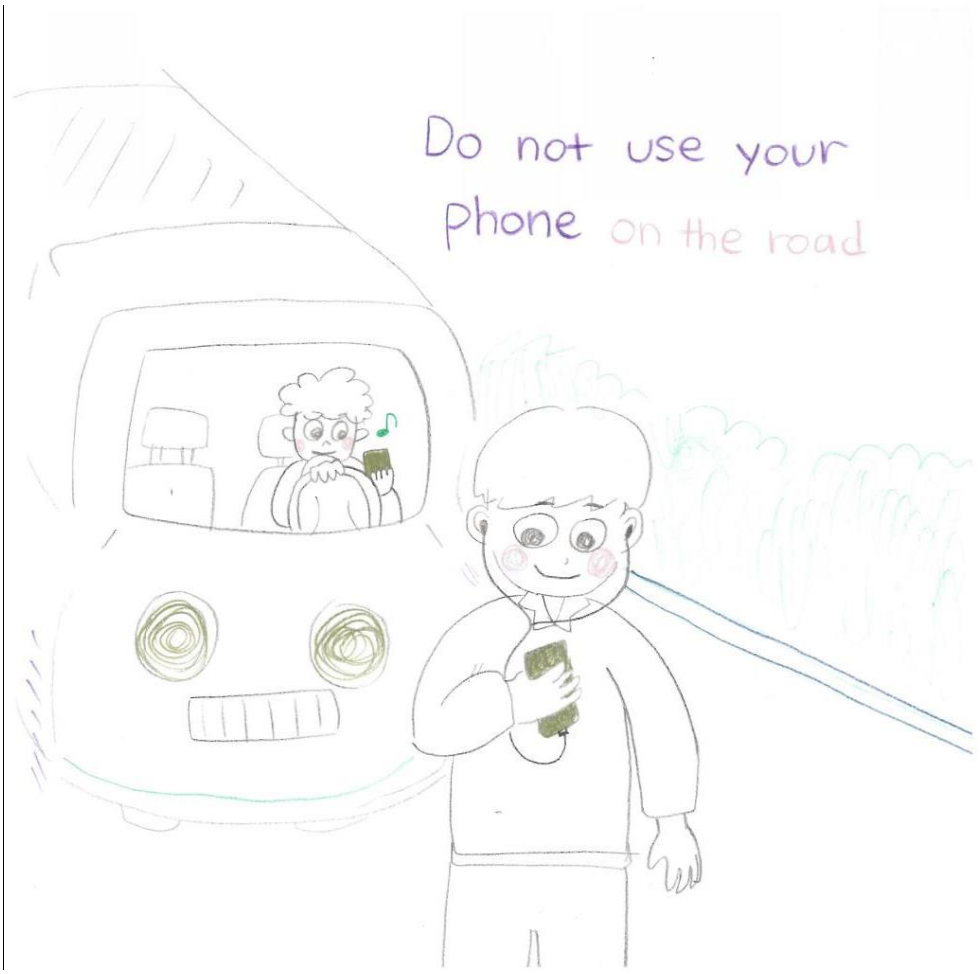


Figure 12 Student Drawing of Distracted Driving and Walking

4.2 Engineering

There were several different suggestions from students regarding engineering treatments that could be utilized to help stop crashes. For example, many students identified barriers to help prevent red light running. Others drew alternative intersection designs, like the roundabout shown in Figure 12.

