Using Infographics and Science Museum Exhibit Design to Communicate Learning

BY ELIZABETH SCHIBUK
This article describes a final project and performance task for a physical science unit thematically centered on the social and environmental implications of manufacturing and disposing of electronics. For the final project in this unit, students are first asked to design and publish an infographic. Subsequently, students collaborate with their peers to create an interactive science museum exhibit about the physical and chemical processes used to manufacture electronics as well as the social and environmental consequences of the electronics industry. The design of these performance tasks are grounded in the idea that students engage more deeply with the science content itself when they are also asked to reflect on the social implications of this knowledge and their own personal decision-making.

In their article about the role of infographics in the science classroom, Polman and Gebre (2015, p. 872) write that “there is considerable recognition in the research literature that using multiple forms of representation such as infographics in science education has motivational, cognitive, and communicational benefits for learnings.” Jane Krauss (2012), writing for the International Society for Technology in Education, discusses how infographics can be used to develop students’ ability to engage in analysis and interpretation, and writes about how projects centered on infographics provide an opportunity for students to develop skills in the creativity and innovation indicators of the National Educational Technology Standards (NETS). The use of infographics in this project, combined with the public audience of the museum event, motivates students to create high-quality content.

The unit

This unit focuses on middle school–level chemistry, while also touching on basic geology and ecosystem science concepts. The essential question for our expedition asks students to consider: “How does our love of electronics impact people and the planet?” During the unit, students move through a series of labs and modeling tasks in which they learn about the chemical and physical properties of materials (such as wood, ceramic, metals, and plastics), the chemical and physical changes required to manufacture synthetic materials and larger components of electronics, and then the environmental and ecosystem effects of the industry (e.g., acid rain from factories, acid mine drainage, heavy metals, e-plastics). Students review previous learning about the interconnectedness of ecosystems as we discuss how pollutants that affect any part of an ecosystem have far-reaching impacts on a wide range of organisms. We also review learning about watersheds, runoff, soil infiltration, and groundwater as we discuss acid mine drainage.

The project

The final project asks students to use an infographic format to describe the effects of the electronics industry on our planet and the science concepts involved with these impacts in an informative, engaging, and coherent manner. Students received the following prompt for their final project:

An infographic is a way to communicate information using a blend of writing, diagrams, graphs, images, and other visuals. A strong infographic communicates a large amount of information about a topic in a way that is appealing to a reader, easy to follow, and engaging to read. Experts use infographics to reach audiences who do not know much about their topic. A strong infographic contains a lot of information and yet is easy to follow and engaging to someone who might not otherwise be interested in the topic. Your task in this project is to create an infographic to engage your audience in considering the social and environmental impacts of electronics.

Creating an infographic to recast their own learning requires students to synthesize and communicate what they have learned using the tools that scientists use every day as they communicate within the discipline and to the broader world: data, statistics, graphs, creative visualizations, images, symbols, flow charts, and succinct and clear written explanations of concepts.
We begin the final project with a gallery walk, looking at a diverse collection of infographics. Students travel through five stations, each with about four similar infographics for them to select from as a focus for their observation. The purpose of the gallery walk is to define criteria for a successful infographic and for students to have a sense of the array of visual tools available to them when creating an infographic. Many of the infographics I use in the gallery walk are taken from the *Best American Infographics* book series (see Resource), which I was able to purchase used at a low price. To supplement the infographics I found in those collections, I simply conducted web searches for infographics related to content we had already studied, and then chose infographics from professional organizations that were high-quality models. One of the sample infographics we study in the gallery walk is one I made based on content from a previous expedition (Figure 1), which allows students to see how a unit of study in seventh-grade science can be synthesized in a coherent and engaging way through an infographic. Students take notes as they travel through the gallery walk using a note-catcher provided, and then we take time as a class to discuss their observations. Students are asked to consider the following as they observe the infographics:

- What do you learn by reading this infographic?
- What are your favorite parts of this infographic?
- What features make it interesting to read?
- What questions do you have about this infographic?

After the gallery walk, I ask students to consider which infographics they consider particularly engaging and why. We discuss powerful data visualizations, and effective use of text, which provides a foundation for students to eventually consider criteria for success as they design their projects.

