SUPPORTING HEALTH-TRANSPORTATION EDUCATION IN SCHOOLS

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CARTEEH

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16. Abstract
The project Supporting Health-Transportation Education in Schools is part of CARTEEH's Education Workforce Development efforts. The mission is to create a synergistic relationship between the center's research program and educational efforts and outputs to (a) prepare future and current decision-makers in transportation and public health fields; (b) educate K–12, college, and university students and the public on the impact of transportation emissions on human health; and (c) increase interest and access to science, technology, engineering, and mathematics career pathways. In support of this mission, the team developed the curriculum unit "What's In Our Air?" for grades 5–8. The lessons were piloted during 10 outreach events in Brazos Valley, reaching 1,775 students and families. The lessons are now available on the CARTEEH website, and as of September 2023, 512 educators from around the world have downloaded the classroom lessons, reaching an estimated 59,000 elementary and middle school students. The lessons were also published in the monthly *Science Scope* practitioner journal for middle school science educators. A subset of educators representing 25 schools across 15 states received air quality monitors to support lesson activities, reaching 1,429 students.

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Executive Summary

The project Supporting Health-Transportation Education in Schools is part of CARTEEH's Education Workforce Development efforts. The mission is to create a synergistic relationship between the center's research program and educational efforts and outputs to (a) prepare future and current decision-makers in transportation and public health fields; (b) educate K–12, college, and university students and the public on the impact of transportation emissions on human health; and (c) increase interest and access to science, technology, engineering, and mathematics (STEM) career pathways. This project was led by Dr. Joanne Olson, a Texas A&M University professor and acting department head for the Department of Teaching, Learning, and Culture in the School of Education and a previous president of the Association for Science Teacher Education. Dr. Olson, along with a team of doctoral students, worked closely with the CARTEEH team on these main areas: (1) Curriculum Materials, (2) Classroom Kits (3) Teacher Training, and (4) Outreach Events.

Curriculum Materials

In alignment with K–12 science standards, the curriculum unit "What's In Our Air?" was developed to promote a deep understanding of the critical issues surrounding air pollution, transportation, and health impacts. The week-long scientific inquiry unit was developed for grades 5–8 with the objective of measuring particulate matter (PM) and addressing sources of air pollution. Each lesson draws on the extensive science education research base to foster a logical flow, questions, and activities that promote a high-quality and meaningful learning experience for students. In the standards-aligned unit, students measure particle levels using air quality monitors and use those data to identify local sources of air pollution. An alternative version of the lesson was provided for schools that did not have access to air quality monitors. Students also explore air pollution around the world, learn about related careers and CARTEEH's research, and propose potential solutions for reducing air pollution. Curriculum materials are freely available on the CARTEEH website including a career spotlight video featuring a CARTEEH engineer. As of September 2023, 512 educators from around the world have downloaded the classroom lessons, reaching an estimated 59,000 elementary and middle school students. The lessons were also published in the monthly *Science Scope* practitioner journal for middle school science educators.

Classroom Kits

To support schools implementing "What's In Our Air?" lessons, 25 schools were provided air quality monitors, reaching 1,429 elementary and middle school students. The team worked closely with these schools to pilot equipment and lessons for updates to improve effective classroom implementation. Students first investigated 2.5 PM levels around their school and discussed potential sources of air pollution. Students then investigated air quality levels around their community including parks, highways, farms, and other selected areas. The results of this investigation were analyzed for sources of air pollution including transportation sources and potential health impacts. Schools then submitted data and shared them with participating schools. The elementary and middle school sites, primarily Title I campuses representing both urban and rural areas, were in Alabama, Arkansas, California, Florida, Kentucky, Missouri, Nebraska, New Jersey, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Texas, and Wisconsin.

Teacher Training

The project team developed professional development training videos to support educators in implementing "What's In Our Air?" lessons. Training videos were developed after piloting the lessons at several local outreach events to ensure quality and effectiveness with the intended audience. Videos are posted on the CARTEEH website and linked in the curriculum units. Additionally, the lessons were implemented with a group of undergraduate engineering students who plan to become high school teachers. The preservice teachers visited CARTEEH and the

TTI Environmental and Emissions Research Facility for a presentation and tour. This experience was followed by a workshop on how to translate this research into a K–12 classroom lesson.

