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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

Photo: provided by Nicole Fontayne-Bárdowell

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Here are some ideas for how high 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-Bárdowel 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

CCSS.MATH.CONTENT.HSA-CED.A. Create equations that describe numbers or relationships.
CCSS.MATH.CONTENT.HSA-HSN.Q.A. Reason quantitatively and use units to solve problems.
CCSS.MATH.CONTENT.HSA-HSN.Q.A.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Common Core State Standards - ELA

CCSS.ELA-LITERACY.SL.9-10/11-12.1. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10/11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY.W.9-10.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
CCSS.ELA-LITERACY.W.9-10.1.D Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
CCSS.ELA-LITERACY.W.9-10.1.E Provide a concluding statement or section that follows from and supports the argument presented.
CCSS.ELA-LITERACY.W.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-LITERACY.W.9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
CCSS.ELA-LITERACY.SL.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
CCSS.ELA-LITERACY.W.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
CCSS.ELA-LITERACY.W.9-10.10 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 tasks, purposes, and audiences.
CCSS.ELA-LITERACY.W.11-12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
CCSS.ELA-LITERACY.W.11-12.1.D Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
CCSS.ELA-LITERACY.W.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)
CCSS.ELA-LITERACY.W.11-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grades 11-12 here.)
CCSS.ELA-LITERACY.W.11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
CCSS.ELA-LITERACY.RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCSS.ELA-LITERACY.W.11-12.10 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 tasks, purposes, and audiences.

Next Generation Science Standards

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering
Science and Engineering Practices
Constructing Explanations and Designing Solutions. Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Disciplinary Core Ideas
ETS1.C: Optimizing the Design Solution
Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
Science and Engineering Practices
Constructing Explanations and Designing Solutions. Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Disciplinary Core Ideas
ETS1.B: Developing Possible Solutions
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.
Crosscutting Concepts
Influence of Science, Engineering, and Technology on Society and the Natural World. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Standards Addressed (Cont.):

Next Generation Science Standards (Cont.):

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy
Science and Engineering Practices
Constructing Explanations and Designing Solutions. Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Disciplinary Core Ideas
PS3.A: Definitions of Energy
At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
ETS1.A: Defining and Delimiting an Engineering Problem
Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
Crosscutting Concepts
Energy and Matter. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
Influence of Science, Engineering and Technology on Society and the Natural World. Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

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

MMA.1.A apply mathematics to problems arising in everyday life, society, and the workplace
MMA.1.D communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate

Texas Essential Knowledge and Skills – Science

P.2.E design and implement investigative procedures, including making observations, asking well-defined questions, formulating testable hypotheses, identifying variables, selecting appropriate equipment and technology, and evaluating numerical answers for reasonableness.
ES.6.B describe and compare renewable and non-renewable energy derived from natural and alternative sources such as oil, natural gas, coal, nuclear, solar, geothermal, hydroelectric, and wind

Texas Essential Knowledge and Skills - Technology Applications

FCS.2.3 publish information in a variety of ways such as print, monitor display, web pages, and video
FCS.5.C investigate measures such as passwords or virus detection/prevention to protect computer systems and databases from unauthorized use and tampering
FCS.5.E discuss the impact of computing and computing related advancements on society
CSI.5.D investigate measures, including passwords and virus detection/prevention, to protect computer systems and databases from unauthorized use and tampering
CSI.5.E investigate how technology has changed and the social and ethical ramifications of computer usage
DDMP.2.A adapt the language and design of a project for audience, purpose, situation, and intent
DDMP.2.D collaborate to create original projects, including seeking and responding to advice from others such as peers or experts in the creation and evaluation process
DDMP.4.A employ critical-thinking and interpersonal skills to solve problems and make decisions through planning and gathering, interpreting, and evaluating data
DDMP.5.D identify and demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, listening attentively to speakers, willingness to learn new knowledge and skills, and pride in quality work
DDMP.6.A define the purpose of a product and identify the specified audience