



5-1-2016

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Julianne Hooper

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Recommended Citation

Hooper, Julianne. (2016). Determining Diesel Education in Urban Middle Schools in Eastern Massachusetts. In *BSU Honors Program Theses and Projects*. Item 156. Available at: http://vc.bridgew.edu/honors_proj/156
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Determining Diesel Education in Urban Middle Schools in Eastern Massachusetts

Julianne Hooper

Submitted in Partial Completion of the
Requirements for Departmental Honors in Social Work

Bridgewater State University

May 1, 2016

Dr. David O'Malley, Thesis Director

Dr. Arnaa Alcon, Committee Member

Dr. Kathy Bailey, Committee Member

Abstract

Previously conducted studies have illuminated evidence that diesel exhaust emission rates are rising in the United States. Rising diesel exhaust emission rates bring more than a higher concentration of particulate matter in the air. Health complications from breathing in the particles of diesel exhaust place all citizens at risk. However, not everyone is equally at risk. Evidence has suggested children are particularly vulnerable to encountering health obstacles that can be caused by inhaling, these particles. This is due to a smaller lung capacity which requires children to breathe more frequently, their cardiovascular and respiratory systems still being in the developmental stages, and their frequent exposure to the air outdoors and diesel engines. Research suggests that children are more susceptible to asthma and other cardiac and respiratory illnesses caused by exposure to diesel particulate. This raises the question: are children learning about the health impact of particulate matter from diesel emission? To determine this, the following sources were examined to explore how youth are being educated about this major health threat:

- curricula of grades six to eight in urban areas in eastern Massachusetts,
- curricula of other districts in the United States
- organizations that provide information about diesel exhaust emissions, air pollution, and the impact they have on human health

Research Question

Do curriculum frameworks available online of the specified urban middle schools in eastern Massachusetts contain content for middle school age students about diesel exhaust

emissions, air pollution, and/or the effect diesel exhaust emissions/air pollution have on human health? If not, what other organizations/institutions in the United States address these topics?

Goal

The goal of this research is to determine if public urban middle schools in eastern Massachusetts teach middle school aged students about diesel exhaust emissions, the role it plays in air pollution, and/or the harm it can cause to the health of the human person. Additionally, the researcher will determine what other organizations/institutions provide information about these topics.

Introduction

Emissions from diesel engines have been identified as a contributor to air pollution (Department of Health and Human Services, 2000). While modern technology allows new diesel engines to burn the fuel without emitting particulate matter at the high rates of older engines, particulate matter from diesel exhaust emissions still poses a risk to health. Particulate matter from diesel exhaust is composed of carbon, ash, metallic abrasion particles, sulfates and silicates (United States Department of Labor: Occupational Safety and Health Administration, 2013). Most of these particles are one fifth to one hundred times thinner than the width of human hair. Due to particulate matter's size and presence in the air, it is easy for humans to breathe in these particles. Upon inhalation of these particles, the human person faces the risk of developing health conditions as a result. Health risks posed by inhaling particulate matter from diesel exhaust include short term and long term effects. Short term health effects include irritation of the nose, eyes, and throat, coughing, nausea, headaches, and dizziness. Long term exposure to particulate matter from diesel exhaust can cause respiratory and cardiovascular illnesses, such as

emphysema, asthma, or chronic heart disease, and different forms of cancer, including lung and throat (Office of Environmental Health Hazard Assessment, 2007).

Despite all humans being at risk of exposure to particulate matter from diesel exhaust, the risk is not equal for all humans. Individuals living in urban communities have a higher likelihood of developing these illnesses due to living in a community with a high volume of traffic, public transportation in the forms of buses and trains, and industrial plants or factories that use diesel engines. The World Bank has identified that urban areas have 19.2 metric tons per person of CO₂ in the atmosphere (2014a). Eighty one percent of the entire United States population lives in a community identified as urban (The World Bank, 2014b). In these urban neighborhoods, individuals living in poverty, females, children, people of color, and Puerto Ricans are more at risk than other populations (Akinbami, Moorman, Bailey, Zahran, King, Johnson, and Liu, 2012).