Now that students have a sense of what they will be creating, we transition into the information-gathering phase. Students are given a hard copy note-taking packet that splits the unit into three sections: Raw Materials, Manufacturing, and Disposal.
Students must analyze all of their learning documented in their science notebooks and the collected print and multimedia resources curated on our Google Classroom, and then include the scientific concepts, facts, and stories into their final infographic. While the infographic project is done independently, students work in “production teams” on the research to help one another remember and organize their most critical learning from the unit. The structure of the production team allows students to talk through their learning one more time and clarify misconceptions in small groups as they work to curate key information. The production teams are intentionally created as heterogeneous groups so that students with different strengths within the unit are grouped together to help each other identify and summarize critical content. For students who struggle with organizing their learning, I work one-on-one to point them toward the important lessons in their science notebooks and print resources in their binders where I want them to pull key details. In addition, I support students’ information gathering with specific probing questions to help guide them toward the most important details. I base these questions on students’ existing notes thus far as I try to help them understand what they have not yet identified. For example, if students have written about how copper

![FIGURE 2: Infographic paper outline](image)

<table>
<thead>
<tr>
<th>FIGURE 2: Infographic paper outline</th>
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</thead>
<tbody>
<tr>
<td><strong>Title</strong></td>
</tr>
<tr>
<td>(1) Pop. Growth + Urbanization</td>
</tr>
<tr>
<td>Bar Graph</td>
</tr>
<tr>
<td>Data on population Growth</td>
</tr>
<tr>
<td>(2) Decline in Biotic Integrity</td>
</tr>
<tr>
<td>Scatterplot</td>
</tr>
<tr>
<td>Biotic integrity vs. Impervious area</td>
</tr>
<tr>
<td>US MAP</td>
</tr>
<tr>
<td>% Urban population</td>
</tr>
<tr>
<td>Boston MAP</td>
</tr>
<tr>
<td>% Impervious surface</td>
</tr>
<tr>
<td>(3) Urban Runoff + Ecosystem Pollution</td>
</tr>
<tr>
<td>Urban water Pollution</td>
</tr>
<tr>
<td>Graphic</td>
</tr>
<tr>
<td>+Impact of rural env. on urban water</td>
</tr>
<tr>
<td>(4) Eutrophication</td>
</tr>
<tr>
<td>Flow chart: Eutrophication</td>
</tr>
<tr>
<td>Photo</td>
</tr>
<tr>
<td>Eutrophication</td>
</tr>
<tr>
<td>+Algae, plankton, fish</td>
</tr>
<tr>
<td>+Oxygen, nitrogen</td>
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### FIGURE 3: Infographic checklist

#### Content requirements
Does your infographic skeleton contain a plan for demonstrating an understanding of:
- The structure of matter (atoms, elements, and molecules)
- Specific examples of the environmental impacts of manufacturing electronics
- The stages in a product’s life cycle, from raw materials to disposal

#### Form requirements
Does your infographic skeleton contain a plan for:
- 2 Graphs
  1. ______________________________________
  2. ______________________________________
- 2 Photographs
  1. ______________________________________
  2. ______________________________________
- 2 additional graphics (flowcharts, icons, maps, or other data visualizations)
  1. ______________________________________
  2. ______________________________________
- 5 captions
  1. ______________________________________
  2. ______________________________________
  3. ______________________________________
  4. ______________________________________
  5. ______________________________________
ore must be converted to pure copper to create the wiring and circuitry for electronics, I ask them about the types of processes that happen, coaching them to realize they need to also write about chemical and physical changes.

During the information-gathering phase of the project, students are asked to collect at least four important science concepts, three captivating facts or stories, and two ideas for potential visuals relevant to each of the three sections of our unit. Once students are finished with their information gathering, they check in with me to review their notes. I not only ensure that they have met the minimum requirements, but also check that they have not omitted key concepts even if they have the requisite number of details. Students have some choice in the content they present in terms of what examples or social/environmental case studies they highlight, but there is a core body of science content (structure of matter, chemical and physical properties, chemical and physical changes) that students are expected to include. Once they have my approval, they are able to move on to the infographic planning stage.

The infographic planning begins with a paper outline that I provide to students (Figure 2). I give students 11” × 17” paper and a pad of sticky notes and ask them to brainstorm and then graphically organize their ideas for their infographic. Students simply headline their sticky notes with the content they would include if the content is visual (e.g., manufacturing waste graph) or list the main ideas using bullet points (e.g., explain chemical and physical changes). To help students create an outline that matches the content expectations for the project, I provide them with a checklist (Figure 3) to help them track their progress as they create their infographic skeleton and to help make sure they do not forget to include specific components. When students can show me that their outline is coherent, covers the required content outlined in the checklist, and is organized in a logical sequence, they can move on to drafting written captions.

