



5-E Classroom STEM Activity:
Technology in Transportation

Jill C. Cataldi

The Tech that Makes Public Transportation Hum

By Dorothy Crouch

Move in the right direction by serving the public through a STEM career in transit. After working in information technology for 14 years, Nicole Fontayne-Bárdowell joined Dallas Area Rapid Transit (DART) in 2014 and in June 2018, she took the role of chief administrative officer. In this job, she leads the technology department by taking responsibility for management information systems, intelligent transportation systems technology, networks, and communications.

"It is very gratifying to know that the work that I do contributes to Dallas Area Rapid Transit's delivery of services to people throughout the region," reveals Nicole. "We help people from all walks of life travel to the different locations that fulfill their lives, whether that is to work, school, medical appointments, or just having fun."

While Nicole finished her undergraduate work in political science and a master's degree in public administration, she hasn't stopped learning. She also received an executive education in negotiation at Harvard University and learned about cross-boundary government technology at the college's John F. Kennedy School of Government.

"Every opportunity and experience increases the value of my skills tool box for the future," says Nicole. "With that in mind, I am a continuous learner and leverage as many channels as possible to increase my technical and professional knowledge."

While she is proud of her own accomplishments, Nicole is also thankful for her team that supports her work. She also sees how they have grown to reach high-level, leadership positions.

"From a technical standpoint, my teams have installed state-of-the-art infrastructure and delivered services over the web and mobile apps, such as DART's Go-Pass 2.0, interactive kiosks and on-board information displays that have improved the customer experience," she explains.

In fact she feels that the hardest, but most satisfying responsibility is training her staff. While guiding employees who have different personalities to form a working team can be a difficult responsibility, accomplishing goals together is one of the best feelings as a manager.

When talking about different jobs in transit, Nicole reveals that in addition to her job, students can look into civil, construction, and electrical engineering; data science; information systems; intelligent transportation systems; cybersecurity; or network engineering.

"Our buses and trains manage so much data and computing that they are moving data centers," says Nicole. "The future is exciting! There will continue to be more automated vehicles, sensors, signals, and data repositories that will allow the transportation industry to continue to expedite service and improve safety." 

NICOLE FONTAYNE-BÁRDOWELL
EXECUTIVE VICE PRESIDENT,
CHIEF ADMINISTRATIVE OFFICER
DEGREES:

- BACHELOR'S IN POLITICAL SCIENCE
 - MASTER'S IN PUBLIC ADMINISTRATION
- YEARS IN THE INDUSTRY:**
4 IN TRANSPORTATION
AND 14 IN MUNICIPAL IT
STEM TYPE: INTEGRATOR



5-E Classroom STEM Activity: Technology in Transportation

Here are some ideas for how middle school teachers could use this story as a launching point for integrated STEM learning. Our activities follow the 5-E Learning Cycle Model.



Part 1: Engage

- 1 Discuss with students different types of public transportation.
 - a. What are some methods of public transportation?
 - b. What careers might be available in public transportation?
 - c. What role(s) does technology play in public transportation?
- 2 Have students read “The Tech that Makes Public Transportation Hum” in *STEM Jobs* magazine.
 - a. Discuss different jobs Nicole Fontayne-Bárdowell lists as areas students can explore.
 - b. Why are each of those jobs important in the transportation industry?



Part 2: Explore

At the end of the article “The Tech that Makes Public Transportation Hum,” Nicole Fontayne-Bárdowell indicates that exciting technological advancements in transportation are still to come. Think about the public transportation that is available or that you have used in the past. What technologies do they use? What areas can be improved? Students will work together in groups to explore public transportation, the uses of technology in transportation, and ways that technology in transportation can continue to advance/improve.

Each group will choose one form of transportation to research.

More than one group can focus on the same mode of transportation.

Within the group, students can take on specific roles.

- 1 **Data Collector/Analyst:** This person will collect data. How common is this mode of transportation? How much is it used? Is it easily accessible? What technology is being used? Is it user friendly? What data has to be looked at and what other factors are at play?
- 2 **Accountant:** The accountant will look at information on costs. What are typical construction costs? Do costs vary by area? Are there ways to modify costs and still make efficient upgrades?
- 3 **Engineer:** The engineer will focus on new technology designs. Design a new system or improve upon an existing system of technology used within public transportation that can help the transit to be more effective. The design can be a detailed idea. New technology is not expected to be built and functional.
- 4 **Cyber Security:** This person will focus on ways the new technology could be misused or compromised. What issues can arise? How can they be prevented? How can they be monitored?