Of the different populations exposed to heightened diesel exhaust emissions, evidence suggests children are more inclined to suffer from negative health consequences. The cardiovascular and respiratory systems of children are still in the developmental stages. As the respiratory systems of children are still developing, children breathe more frequently, causing them to inhale a larger quantity of air, and air pollutants (Natural Resource Defense Control, 1997). Children also expose themselves to more air pollution by spending more time playing outdoors, taking a bus to and from school on a nearly daily basis, and being closer to ground level where pollutants tend to settle as they are heavier than the air.

If these children are exposing themselves more frequently to this polluted air, and are physically vulnerable to cardiovascular and respiratory illnesses caused by particulate matter

from diesel exhaust, are they being educated about it? One of the main sources of information for this population is content they receive in the classroom. Does the curriculum used in the classroom educate these students about this problem? To explore an answer to this question, twelve middle schools in urban neighborhoods in eastern Massachusetts were surveyed. This area was chosen as evidence has reflected that eastern Massachusetts has some of the worst air pollution in the country and urban neighborhoods rank higher than rural communities in regards to air pollution from diesel exhaust (State of the Air, 2015). The Massachusetts Department of Education had not updated the current middle school science curriculum framework since 2006 at the time of this surveys administration (Massachusetts Department of Education, 2015). While there is a plan to move forward and change the state standards of Science, Technology, and Engineering in Massachusetts schools, the revised program will be focusing on preparing students for college programs instead of changing the majority of the content (Massachusetts Department of Elementary and Secondary Education, 2013). This change will be further discussed in the discussion portion of the paper. Twelve eastern Massachusetts middle School curriculums were explored to determine if students are receiving the information they need to make informed decisions about their exposure to diesel exhaust emissions. By exploring these fourteen curriculum frameworks provided online, the researcher will seek to determine if urban schools in eastern Massachusetts include information about diesel emissions, air pollution, and their role on human health.

Method

An investigation into what local school districts are teaching to sixth, seventh and eighth grade students will be conducted to answer the research questions- “Do curriculum frameworks provided online of urban middle schools on the east coast of Massachusetts educate middle

school age students about diesel exhaust emissions, air pollution, and/or the effect diesel exhaust emissions/air pollution have on human health? If not, what other organizations/institutions in the United States cover these topics?” The online curriculum frameworks of twelve eastern Massachusetts urban middle school science online curriculum frameworks were analyzed to determine content. As content varies by teacher, the curriculum framework of the school provided online offers a baseline of what each educator is instructed to teach their students. These twelve middle schools were chosen to be surveyed due to evidence of heightened particulate matter from diesel exhaust emissions in urban settings, and evidence that shows the quantity of particulate matter from diesel exhaust is higher in eastern Massachusetts than most other places in the United States (Clean Air Task Force, 2005). The curriculums were examined to see if the students would be learning about: 1) diesel exhaust emissions 2) air pollution and 3) the impact diesel exhaust emissions, or air pollution, poses to the health of humans.

Curriculum Analysis

<u>City</u>	<u>Diesel</u>	<u>Air Pollution</u>	<u>Health Impacts</u>
Boston	Not Included	Not Included	Not Included*
Cambridge	Not Included	Not Included	Not Included
Brockton	Not Included	Not Included	Not Included
Lowell	Not Included	Not Included	Not Included
Fall River	Not Included	Not Included	Not Included
New Bedford	Not Included	Not Included	Not Included
Lynn	Not Included	Not Included	Not Included
Woburn	Not Included	Not Included	Not Included

Haverhill	Not Included	Not Included	Not Included
Salem	Not Included	Not Included	Not Included
Somerville	Not Included	Not Included	Not Included
Brookline	Maybe**	Maybe**	Maybe**

(Cambridge Public Schools, 2015a; Cambridge Public Schools, 2015b; Cambridge Public Schools, 2015c; Brockton Public Schools, 2011a; Brockton Public Schools, 2011b; Brockton Public Schools, 2011c; Lowell Public Schools, 2014; Massachusetts Department of Education, 2015; New Bedford Schools, 2015a; New Bedford Schools, 2015b; New Bedford, 2015c; Lynn Public Schools, 2015; Woburn Public Schools, 2015; Haverhill Public Schools, 2011; Salem Public Schools, 2015; Massachusetts Department of Education, 2006; Somerville Public Schools, 2007)