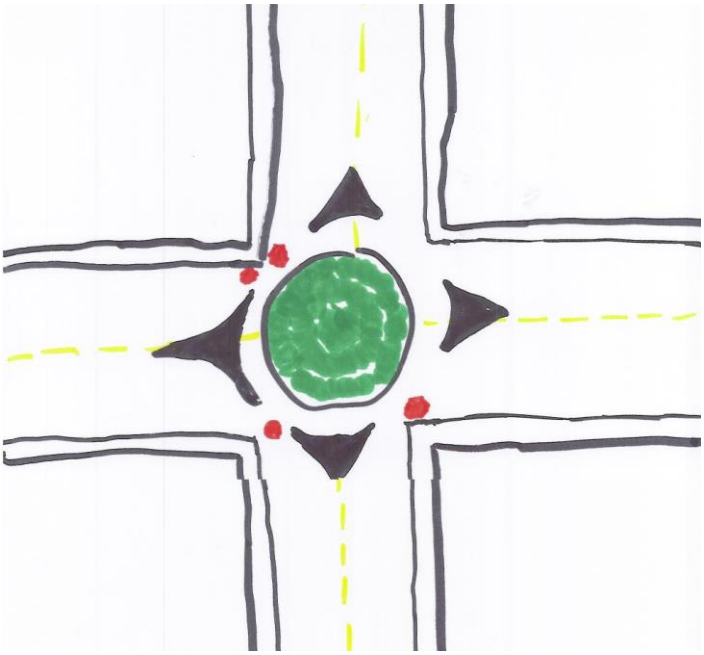


Figure 13 Student Drawing of Roundabout

Some students focused on using engineering treatments to help prevent bicycle crashes. Pulling from an example discussed in the presentation, one student wanted to find a solution to door zone crashes (when a vehicle door opens into the bike lane and causes a collision). Figure 13 shows the student's design solution, suggesting a form of buffered bike lanes that separates the parked cars from the bicycle travel lane.

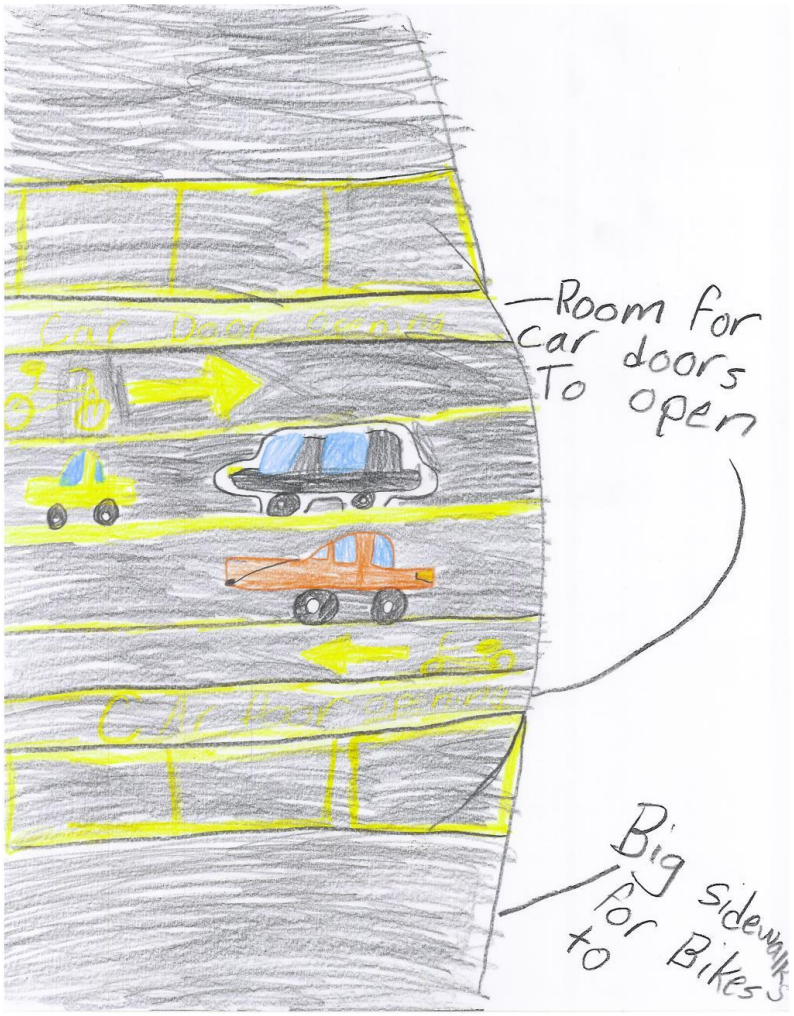


Figure 14 Student Solution for Dooring

Other students discussed the role that technology could play in improving transportation safety, such as using flashing lights to make traffic control devices more conspicuous (Figure 14) or to improve bicyclist visibility. Interestingly, one student also mentioned using software to visualize engineering designs in three dimensions before implementing the design in the real world.