Part 3: Explain

Each group of students will present their projects. Students will be expected to share researched information on the type of public transportation they selected as their focus. They will be expected to provide data collected, costs, pros and cons of technological advancements, how to stay protected, and their new design. Each member is responsible for presenting the information for which they were responsible. Students will use technology such as PowerPoint, Google Slides, or iMovie to create and deliver their presentations. All calculations, pictures, and research should be included.



Part 4: Elaborate

Once presentations are complete, have students reconvene in their groups and discuss the proposed technologies. Which do they believe would be most impactful or successful and why?

After they are done evaluating the technology presented, have students look at public transportation options through a different lens. What are the biggest deterrents to using public transportation (cost, accessibility, scheduling, etc.)? Once they have identified some of the most significant issues within their groups, have them poll their peers in person and/or via a platform like Facebook to discover which of those issues are most important to people and have the greatest impact on their use of public transportation. Students will work within their groups to gather, track, and interpret this data. They will now review the proposed technologies again to see whether any of them addressed the issues that their population deemed were most important, and if so, which would be most beneficial to the public and why.

Each group will submit a formal writing assignment regarding the data they collected (complete with graphs and/or tables), the conclusions they drew from that data, and which technology proposed by their classmates would best address the issues people have with public transportation and why. The assignment can be graded for completion or as a formal writing assignment at the discretion of the teacher.



Part 5: Evaluate

Students will be evaluated for their presentations using the following rubric. Students will be provided the rubric at the start of the assignment to aid in the completion of the project. Each group will be graded, therefore all students in the group will receive the same score.

Scoring Rubric

___ /5 Participation

Did all 4 members of the team contribute?
Is there significant research and data to support that each member did their part?

___ /15 Research

Was significant research completed?
Is there adequate data?
Are typical costs provided?
Is the provided financial information relevant to the overall project?
Is the design included?
Is the design explained so that it is apparent why that design has been chosen?

___ /10 Presentation

Is the information displayed in a visually appealing way?
Is it neat and organized?
Are pictures of the project included and relevant to the overall theme of the project?

___ /10 Calculations

Were necessary calculations performed and completed accurately to include the distances traveled and all necessary costs and any necessary conversions?

___ /10 Presentation

Did the presentation cover all areas of the process?
Was the presentation clear and easy to understand?

___ /50 Total

Standards Addressed:

Common Core State Standards - Math

Potential Standards Include:

CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.

CCSS.MATH.CONTENT.6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

CCSS.MATH.CONTENT.6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship.

CCSS.MATH.CONTENT.6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

CCSS.MATH.CONTENT.6.SPA.1 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

CCSS.MATH.CONTENT.6.SPA.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

CCSS.MATH.CONTENT.6.SPA.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

CCSS.MATH.CONTENT.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

CCSS.MATH.CONTENT.6.SP.B.5.A Summarize numerical data sets in relation to their context, such as by:

A. Reporting the number of observations.

CCSS.MATH.CONTENT.6.SP.B.5.B Summarize numerical data sets in relation to their context, such as by:

B. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.

CCSS.MATH.CONTENT.6.SP.B.5.C Summarize numerical data sets in relation to their context, such as by:

C. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.

CCSS.MATH.CONTENT.6.SP.B.5.D Summarize numerical data sets in relation to their context, such as by:

D. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

CCSS.MATH.CONTENT.7.RP.A.3 Use proportional relationships to solve multistep ratio and percent problems.

CCSS.MATH.CONTENT.7.SPA.1 Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population.

Understand that random sampling tends to produce representative samples and support valid inferences.

Common Core State Standards - ELA

CCSS.ELA-LITERACY.RI.6.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

CCSS.ELA-LITERACY.W.6.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

CCSS.ELA-LITERACY.W.6.7 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

CCSS.ELA-LITERACY.W.6.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

CCSS.ELA-LITERACY.W.6.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

CCSS.ELA-LITERACY.SL.6.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

CCSS.ELA-LITERACY.SL.6.4 Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

CCSS.ELA-LITERACY.SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

CCSS.ELA-LITERACY.W.7.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

CCSS.ELA-LITERACY.W.7.7 Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.