* Boston, Massachusetts: While the curriculum framework provided by Boston Public Schools does not specifically include information about diesel exhaust emissions, air pollution, or the risk it poses to the health of the human person, it does talk about the capabilities of the respiratory system. In the unit, The Respiratory and Circulation Systems, students will learn about the strengths and limitations of lung capacity, the gas exchange in respiration, and how to collect data on lung capacity. However, it does not indicate that it discusses the impact of diesel exhaust emissions, or air pollution, on human health (Boston Public Schools 2015a; Boston Public Schools, 2015b).

** Brookline, Massachusetts: While the curriculum framework for the Brookline Public School system does not specifically mention covering diesel exhaust emissions, air pollution, or its effect on human health, it does make a point to cover human's role in climate change. This may provide an opportunity to discuss air pollution (Brookline Public Schools, 2015).

While the survey of online resources regarding the curricula of these twelve urban districts in eastern Massachusetts seems to indicate that diesel exhaust emissions, air pollution,

and the role they play on human health are not covered, there is the potential to integrate material based on topics already covered in the curriculum frameworks. A majority of the curricula surveyed base their frameworks on the Massachusetts Department of Education's science curriculum framework or have similar curriculum objectives. After an analysis of the Massachusetts Department of Education's science curriculum framework and topics observed in the majority of the curricula, the researcher found that students are expected to learn about the cardiovascular and respiratory systems, the composition of the atmosphere, mass and density, and changes to Earth's environment over geological time (Massachusetts Department of Education, 2006). As students learn about different systems within their bodies, they also have the opportunity to learn what inhibits the functioning of these systems. Even though the current curriculum does not explicitly address issues of diesel particulate, there is the potential to include examples which could address this issue as a health risk. Understanding what naturally occurs in the atmosphere will allow students to understand what does not occur there naturally and what happens when there is a change to the composition of the atmosphere. As students learn about mass and density, they will understand that the heavier particulate matter tends to sink when it is released into the atmosphere, allowing people to breathe it in. Finally, students have the opportunity to see what changes have occurred over geological time and see the impact human existence and the emergence of technology that uses diesel fuel have on the atmosphere.

After surveying the available information online regarding the science curricula of 12 eastern Massachusetts school districts there appears to be no content included regarding diesel particulate. This deficit could be filled by inclusion of content to address this issue and the health implications. Outside of the Massachusetts Department of Education, different states and organizations have already been shifting their lesson plans and developing adaptable curriculum

programs to cover diesel exhaust emissions, air pollution, and their impact on human health. After observing the lack of information about diesel exhaust emissions, air pollution, and their impact on human health, the researcher further investigated what individuals or organizations are discussing these issues and how they share the information. To determine how students are learning about diesel, air pollution, and its impact on human health, three state curriculums, one popular science standard framework, and three adoptable curriculums for instructors to integrate into middle school age education were analyzed.

The curriculum frameworks established by the Colorado Department of Education call for students to take responsibility over what is happening to the environment and focus on how human technology impacts the environment. Similar to the Massachusetts state curriculum standard, Colorado students in the eighth grade are expected to cover physical science, life science, and earth systems science. In the life science unit, an emphasis is placed on students understanding the impact of human activity on ecosystems (Colorado Department of Education, 2009).

The Department of Education in California is currently working on reshaping its science curriculum framework. California utilizes the Next Generation Science Standards, a set of standards for science education that can be adopted by any school district, when creating their curriculum. The current science curriculum frameworks, last revised and released in March of 2015, do emphasize educating California students on changes in the environment caused by human activity. However, in November of 2015, a draft was released through their website, highlighting the science education goals for sixth, seventh, and eighth grade students. This new curriculum will be used starting in 2016. The curriculum draft includes an emphasis on humans' impact on the environment, similar to the one currently used, but places an even greater

emphasis on human impact and includes more specific detail and activities so students understand the seriousness of the problem. In the sixth grade, students are introduced to the idea that the actions of humans can alter the state of the atmosphere. Students will construct models to understand temperature changes that occur in California and compare them to other parts of the world. Students are encouraged to determine whether this is a natural change or if pollution from humans plays a role. The curriculum also highlights the changes emissions from diesel powered vehicles, power plants, factories, and machines can cause and have caused on the environment. Teachers are encouraged to discuss with students the impact diesel exhaust emissions can have, and the rate at which the state of California consumes diesel fuel and emits pollution in comparison to the rest of the country. This information is shared under the sixth grade student's Earth Science unit, a unit that sixth grade students also focus on in Massachusetts (California Department of Education, 2015).