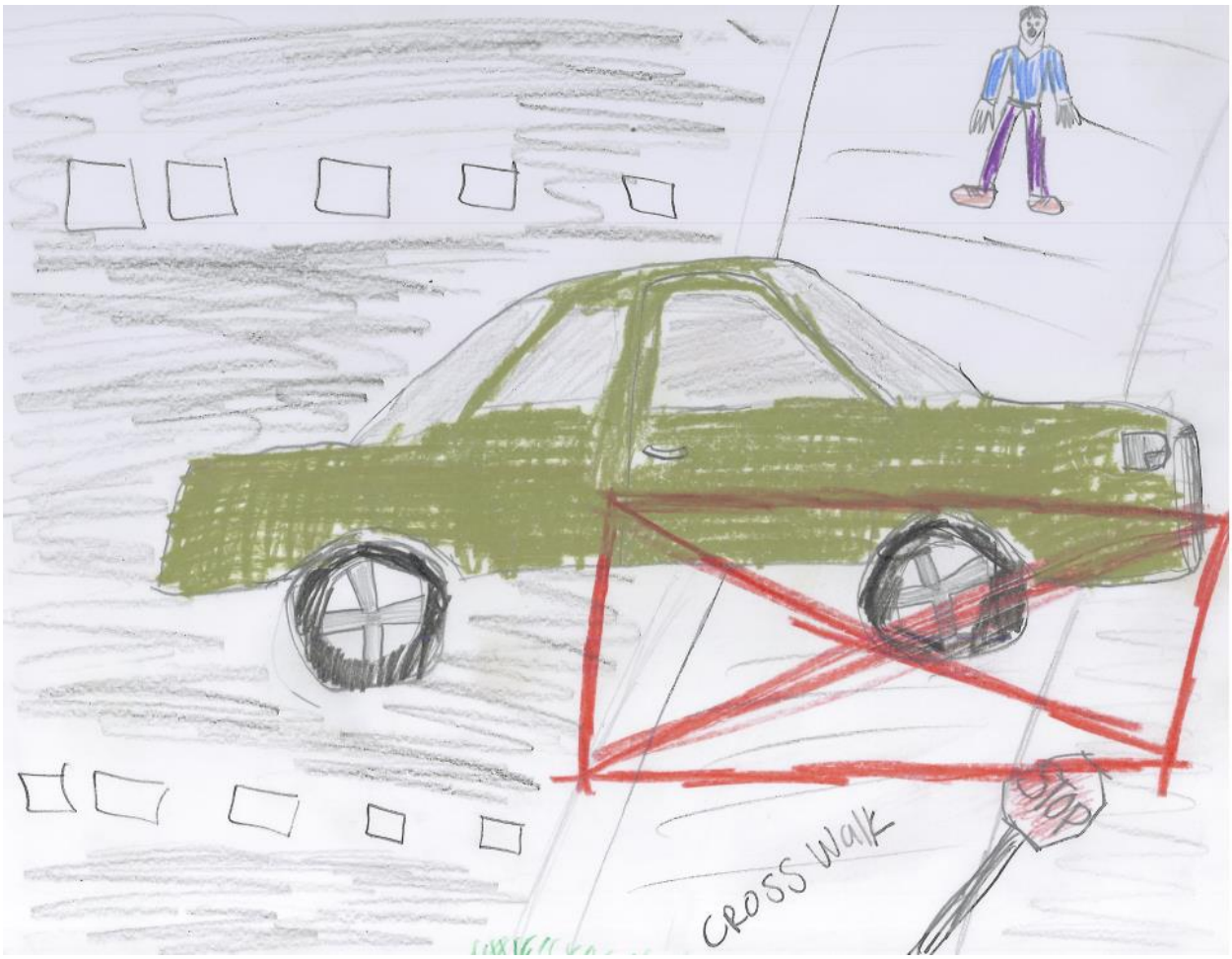


Figure 15 Student Drawing Depicting Lighted Crosswalks

The majority of students also specifically mentioned connected and autonomous cars, with one student cautioning that they would be safer only "if they're smarter than humans". Autonomous vehicles were tied to reducing driver error, with one student stating that "there's the idea that most car accidents are caused by human error, so we can invent a self-driving car" to reduce crashes. Students also discussed how adding sensors to vehicles and bicyclists would make for a safer environment. One student who chose to record a verbal response told an Oregon State University researcher that they knew that cars have "stopping systems in them" and they "thought that maybe a bike could have that, too". This theme was also depicted in a handful of

student drawings. Figure 15 shows three different vehicles equipped with sensors (in yellow) that would alert drivers to an imminent crash and stop the vehicle.