CCSS.ELA-LITERACY.W.7.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

CCSS.ELA-LITERACY.W.7.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

CCSS.ELA-LITERACY.SL.7.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.

CCSS.ELA-LITERACY.SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

CCSS.ELA-LITERACY.SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

CCSS.ELA-LITERACY.W.8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

CCSS.ELA-LITERACY.W.8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

CCSS.ELA-LITERACY.W.8.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

CCSS.ELA-LITERACY.W.8.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

CCSS.ELA-LITERACY.SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

CCSS.ELA-LITERACY.SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

CCSS.ELA-LITERACY.SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Standards Addressed (Cont.):

Next Generation Science Standards

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Science and Engineering Practices

Asking Questions and Defining Problems. Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful.

Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.

Crosscutting Concepts

Influence of Science, Engineering, and Technology on Society and the Natural World.

All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Science and Engineering Practices

Engaging in Argument from Evidence. Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.

Disciplinary Core Ideas

ETS1.B: Developing Possible Solutions

There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.

ISTE Standards for Students

3d Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

4a Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.

4b Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.

Texas Essential Knowledge and Skills – Math

Potential Standards Include:

6-8.1.A apply mathematics to problems arising in everyday life, society, and the workplace

6-8.1.D communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate

6.4.B apply qualitative and quantitative reasoning to solve prediction and comparison of real-world problems involving ratios and rates

6.5.A represent mathematical and real-world problems involving ratios and rates using scale factors, tables, graphs, and proportions

6.9.A write one-variable, one-step equations and inequalities to represent constraints or conditions within problems

6.12.A represent numeric data graphically, including dot plots, stem-and-leaf plots, histograms, and box plots

6.12.B use the graphical representation of numeric data to describe the center, spread, and shape of the data distribution

6.12.C summarize numeric data with numerical summaries, including the mean and median (measures of center) and the range and interquartile range (IQR) (measures of spread), and use these summaries to describe the center, spread, and shape of the data distribution

6.12.D summarize categorical data with numerical and graphical summaries, including the mode, the percent of values in each category

(relative frequency table), and the percent bar graph, and use these summaries to describe the data distribution

6.13.B distinguish between situations that yield data with and without variability

7.4.A represent constant rates of change in mathematical and real-world problems given pictorial, tabular, verbal, numeric, graphical, and algebraic representations, including $d = rt$

7.4.B calculate unit rates from rates in mathematical and real-world problems

7.4.D solve problems involving ratios, rates, and percents, including multi-step problems involving percent increase and percent decrease, and financial literacy problems

7.6.F use data from a random sample to make inferences about a population

7.12.B use data from a random sample to make inferences about a population

Texas Essential Knowledge and Skills – Science

Potential Standards Include:

6-8.3.A analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student

6.7 research and discuss the advantages and disadvantages of using coal, oil, natural gas, nuclear power, biomass, wind, hydropower, geothermal, and solar resources

6.7.B identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces

6.8.C calculate average speed using distance and time measurements

8.6.A demonstrate and calculate how unbalanced forces change the speed or direction of an object's motion

8.6.B differentiate between speed, velocity, and acceleration

8.6.C investigate and describe applications of Newton's three laws of motion such as in vehicle restraints, sports activities, amusement park rides,

Earth's tectonic activities, and rocket launches

Standards Addressed (Cont.):

Texas Essential Knowledge and Skills - Technology Applications

- 6-8.2.B communicate effectively with multiple audiences using a variety of media and formats
- 6-8.3.B discuss and use various search strategies, including keyword(s) and Boolean operators
- 6-8.3.D process data and communicate results
- 6-8.4.B plan and manage activities to develop a solution, design a computer program, or complete a project
- 6-8.4.C collect and analyze data to identify solutions and make informed decisions
- 6-8.4.D use multiple processes and diverse perspectives to explore alternative solutions
- 6-8.4.E make informed decisions and support reasoning
- 6-8.6.A define and use current technology terminology appropriately