Outreach Events

A STEM outreach kit was developed to support CARTEEH's public outreach programming to provide a hands-on experience for the public that is scalable and increases awareness of air pollution and health impacts, CARTEEH's research, and STEM careers. The kit includes a trifold board featuring CARTEEH's research and background. At the CARTEEH station, students engage with a swine lung display that dramatically shows the impacts of air pollution, participate in smog in a jar activity using air quality monitors, engage with a CARTEEH researcher, and draw solutions for reducing air pollution from transportation in a mural displayed at the school. Over the course of the project, the team supported 10 outreach events in Brazos Valley, reaching 1,775 students and families.

Acknowledgments

The project teams would like to acknowledge the efforts of K–12 teachers who piloted the “What’s In Our Air?” lessons in their classrooms.

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Curriculum Materials

In alignment with K–12 science standards, the curriculum unit "What's In Our Air?" was developed to promote a deep understanding of the critical issues surrounding air pollution, transportation, and health impacts. The week-long scientific inquiry unit was developed for grades 5–8 with the objective of measuring particulate matter (PM) and addressing sources of air pollution. Each lesson draws on the extensive science education research base to foster a logical flow, questions, and activities that promote a high-quality and meaningful learning experience for students. In the standards-aligned unit, students measure particle levels using air quality monitors and use those data to identify local sources of air pollution. An alternative version of the lesson was provided for schools that did not have access to air quality monitors. Students also explore air pollution around the world, learn about related careers and CARTEEH's research, and propose potential solutions for reducing air pollution. Curriculum materials are freely available on the CARTEEH website including a career spotlight video featuring a CARTEEH engineer.

Lesson Overview

The K–12 lessons follow an overarching learning cycle, which starts with an "Explore" phase, moves to "Concept Development," and ends with "Application." This research-based sequence helps to build a deep and robust understanding of concepts related to air pollution by first allowing students to explore through concrete experiences followed by connecting those experiences to key concepts and then an opportunity to transfer these ideas to a new context to deepen learning.

- Explore: Students have concrete experiences with particles in the air. Students design and conduct an investigation measuring levels of air particles around the school and community.
- Concept Development: Students identify and explain sources of natural and man-made air pollution.
- Application: Students apply knowledge of sources of air pollution by predicting air quality in a Mystery Town game.

Table 1 provides a more detailed look at lesson activities, and Figure 1 shows an overview of the lesson plan.

Table 1. Overview of "What's In Our Air?" lesson.

Day 1	Day 2	Day 3	Day 4	Day 5
Gather prior knowledge on air pollution. Provide a concrete experience with particles in the air. Introduce natural and man-made sources of air pollution. Introduce health impacts.	Measure air pollution around the school. Introduce particulate matter and air quality monitors. Conduct smog in a jar demonstration.	Select locations to measure around the community. Analyze particulate matter levels and related sources of air pollution.	Compare local air quality readings to regional global readings. Identify air pollution sources and investigate impacts on health.	Apply knowledge of air pollution to a Mystery Town activity.

Figure 1. Overview of "What's In Our Air?" lesson.

The lessons were developed through piloting at several local K–12 outreach events along with testing in undergraduate classrooms with preservice students. Figure 2 shows undergraduate students in the College of Engineering trying out the Mystery Town game that is part of the unit.

Figure 2. Mystery Town game.

One goal of the K–12 lessons was to promote awareness of real-world projects and science, technology, engineering, and mathematics (STEM) career pathways, including CARTEEH efforts. The lessons included links to CARTEEH projects, and the teacher slides featured the various STEM professionals and real-world examples related to air pollution, transportation, and health. The project team also developed a career spotlight video, shown in Figure 3, that featured Jeremy Johnson, a research assistant in the CARTEEH Air Quality Division.

Figure 3. Career spotlight video.