Figure 16 Vehicles with a Crash Warning System

4.3 Enforcement

Enforcement was another common theme among the students. Some thought that penalties for unsafe behavior should be increased, with one student mentioning that if people speed, there should be a law that they "can't ride in a car for one week" while another thought that a person who ran a red light should pay a $2,000 fine "or $5,000 for a close call". Students recognized that fines and increased enforcement were an effective option in changing unsafe driver behavior. Many also tied increased enforcement to advances in technology, saying that red-light

running cameras should be implemented in more locations. One student even suggested that individual vehicles could be equipped with cameras and if other vehicles were "speeding, it would take a picture of the license plate" and fine the offending drivers.

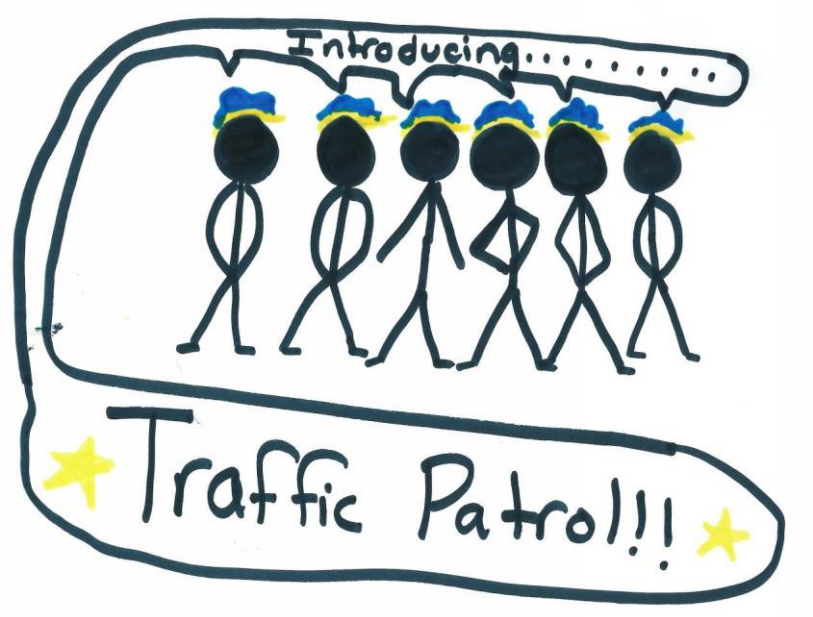
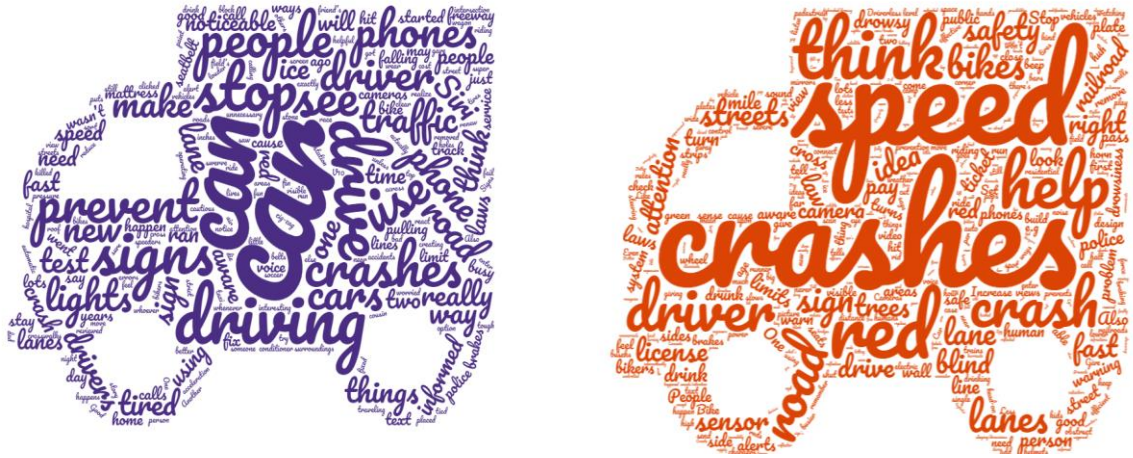