In 2014, the state of Oregon adopted the Next Generation Science Standards (Oregon Department of Education, 2015). Unlike California, which uses the NGSS as a base to which they add on their own content, Oregon does not state that they make any alterations to the recommendations. For students in grades six through eight, the NGSS focused a portion of their lessons on changes in the environment from human activity. This unit takes a look at what causes air pollution, and what air pollution can do to the environment. The NGSS also places an emphasis for educators to explain to students the impact air pollution has on human health. They recommend educators also cover what action is being taken to fix this issue and steps students can take to reduce the amount they contribute to the pollution of the air (Oregon Department of Education, 2015; Next Generation Science Standards, 2015).

The Next Generation Science Standards began development in 2007 as a result of the low science and math test scores within the United States. The final standards were released in 2013 (Next Generation Science Standards, 2016a). The NGSS uses three elements when teaching science material: practices, core ideas, and cross cutting (relating material to different educational domains). The developers believe that students should use models to understand the content on which they are focusing. To be considered a core idea, the topic must have a broad importance across multiple science or engineering disciplines/be a key organizing concept of a single discipline, provide a key tool for understanding or investigating more complex ideas and solving problems, relate to the interests and life experiences of students/ be connected to societal or personal concerns that require scientific or technological knowledge, and/or be teachable and learnable (Next Generation Science Standards, 2016b). The Next Generation Science Standards includes information about humans' role in air pollution, and the impact it causes on their health. In the section MS-ESS3-3 Earth and Human Activity, students focus on how the rate of consumption creates air pollution. This is a result of shipping methods and use of machinery that utilizes diesel fuel. This unit also focuses on how this air pollution affects the overall biosphere, and impacts living things (Next Generation Science Standards, 2016c). In the section, entitled MS Human Impacts, students learn how to interpret data that reflects the areas per capita that produce the most air pollution. This unit also focuses on what tools are commonly used that aid this increase of pollution. To reflect the relevancy of consumption and pollution, the unit ends by focusing on how these two factors harm the health of humans (Next Generation Science Standards, 2016d). Finally, in the unit MS-ESS3-5 Earth and Human Impact, students will learn about how fossil fuel combustion negatively impacts human health (Next Generation Science

Standards, 2016e). Along with California and Oregon, forty other states currently use the Next Generation Science Standards.

Schools, while the primary source of information for children, are not the only resource for obtaining information about diesel exhaust emissions, air pollution, and the impact they have on human health. The Environmental Protection Agency provides tools for educators to incorporate into their curricula, programs to aid in the reduction of diesel exhaust emissions, and information for individuals who are curious about the topic of diesel exhaust emissions and the impact it has on society. The E.P.A. established a program called “E.P.A.’s Clean School Bus” that educates individuals who have a vested interest in school buses, such as school faculty, a bus company, parents, and students. The program discusses ways to reduce emissions from buses that utilize diesel. The program provides a list of things that school officials, bus owners, bus drivers, parents, and students can do to take action about reducing emissions and educating people about the problems caused by these emissions. This information is made public on the E.P.A.’s website, allowing everyone to have access to this program (Environmental Protection Agency, 2016).

Yale-New Haven Teachers Institute provides a curriculum to educate students and teachers on diesel exhaust emissions and how it specifically impacts their students. Kathleen Z. Rooney’s (2011) program, *Take the Long Way Home*, provides introductory information about diesel exhaust and how it effects young children, an explanation of what impacts children’s exposure to diesel exhaust emissions have in the area of New Haven Connecticut, how particulate matter from diesel exhaust emissions impacts human health, and a lesson plan with provided materials to educate students on diesel exhaust and its impact on human health. To ensure educators that this content is related to what students are already focused on in school and

will be able to understand the concepts presented in this program, Rooney provides a list of district standards that reflect how content that students are already learning about can be integrated into this program, or vice versa.

