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Unconventional Transportation

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Introduction

My middle school students would say that recycling matters, however they would not hesitate to crumple up a piece of paper that had a minor pencil written error on it and toss it towards the trash bin. Many adults would also say that recycling makes a difference yet they too trash a multitude of "junk mail" received daily. We say we care about our environments; we say we value the things we have and the place we live. Yet our actions, including reactions and inactions, speak otherwise.

I teach at John Hay Academy. We are a Pre-Kindergarten through Eighth grade school in Chicago's furthest Westside neighborhood of Austin. We have about a 98% African American population. About 93% of our students receive free or reduced priced lunch services. We are a neighborhood school and most of the students live within walking distance. The surrounding community has a high rate of transiency which leads to some instability in school attendance as students move from school to school. This unsteadiness contributes to students coming to sixth grade with varying levels of prior knowledge.

I teach two 140 minute blocks of sixth grade math and science. Each of my two classes has thirty-two students enrolled. We sit in cooperative learning groups of six students per table. All learning in our classroom must have a cooperative element to it. Most students are able to choose their own learning community groups. Nearly all my students share an interest in science and the discovery of answers to questions past and present. Nothing delights both my students and me more than the light bulb moments of new discoveries, further inquiry, and thought provoking analysis. Math and science allows students who struggle with reading and writing an even opportunity for success. Hands on manipulatives, experimentation, and kinesthetic learning evoke a positive response to scientific and mathematic principles. Science instruction in my classroom lights fires, both figuratively and literally. It is my student's favorite time of day. This passion, creativity, and willingness to explore are what I will tap into greatly for this ten week unit.

Rationale

Human systems are incontestably responsible for Earth system changes. Specifically the human system of energy need and use is responsible for a large portion of global environmental changes. According to Intergovernmental Panel on Climate Change (IPCC), energy supply and transportation are responsible for 39% of all GHG Emissions (Green House Gasses). The United States and Canada are responsible for 19.4% of global pollution and have only 7% of the world's population.[1] According to the US Department of Energy's (DOE) Transportation Energy Data Book, in 2007, the United States alone consumes 24.1% of the world's produced petroleum.[2] Something about these startling statistics does not quite add up.

Humans have made some impact on every inch of the Earth. According to a 2005 MIT study hurricanes and tropical storms have shown increased intensity since the 1970's. According to the Environmental Defense Fund, an area about the size of Texas of Arctic Sea water has melted according to the Arctic Climate Impact Assessment. US Geological Surveys predict that Glacier National Park will have no glaciers left by 2030.[3] The Environmental Protection Agency (EPA), predicts a high likelihood of coastal erosion, higher summer heat intensities, lowered water level of rivers and lakes, decrease in water quality, increased wildfire potential, and a decreased yielding in crops.[4] The EPA states that these are all a direct effect of human activities and choices.

The statistics of human impact on the environment are indisputable. The rate of climate change and human impression is undeniable. Species extinction, changes in weather patterns, erosion, increased human population, and atmospheric transformation is irrefutable. Disputable, however, is the irreversibility of human influence. Can we replace, reuse, and repair our Earth, its resources, and our environment? Only time and effort towards this will tell. Efforts need to be purposeful, swift, and abundant. However this generation cannot do it alone. Therefore it is essential that we evolve and integrate ecology into mainstream education. Educating the next generation of Earth's caregivers, insisting in prioritization of conservation, and instilling the importance of proactive change will alleviate all doubt as to the importance of ecology. Education is the answer for expediting the process of rejuvenation.

Background

For these reasons it is paramount that value the science of ecology. However, we must also understand the dynamics of the causes of human impacts on the Earth in order to properly teach ecological improvements. Everything is made up of energy. From the pebbles above the concrete, to the mango on your plate everything is made up of energy. Thoughts, feelings, emotions, all have energy. Energy however has some very interesting characteristics. Energy is never created nor destroyed; it only has the ability to transform. Globally we need and use energy for a multitude of purposes from growing food to running the vacuum. Energy moves cars along the road and trains along the tracks. Energy allows us to listen to our IPODs while typing on a laptop. It comes from many different sources and comes in several different forms of matter.

We divide energy into two sub categories, non-renewable and renewable. Energy that is limited is called non-renewable energy. These forms of energy are available in restricted supply, and are not readily replaceable.