Figure 17 Student Drawing Showing Increased Enforcement

Chapter 5 Discussion

While the "3 E" Model is helpful to categorize student responses, other themes were evaluated by the project team. To help understand some of the cohesive themes across the responses, word clouds were created from written student responses collected by Oregon State University and University of Washington.



University of Washington Oregon State University

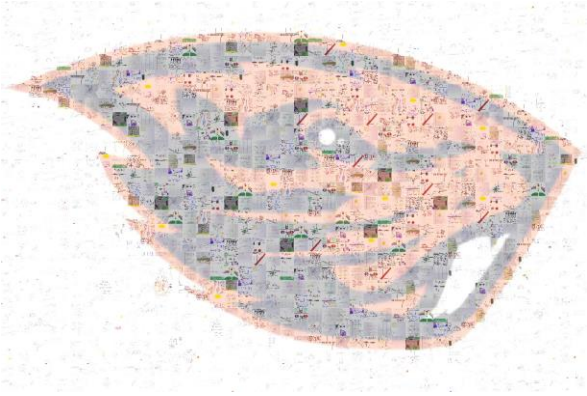
Figure 18 University Word Clouds

In Washington, the word cloud shows that students were most focused on preventing crashes associated with cars (using the words car, cars, drive, drivers, driving). Many students also identified ways to prevent crashes with signs and lights, as seen by the prominence of these words in the word cloud.

In Oregon, many student responses included the words speed, crashes, red and driver. These were some of the topics introduced by the research team in the presentation. Speeding and red light running were both identified in the presentation as potentially contributing causes of crashes. Driver error was another major component of the presentation. The students decided to

focus their responses on these themes, thinking of specific ways to reduce these type of crashes. To a lesser extent, students also thought about bike issues and how limited sight distance plays into crashes.

In addition, the project team synthesized all of the student drawings into cohesive graphics depicting student's thoughts on preventing crashes. Student drawings were combined into picture mosaics of in the shape of each university's logo, as shown in Figure 18.



Oregon State University

University of Washington

University of Idaho

Figure 19 University Photo Mosaics

To help understand trends across the Pacific Northwest, all of the student responses across the universities were combined to create both a word cloud and a photo mosaic. These combined graphics are shown in Figures 19 and 20.