Clean Air, Healthy Children: Teacher's Guide and Activities for Young Children is a resource made available by the Wisconsin Department of Natural Resources: Bureau of Air Management for teachers to take and apply to their own classroom setting. This program encompasses the connection between respiratory issues and air pollution, and the student's role in identifying solutions. The program starts by discussing the connection between respiratory illness and air pollution. The program then dives into the details of respiratory illness, what common machines produce particulate matter, and what students can do to help reduce their share of pollution. The program educates students through worksheets, activities that display concepts of air pollution and health complications caused by it, and lesson plans for instructors to appropriately deliver information about air pollution and the impact they have on human health (Wisconsin Department of Natural Resources, 2012).

Results

The researcher found that the twelve urban middle schools in eastern Massachusetts do not specifically include information about diesel exhaust, air pollution, and the effects they have on human health, based on the information they include in their curriculum frameworks provided online. While Massachusetts has yet to update their curriculum frameworks and standards, five other states include information about diesel, air pollution, and/or their impact on human health. The Next Generation Science Standards also present an adaptable science standard for schools that include information relevant to the modern day problem of diesel exhaust emissions, air

pollution, and the impact they have on human health. Other organizations are producing lesson plans for teachers to integrate into their daily lessons or for instructors to establish a program external to the school curriculum to help young people learn about diesel exhaust emissions, air pollution, and the impact they have on human health.

Conclusion/Discussion

The researcher set out to determine whether public middle schools in twelve urban communities in eastern Massachusetts educate their students on diesel exhaust emissions, air pollution, and the role they play in human health. To do this, the team surveyed the curriculum frameworks provided online to understand what information districts chose to educate their students on, and what teachers of that district were instructed to teach. The team found that no school specifically included information about diesel exhaust emissions, air pollution, or the impact it has on human health. However, the team believes that there are areas where this information could be included.

Helping students to understand what diesel exhaust emissions are, what air pollution is, and how these two impact human health have significant implications in relation to social justice and the welfare of this population. In eastern Massachusetts, there is a concentration of cities and urban neighborhoods. In these cities and urban neighborhoods, there are higher volumes of traffic, public transportation, shipping, and other industrial activity that take place. In the state of Massachusetts, children from birth to fourteen years old had higher rates of asthma than the national average. Additionally, children of color and children from low income families experience higher rates of asthma than other populations of children (Centers for Disease Control, 2009). These high rates of asthma among children can be attributed to the physiological

development of their respiratory and cardiovascular systems, their height, which places them closer to the ground where particulate matter settles, and their high exposure to diesel exhaust through mediums such as school buses. For children of color and low income families, the risks are greater. Children of color are more likely to be living in poverty and to be living in an urban setting (Natural Resources Defense Council, 1997). Children of low income families tend to spend more time playing outdoors as a result of not being able to purchase computers, gaming systems, or other indoor activities. During the summer, families tend to spend more time outdoors as a result of the lack of air conditioning. The close proximity of these families with children to higher volumes of traffic, public transportation, shipping, and other industrial activity, coupled with these risk factors, make children more susceptible to other populations (Natural Resources Defense Council, 1997).

The Natural Resources Defense Council recommends combating these high rates of asthma by informing people when they are young about the hazards around them and their effects. By educating students about how to identify contributing factors to air pollution, how air pollution impacts human health, identifying the signs, and how to avoid them, this population will understand how to reduce their chances of developing an illness caused by various forms of air pollution. If individuals are taught at a young age about the implications of exposure air pollution, and the importance of reducing anthropogenic activity that contributes to air pollution, they may model their life choices in response to this understanding.

Children are one of the most vulnerable populations to the effects of diesel exhaust emissions. Most of the supporting data that reflects this information did not emerge until after the Massachusetts Department of Education released their last version of the Science and Technology curriculum framework in 2006. The analysis of the curricula reflects that there are

topics discussed in frameworks, such as humans' role in climate change or the capabilities of the human lungs, into which this information can be incorporated. It is important to update and include in curricula scientifically relevant health information as it emerges. As middle school aged students are a population affected by this issue, schools have the ability and responsibility to incorporate this decade old data into their curricula.