Curriculum Outputs

A major output of the project was the publication "What is in our air? An inquiry lab exploring sources of air pollution in your community" in *Science Scope*, Volume 46, Issue 4. This monthly publication is a practitioner journal that targets middle school science educators. The CARTEEH lesson is also freely available on the CARTEH website. As of September 2023, 512 educators from around the world have downloaded the classroom lessons, reaching an estimated 59,000 elementary and middle school students. Figure 4 highlights the main components of the science unit including a health demonstration, smog in a jar pollution activity, and testing with air quality monitors.

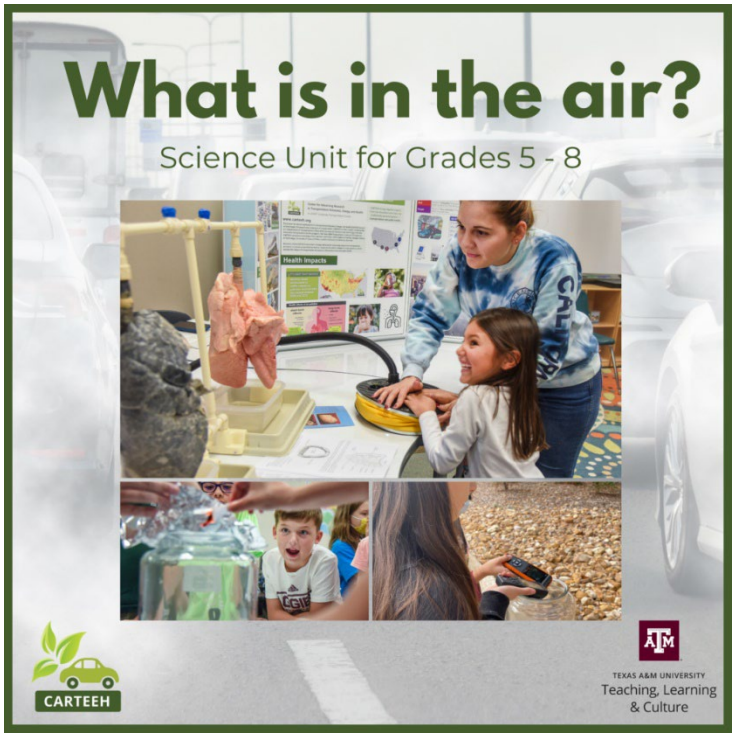

Figure 4. Science unit overview.

Classroom Kits

To support schools implementing "What's In Our Air?" lessons, the project team selected schools to participate in a pilot program. Each school was provided early access to the lessons and received air quality monitors. The team worked closely with these schools to pilot equipment and lessons for updates to improve effective classroom implementation. Students first investigated 2.5 PM levels around their school and discussed potential sources of air pollution. Figure 5 shows students using the provided air quality monitors to test particulate matters created from a contained fire. Students then investigated air quality levels around their community including parks, highways, farms, and other selected areas. Figures 6 and 7 shows students collecting this data and recording results. The data from this investigation were analyzed for sources of air pollution including transportation sources and potential health impacts. Schools then submitted data and shared them with participating schools.

Figure 5. Students in College Station, Texas, using air quality monitors with the smog in a jar demonstration.

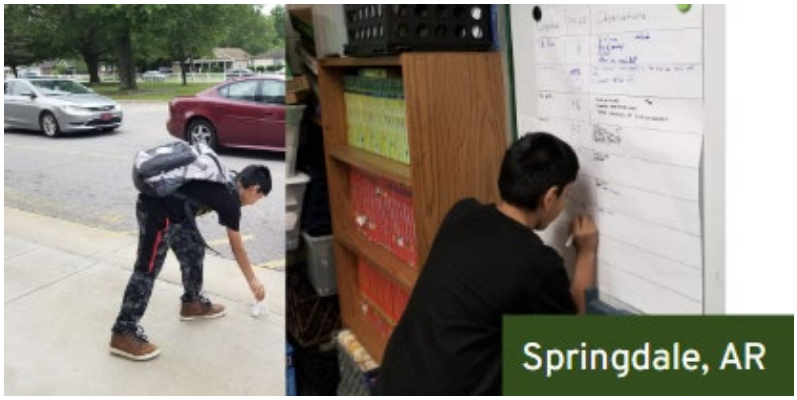

Figure 6. Students at Westwood Elementary School collecting and recording air quality data near a local road.