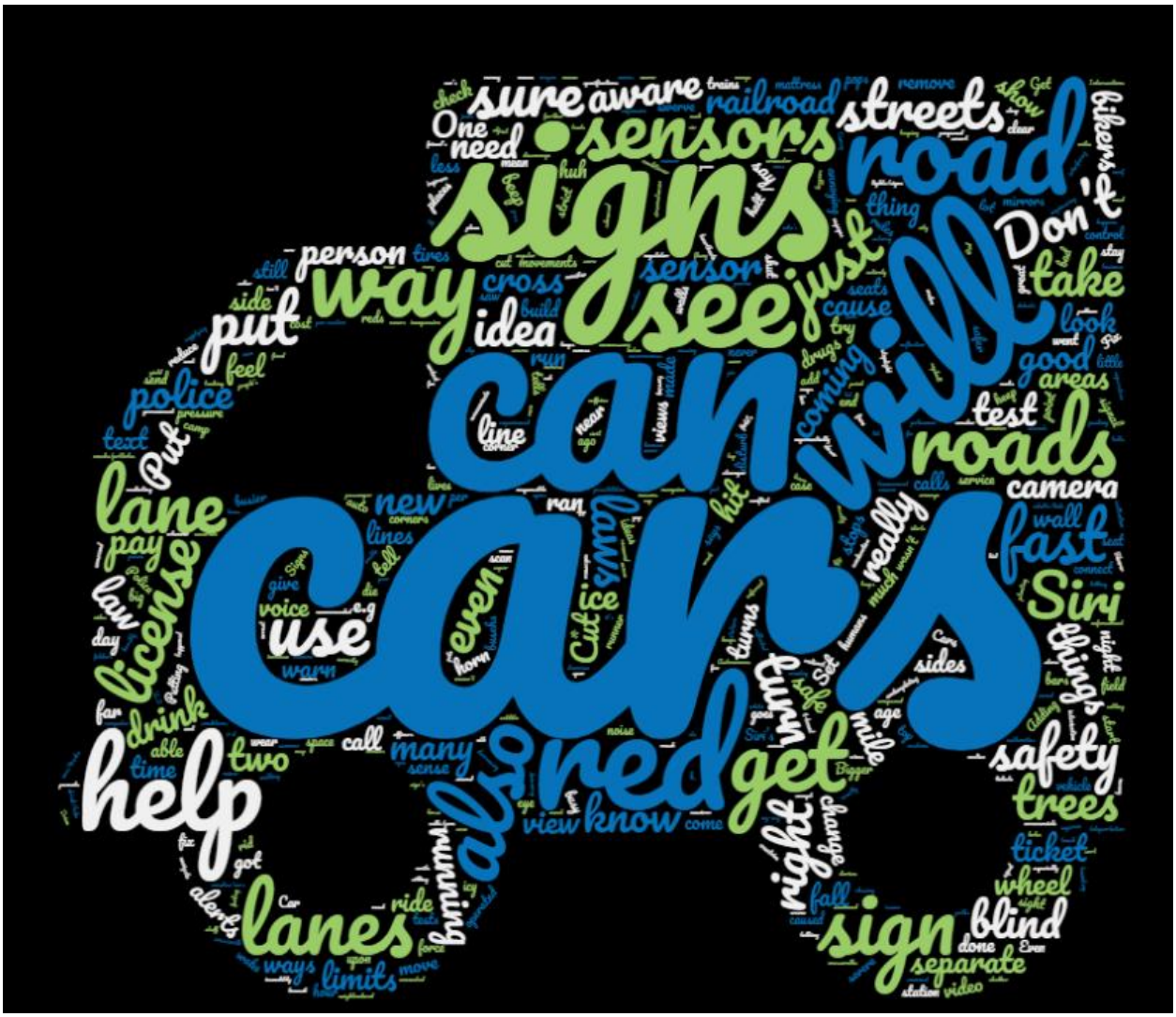


Figure 20 Pacific Northwest Word Cloud

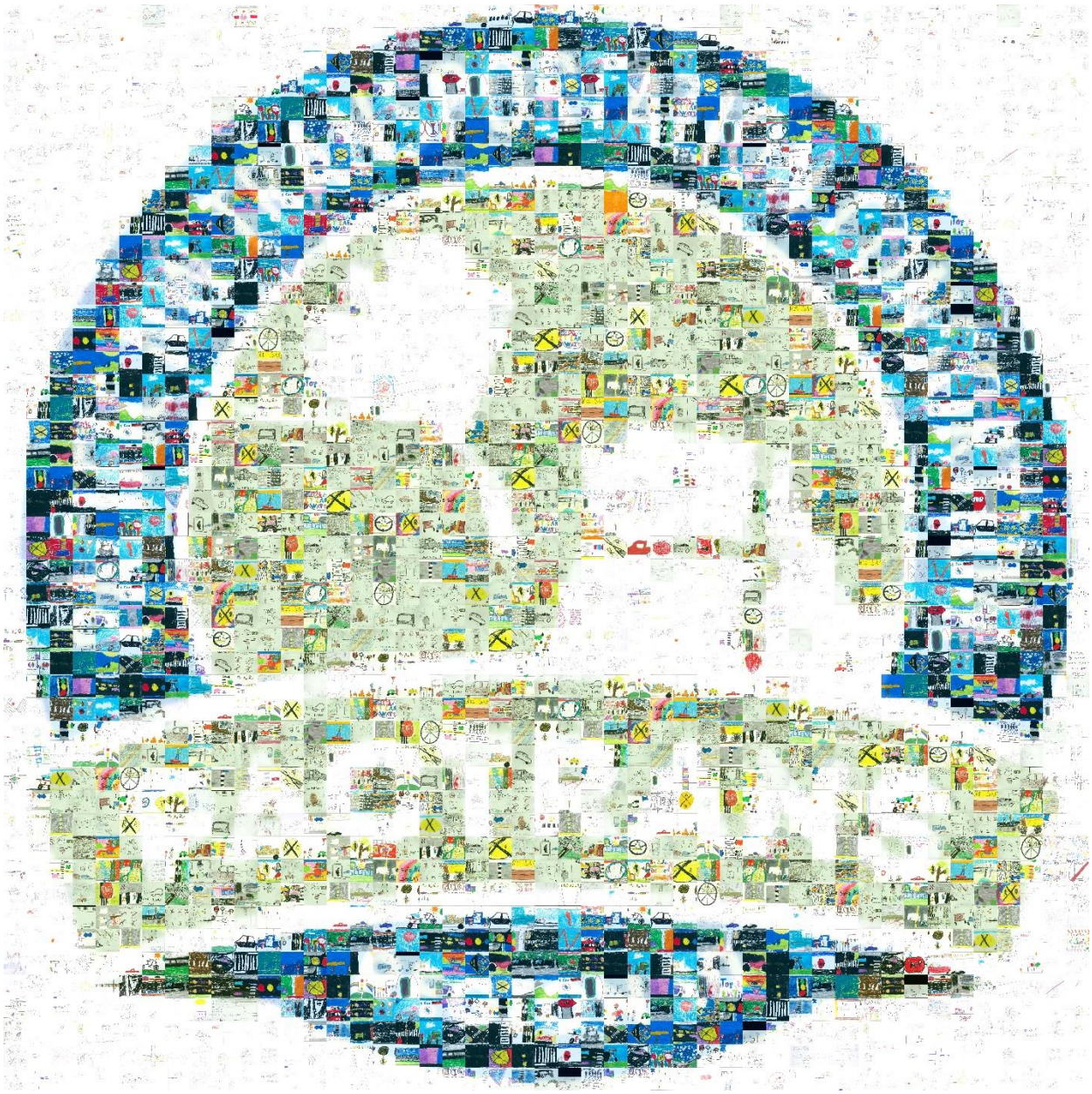


Figure 21 Pacific Northwest Photo Mosaic

Across the Pacific Northwest, students heavily used the words cars, signs, road, and red. Bikes became less conspicuous when the word clouds were combined. Interestingly, when the written responses of students across the Pacific Northwest were combined, specific verbs such as help, can and will stand out in the word cloud. This demonstrates the students' proactive attitude in their responses when talking about ways to reduce crashes. It highlights the understanding that an active stance must be taken to help improve transportation safety.

Overall, many of the themes seen across the Pacific Northwest were similar. This was in part due to related topics in the presentations given by each university. The students were also able to make the connection between engineering, education, and enforcement treatments on improved safety. By focusing the presentations on issues in the locations where the students live, they seemed to identify strongly with the safety issues that were presented. Overall, the students were very engaged in the material, with one 7th-grade student even telling a researcher from Oregon State University that they now want to become a transportation engineer when they grow up.

In the end however, one student response seems to properly summarize the importance of transportation safety and the intent of this project. The student stated, "It's important to make sure people actively understand and remember [the dangers of driving]. There are too many idiots in the world to stop [all crashes], but you can try to make them understand safety at a young age."

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