I have students type their infographic captions before working in the software so that I can provide feedback and ensure that the writing is coherent and that the science is sound before they get lost in design and format. I use a template that students access via Google Classroom to type their captions, and embedded in the template is a sample caption from the model infographic (Figure 4) I created and displayed in our initial gallery walk. Typing the text for the infographic is an important check for understanding before students get too deep into the design phase, and it allows me to identify students who need additional support to summarize their learning. Once students are ready to move into the design phase, they use Visme (www.visme.co) to create their infographics. Of all the infographic design platforms available, I chose Visme because they offered inexpensive short-term licenses that allowed me to create and manage accounts for all my students. I could easily view and then download their infographics as high-resolution images or PDFs. The Visme software is also very student friendly. The website has a large library of preloaded images and icons, good graphing and data visualization tools, and students’ work is saved automatically.

With all of this pre-work of gathering content, organizing content, and drafting writing, the actual infographic creation process does not take very long, and students can enjoy focusing on design, aesthetics, and visual storytelling because they have already done the most difficult cognitive work. Even though students have already written their captions, it is still

<table>
<thead>
<tr>
<th>FIGURE 4: Infographic caption</th>
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<tbody>
<tr>
<td><strong>Title:</strong> Urbanization</td>
</tr>
<tr>
<td><strong>Text:</strong> Over the past 70 years, the world population has grown from just over 2 billion to over 7 billion people. At the same time, the world’s population has become more urban and less rural. This means that there are many more people living in cities, and far fewer people living in less-developed areas. As the world’s urban population grows, there is more and more development, creating a greater amount of impervious land surface. This impervious cover impacts the environment.</td>
</tr>
</tbody>
</table>
### VISUALIZING THE ENVIRONMENTAL EFFECTS OF ELECTRONICS

<table>
<thead>
<tr>
<th>Learning Target</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can apply my knowledge of the science of materials.</td>
<td>You do not yet show that you have understood the difference between synthetic and natural materials.</td>
<td>You show a developing understanding of the difference between synthetic and natural materials.</td>
<td>You show a proficient understanding of the difference between synthetic and natural materials.</td>
<td>You have met the expectations for proficiency. You can comfortably and clearly use the terms atoms, elements, and compounds when writing about larger scientific concepts and issues.</td>
</tr>
<tr>
<td>You mention and/or can identify materials and natural materials.</td>
<td>You show a developing understanding of the ways that sourcing materials for manufacturing and disposing of electronics can impact the environment.</td>
<td>You show a proficient understanding of the ways that sourcing materials can impact the environment.</td>
<td>You can clearly and accurately communicate scientific and technical information. You use precise and correct technical vocabulary in your writing, images, and data visualizations to create a coherent narrative about the environmental impacts of electronics.</td>
<td></td>
</tr>
<tr>
<td>You may make reference to the important concepts about chemical and/or physical changes, but your work does not show evidence of understanding these concepts.</td>
<td>You may make reference to the important concepts, but your explanations lack depth, or contain misunderstandings.</td>
<td>You can clearly communicate scientific and technical information. You use a combination of writing, images, and data visualizations to create a coherent and thoughtful narrative about the environmental impacts of electronics. You mention and/or can identify chemical and/or physical changes, but your explanations lack depth, or contain misunderstandings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>You do not yet show that you have understood the difference between synthetic and natural materials.</td>
<td>You make reference to the important concepts, but your work does not show evidence of understanding these concepts.</td>
<td>You do not yet show that you have understood the difference between synthetic and natural materials.</td>
<td>You struggle to communicate scientific and technical information. You use a combination of writing, images, and data visualizations to communicate your understanding of the environmental impacts of electronics. Your infographic needs additional writing, titles, or graphics for it to come together to tell the full story you are trying to communicate. The different sections of your infographic seem disconnected from one another.</td>
<td></td>
</tr>
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</table>

*Figure 5: Rubric*
easy for them to get lost in a particular graphic or formatting choice as they work, so I frequently refer them back to both their outline and their checklist to help them make sure they do not miss key content that they had planned to include. We completed the infographics in three class periods.