Figure 7. Students at Meridian Elementary collected data at a park and near an intersection.

Classroom Kit Outputs

A total of 25 schools were provided air quality monitors, reaching 1,429 elementary and middle school students. The elementary and middle school sites, primarily Title I campuses representing both urban and rural areas, were

in Alabama, Arkansas, California, Florida, Kentucky, Missouri, Nebraska, New Jersey, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Texas, and Wisconsin. Figure 8 shows a map highlighting these 25 schools:

- Baseline Academy, Little Rock, AR.
- Lincolnton High School, Lincolnton, NC.
- Meridian Elementary, El Cajon, CA.
- Cassidy Elementary, Lexington, KY.
- Joe Adair Outdoor Education Center, Laurens, SC.
- Gratz Brown Elementary, Moberly, MO.
- Westwood Elementary School, Springdale, AR.
- Sealy Elementary School, Sealy, TX.
- Christa McAuliffe School, Brooklyn, NY.
- Pomo Elementary, Clearlake, CA.
- Cheldelin Middle School, Corvallis, OR.
- State Library of PA, STEMlab, Harrisburg, PA.
- Christ the Teacher Academy, Fort Lee, NJ.
- Surf Skate Science Homeschool Co-op, Coconut Creek, FL.
- Linden Elementary, Fremont, NE.
- Mercy Academy, Louisville, KY.
- Henderson JH (Stephenville ISD), Stephenville, TX.
- Pelham Oaks Elementary, Pelham, AL.
- Lakeforest, Greenville, NC.
- Waunakee Community Middle School, Waunakee, WI.
- Parkway Christian School, Davie, FL.
- Redland Christian Academy, Homestead, FL.
- Calusa Preparatory School, Miami, FL.
- Ferris High School, Ferris, TX.
- School of the Holy Child, Rye, NY.

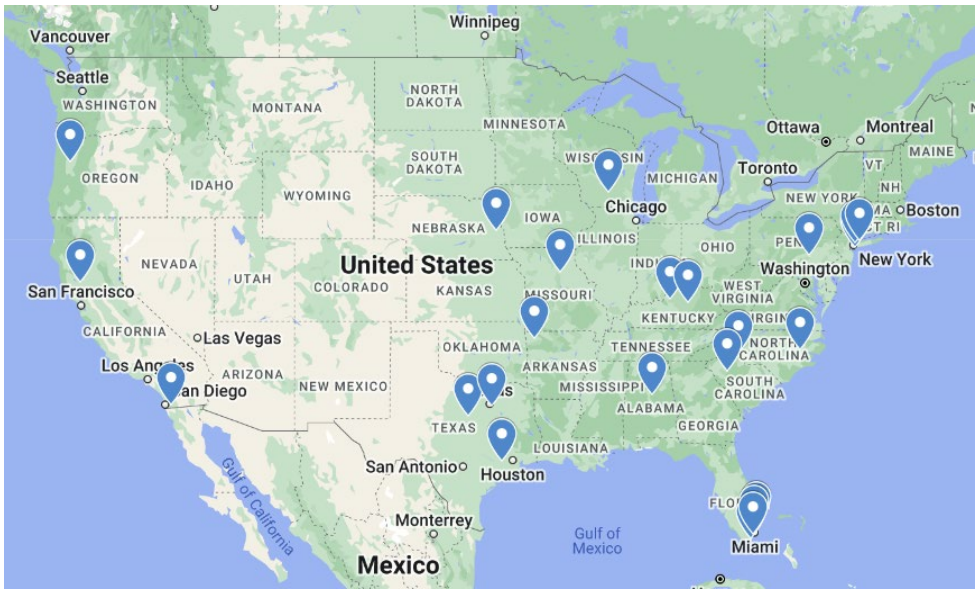

Figure 8. Map of schools.

Teacher Training

The project team developed professional development training videos to support educators in implementing "What's In Our Air?" lessons (Figure 9). Training videos were developed after piloting the lessons at several local outreach events to ensure quality and effectiveness with the intended audience. Videos are posted on the CARTEEH website and linked in the curriculum units.