The Departments of Education in Colorado, California, and Oregon have updated their curriculum frameworks to include information about diesel, air pollution and/or the effect it has on human health. To help these states present the most factual and timely information about these forms of pollution and how this relates to humans, the Next Generation Science Standards act as a guide. While Massachusetts submitted an application to be a lead partner of the Next Generation Science Standards in 2011, they had not yet provided an implementation plan about how they anticipate integrating this material into their curriculum framework, and their state framework does not reflect those of the Next Generation Science Standard as of January 2016 (Next Generation Science Standard, 2016f).

While it may be a significant task to revise an entire curriculum, schools can choose to implement pre-developed programs. To help students obtain information about diesel, air pollution, and the impact it has on human health, organizations, teachers, and/or scientists external to schools have developed curriculums that can be adapted to the current curriculum or implemented as an after school or community-based program. There are several programs available online for instructors to use in the classroom setting, in an after school program, or as a summer course.

The Massachusetts Department of Education announced in 2009 that it would be working to update its science curriculum framework. That science curriculum framework had been updated three years earlier in 2006. After this study's survey of the twelve districts' science curriculum frameworks, the Massachusetts Department of Education announced and released their new science and technology curriculum framework in February of 2016. This new framework incorporates education about human's role in pollution (Massachusetts Department of Education, 2016a). The researcher wishes to highlight that the release of a new framework from the Massachusetts Department of Education occurred while data was being collected and analyzed from local school districts. The release of the new framework from the Massachusetts Department of Education will be addressed in the section on implications for future research.

In the Massachusetts Department of Education's 2016 Science/ Technology curriculum frameworks, there are two areas that allow for the opportunity to teach students about diesel exhaust, air pollution, and the impact they have on human health. In the 7th grade unit of the Massachusetts Science/Technology framework, Earth and Human Activity (7.MS-ESS3-4), students will learn about human consumption of natural resources, such as fossil fuels, and how the consumption of these resources impacts humans, including their health status. In the 8th grade unit, Earth and Human Activity (8.MS-ESS3-5), students will focus on how resource consumption, such as include fossil fuel combustion, deforestation, and agricultural activity, impacts climate. The new lesson plans are small pieces of the overall picture that address diesel and its relation to the natural and social environment. To help students understand the topics covered by the new curriculum framework, external programs beyond the classroom, such as those mentioned in this paper, can supplement content that students will learn in this new curriculum framework (Massachusetts Department of Education, 2016b).

This newly released change in the Massachusetts' science/technology curriculum frameworks asks local school districts to reframe their own science curricula to match this new standard. It is unclear how soon the state wide change will be made, or what material educators will incorporate into their specific curriculum to meet these standards. Through this action, however, it seems to reflect that the Massachusetts Department of Education recognizes this information as critical to student learning, health and social well-being. By understanding the role humans play in air pollution, the impact air pollution has on health, and how humans can change their behavior for a future of cleaner air, students who are taught according to the 2016 Massachusetts curriculum guidelines have the potential to change the future of health in Massachusetts.

Limitations and Future Research

The results of this study have limitations which affect the conclusions that can be drawn. The researcher chose to look at the publicly available, online curriculum frameworks of twelve different public schools in eastern Massachusetts. Due to time constraints on the researcher's use of faculty surveys and interviews was not a feasible option. These online curriculum frameworks may not reflect what is being taught in classrooms by teachers as the curricula of individual teachers was not able to be assessed.

Recommendations for future research include surveying and/or interviewing the creators of the curriculum frameworks and teachers. Surveying the creators of curriculum frameworks could offer insight about why certain information is chosen to be a part of the curriculum. Similarly, surveying and interviewing teachers about content they teach that differs from the established curriculum frameworks may offer a more accurate picture of what students are being

taught in the classroom. Future data collection could measure changes schools and teachers in eastern Massachusetts make to meet the new curriculum frameworks released by the Massachusetts Department of Education in 2016.

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