Students’ final infographics (see Online Supplemental Materials) are assessed using a rubric (Figure 5) that includes two content learning targets and one learning target about effectively communicating scientific information. The rubric includes specific language defining each level of achievement (on a four-point scale) for each of the three learning targets. In the final days of the project, we review the rubric together as a class, and students are asked to identify and reflect on which areas of the rubric they are making strong progress in and in which they are making less progress in demonstrating proficiency. Their reflection has no bearing on their grade, but the reflection process encourages them to be aware of areas of the rubric they may have been neglecting, which helps them understand the expectations for high-quality work. Overall, I found that students scored well on this project. Students enjoyed the opportunities for creativity afforded by the infographic format, and knowing that they would have a large public audience at their celebration of learning motivated students to create polished work.

**Museum exhibit: The Celebration of Learning**

As a school with a focus on interdisciplinary project-based learning, one of the hallmarks of our curriculum is exhibitions of student work, which we call “Celebrations of Learning.” The exhibits (Figure 6) mark the culmination of a major unit and are typically designed as an event where students publish and showcase their final products for a public audience. I often organize my Celebrations of Learning with less of a focus on the final product, and more of a focus on retelling the journey of our learning expedition, from the initial stages through to the final project.

For the Celebration of Learning for this unit, I framed the event as a one-time viewing of an exhibit about the social and environmental implications of manufacturing electronics. The exhibit was being hosted by a fictitious museum titled the “Conservatory Lab Charter School Museum of Art, Science, and Nature.” With about two weeks remaining in the expedition (right as we were wrapping up our final assignment and getting ready for the final project), I solicited student volunteers to join my Celebration of Learning Student Steering Committee to work as exhibit designers leading up to the exhibit and as museum docents on the day of the exhibition. When planning the celebration, I control for quality and coherence by creating the structure within which students design their exhibit, but I work to support students in feeling as though they have authorship over their exhibit station.

The goal in soliciting student steering committee volunteers is to transfer some of the ownership of the process to students who thrive with leadership roles. There are no requirements or preconditions to being on the planning committee, and no extra credit (see Online Supplemental Materials for a template for steering committee notes). I bill it to students as an opportunity for leadership. There are usually about 10 students who express interest and a smaller subset who actually attend the meetings. The number of volunteers does not need to necessarily match the number of stations. Students can be paired to co-design stations or be given roles, such as “graphic designer,” to create programs.

Before our first meeting, I outlined a vision for the exhibit in which there were five sequential stations:

1. **The Language of Chemistry**
   Students teach visitors the same foundational language of chemistry (atom, element, molecule) that they had learned.

2. **Raw Materials**
   Students begin by teaching guests at their station about the different types of physical properties of materials, and what makes certain materials suitable to certain components of a computer. Students demonstrate that metals conduct electricity, while plastics and wood do not. Students also teach visitors about the difference between raw and manufactured materials, and discuss why copper mines are needed to produce a critical raw material.
needed for electronics. Students lead guests through an activity modeling water flow through a watershed, and discuss the environmental and health impacts of acid mine drainage.

3. Manufacturing
Here, students show guests the circuit boards that they etched earlier in the unit, and guests can test the conductivity of the circuit boards. Students continue to discuss with guests the distinctions between raw and manufactured materials, and the chemical processes needed to manufacture electronics. Students also share what they had learned during the unit about the hazardous waste produced during manufacturing processes.

4. Disposal
As the exhibit is set up for students to help guests understand the impact of electronics from sourcing all the way through to disposal, the final station is where students share what they have learned about the difficulties dealing with e-waste and e-plastics. Students show guests how they can track the journey of specific pieces of e-waste across the globe using the MIT Monitor program. Students apply their understanding of chemistry to tell their guests about how synthetic plastic, unlike many natural materials, cannot readily decompose and thus creates excess waste that we struggle to deal with in the developed world.

5. Final Projects: Infographic Display
All of the students’ infographics are on display at this final station. Students hosting this station describe the process and experience of creating the infographics.

Again, these stations are specific to the content of our unit, but the structure helps students compartmentalize and describe discrete subtopics and stages in a unit of study. Students were allowed to assign themselves to a specific station, which ensures that they feel confident in the content they must design for teaching. For each station, the student exhibit designers needed to map out:

1. The topically relevant student work to showcase.
2. The learning activities and modeling tasks that visitors would engage in to help build an understanding of the relevant content. (Most of these are drawn from learning activities we did in class, where the students must now facilitate the tasks, though in certain cases, students design their own activities or put a new spin on an activity we did in class).
3. The visual materials needed to support learning at that station.
4. The “script” students would read to welcome guests to their station of the exhibit, present the student work, and coach them through the selected activities.