Overview of "What's in the Air" Lessons

Figure 9. Professional development video for lessons.

Additionally, the lessons were implemented with a group of undergraduate engineering students who plan to become high school teachers. The preservice teachers visited CARTEEH and the Texas A&M Transportation Institute (TTI) Environmental and Emissions Research Facility for a presentation and tour (Figure 10). This experience was followed by a workshop on how to translate this research into a K–12 classroom lesson.

Figure 10. Texas A&M preservice students at TTI Environmental and Emissions Research Facility.

Teacher Training Outputs

To support educators, the team hosted online training sessions and two training courses for preservice teachers, and attended two major science education conferences. These efforts, listed below, reached a total of 210 educators.

- December 9, 2021: Educating the Future Workforce on Transportation Emissions, Energy and Health 12.9.21 (Online Webinar - https://www.youtube.com/watch?v=Ca8RjqBSNM4)
- July 2022: “What is in our air?” Introducing Air Pollution for grades 5-8. 2022 NSTA National Conference, Chicago, Illinois.
- November 2022: Preservice Undergraduate Course for Elementary Teachers
- October 2022: "What is in our air?" Environmental Science for Middle School. Science Teachers Association of Texas (STAT) Conference for the Advancement of Science Teaching.
- April 22, 2022: Preservice Undergraduate Student Field Trip to CARTEEH and TTI Environmental & Emissions Research Facility

Outreach Events

A STEM outreach kit was developed to support CARTEEH’s public outreach programming to provide a hands-on experience for the public that is scalable and increases awareness of air pollution and health impacts, CARTEEH’s research, and STEM careers. The kit includes a trifold board featuring CARTEEH’s research and background. At the CARTEEH station, students engage with a swine lung display that dramatically shows the impacts of air pollution, participate in smog in a jar activity using air quality monitors, engage with a CARTEEH researcher, and draw solutions for reducing air pollution from transportation in a mural displayed at the school (shown in Figure 11–Figure 14). Over the course of the project, the team supported 10 outreach events in Brazos Valley, reaching 1,775 students and families.

Figure 11. Families engaging with the CARTEEH STEM station on air pollution and health.

Figure 12. Project team at local STEM Family Night on April 25, 2022.

Figure 13. CARTEEH researcher sharing data with elementary students at Forest Ridge Elementary School.

Figure 14. Students drawing ideas to reduce transportation emissions.

Outreach Outputs

The project team supported nine outreach events in the Brazos Valley for K–12 students and their families along with one event for preservice teachers, reaching a total of 1,775 students and families. These included the following:

- December 1, 2021: Expanding Your Horizons Workshop in College Station, Texas (300 participants).
- March 29, 2022: Kingsoborough Middle STEM Night in San Antonio, Texas (175 participants).
- April 25, 2022: Forest Ridge Elementary STEAM Night in College Station, Texas (350 participants).
- June 2022 : Aggie STEM Camp (50 participants).
- October 18, 2022: Greens Prairie Elementary STEM Night in College Station, Texas (350 participants).
- December 3, 2022: Expanding Your Horizons Conference in College Station, Texas (100 middle school participants).
- March 5, 2023: Kingsoborough Middle STEM Night in San Antonio, Texas (175 participants).
- May 5, 2023: Leal Middle STEM Night in San Antonio, Texas (175 participants).
- May 20, 2023: Terrell Wells Middle STEM Night in San Antonio, Texas (120 participants).

Conclusion and Future Efforts

In conclusion, the Supporting Health-Transportation Education in Schools project established a synergistic relationship between the center's research program and the Texas A&M School of Education to create impactful STEM-based educational materials that were disseminated to schools across the nation. Through piloting in local STEM outreach events, collaborating with K–12 schools around the country, and disseminating results through conferences, videos, and a journal, the project team was able to reach an estimated 59,000 elementary and middle school students and 722 educators. Future efforts will build on this work to develop science-based materials for high-school students, translate materials to Spanish, and expand the number of grants to cover air quality monitors for underserved schools.