Members of the student steering committee worked with me during lunch and after school to design their stations. We have an afterschool program, and meeting outside of class time is not a logistical challenge. Furthermore, I find it builds much more investment and sense of leadership in students on the committee when they have committed to meeting outside of class. Regardless of this structure, however, the project could still work with students

FIGURE 6: Museum exhibit
planning the exhibit in teams during class and giving each team member a specific role.

In the class period before we were to host our museum exhibit (to which we invited students from other classes, faculty, families, and “friends of the school” from the community), the volunteer exhibit designers worked with the rest of their peers to “train” them to help run the different exhibit stations. I assigned an additional two to three students from the class to each station and designated an official greeter and museum tour guides who would escort elementary school guests through the exhibit. Even though not all of the students were on the steering committee, each student has an opportunity to contribute and show leadership as they plan for their specific role within their assigned exhibit station, and I have always found that all students, not just those on the committee, show their best selves at the celebration and take pride in their work. I teach two small sections of this course, but both sections work together to create a single museum exhibit. Our small school allows for scheduling flexibility. As a result, in the days before the final event, we combine classes and students are able to work as a larger grade-level team, in exhibit subgroups, to prepare for the event.

The leadership team and I create a classroom map ahead of time to decide where each station will be located and what the visitor flow will be like throughout the exhibit, and then the leadership team guides their station peers in crafting a vision for their station and setting up their section of the room. I have lots of craft materials on hand for students to make signs as they get started. The last period before the museum exhibit is organized chaos with students moving around, getting materials organized, and rehearsing their scripts. I have found my role at this point is just to help students find the materials they need; students are sufficiently motivated by the anticipated audience and by their peers to really work together to put together a strong event. I provide each station group with a checklist of what they need to prepare, and step back as students work to get ready. On the day of the event, I always schedule the celebration to begin about 10 minutes after the start of class. This gives students time to get settled at their station, rehearse their scripts, and then for me to give the class a pep talk and set expectations (staying at your station, actively engaging audience in discussion) for the event. In general, I would schedule the event for about 45 to 60 minutes. Any longer than this and I find students struggle to sustain their attention.

**Differentiation**

We often talk about differentiation in terms of accommodations required to access learning. Throughout our unit of study, students were provided with accommodations as needed to access content. However, the paired performance tasks of the infographic and museum exhibit provided access to excellence in another way: The variety inherent in this assessment gave every student a space to shine. Between writing the captions for the infographic, creating multimedia content, aesthetic design of the infographic, organizing for the museum exhibit, presenting at the exhibit, and leading groups of younger students, every student had some place in the assessment sequence where their particular set of strengths enabled them to rise as a leader, and every student had at least one area in which they felt less
confident and needed support from their peers. Overall, during this assessment process, I saw some of the best work and strongest engagement my most struggling students had demonstrated all year.

Closing reflections

My goal for our celebration of learning was to give students an opportunity to both showcase and synthesize their learning journey. As I observed students designing, rehearsing, and then facilitating the museum exhibit, I realized that the performance task had the additional benefit of providing students significant additional practice with the content itself. You cannot teach what you do not yet understand, and with the knowledge that we had a large guest list coming to tour our museum, students were deeply invested in making sure they could properly teach the sliver of content they were responsible for at their station.

Guests at our museum were given a program that contained information about the unit and the final project, as well as the following guiding questions to help facilitate their dialogue with students during the exhibit.

• What is your station about?
• What can you teach me about your topic?
• What activities and assignments did you do in class related to this topic?
• What did you most enjoy learning about during this expedition?
• What work are you most proud of?
• How has this unit changed the way you think about electronics?

Students were given advance copies of the program and the guiding questions for guests, and during the exhibit preparation phase, students were asked to rehearse their answers to the questions listed. The final question on the list asks: “How has this unit changed the way you think about electronics?” While students have showcased their physical science learning about the natural and material world, here they are asked to reckon with the idea framed in the Next Generation Science Standards Understandings on the Nature of Science that “science knowledge can describe consequences, but is not responsible for society’s decisions,” and that each of us needs to decide for ourselves if and how we leverage our scientific understanding of our impact on the planet to change our individual actions (NGSS Lead States 2013, Appendix H, p. 6).

REFERENCE