Coal is a non-renewable energy source. According to the Energy Information Administration (EIA), coal represents about 22.5% of energy consumption.[5] Coal is burned and used to heat water to produce steam in large processing plants. The steam is used to turn turbines which convert and store energy. Coal is inexpensive, however it produces carbon-dioxide, sulfur-dioxide, and methane gasses as byproducts. These gases are harmful to the environment.

Natural gas is also a non-renewable form of energy. It is used to heat homes and fuel stoves. The EIA states that natural gas makes up 23.3% of energy consumption.[5] Although Natural Gas is delivered with 90% efficiency is not easily transportable without transforming to liquid form.

Nuclear power is produced from uranium. Fission releases heat which turns turbines. The atoms within uranium are split; this process releases energy in the form of heat. Nuclear power produces 8.3% of the energy consumed.[5] Although no carbon dioxide emissions exit into the atmosphere using this process, nuclear energy produces nuclear waste and radiation which are highly toxic.

Oil is the most abundantly used source for energy consumption (37.5%).[5] Oil is only used for a small portion of electricity making, but oil fuels almost all forms of transportation. Oil is made into useable energy through a process of distillation. Oil, natural gas, and coal are fossil fuels which mean that they are created from the remains of fossils. The demand for these fossil fuels, especially oil is on the rise. Yet, peak collection of oil may not be very far away. Besides the increasing costs of oil, burning of it produces harmful greenhouse gases.

In 2007, the world petroleum consumption averaged 85.9 million barrels per day. The United States alone consumed 19.44 million barrels per day or 24.1% of all consumption. Petroleum alone was 56.9% of all imports in 2007. The DOE writes that of the petroleum imported 68.3% went towards transportation, of which 83.9% of the transportation petroleum is used on highways.[2]

Even if every human being were to cut their energy usage of these nonrenewable energy sources, we would still be emitting harmful gasses into our atmosphere and creating toxic waste. We need to do more to change the structure and components of our energy sources and usage. Renewable energy sources are replaceable or recreated within a short period of time. Renewable energy sources tend to be less utilized, and are currently being studied and used for their many benefits.

Biomass is the most abundantly used form of renewable energy (3.6%).[5] Biomass is made up of food and animal waste. Burning biomass produces heat. Also chemical energy from organic waste creates methane or biofuels. The best part of biomass is that it recycles waste, and is easily storable. However, biomass does produce some carbon dioxide when burned.

Hydropower is available every day, all day long. It is always moving, predicable, and reliable. However it is only available near large bodies of moving water. Transporting this form of energy from coastal communities to inland would be costly. According to the EIA, Hydropower currently accounts for 2.4% of energy generation.[5]

Wind energy is considered renewable because wind restores itself. Wind energy is used to make electricity. Large windmills can be placed on or offshore for collecting the force of the wind which moves turbines which transform to electricity. Wind is unfortunately unreliable. The wind however blows more at night which is when demand for energy is at its least. Windmills have also been the cause of many deaths of birds who get caught in the mills during migration season. Wind energy currently only represents .3% of all consumed energy.[5]

Geothermal uses the Earth's heat to generate electricity. Temperatures below the Earth's surface are constant. It can be extracted from naturally occurring places, but also only accounts for .3% of generation.[5]

Finally, the remaining renewable resource is solar power. Solar power is the most underutilized renewable energy source. The sun is available all day and can be used for photovoltaic (electricity) or thermal (heat) uses. The sun despite being capable of supplying all of our needs only generates .1% of all energy consumed.[5] Development of the solar industry is dependent upon availability of raw materials. Stabilizing the cost and supply of these materials has been a major platform of issues for the industry. Since the intensity of sunshine isn't controllable, the supply isn't always 100 percent reliable. However, it is somewhat predictable.

Since energy is not created nor destroyed, it is the methods of converting one form of energy to another that poses risks to our environment and therefore health. Some doubt or misunderstand the primary environmental implications of our need for energy that is consistent, reliable, and abundant. Perhaps this is because current adult generations assume major catastrophe is not probable in their lifetime. However, this viral contagious complacency is the major symptom of a planetary catastrophe. Evidence of global climate change is copious.

A May 8, 2009 article found in the McClathy News found that In Chacaltaya, Bolivia an 18,000 year old glacier has melted completely. What used to be a scenic half day's drive up to 17,000 feet above sea level no longer exist.[6] Anwen Roberts of the Spiegel International News reports that an entire population is being displaced from the island country of Tuvalu as rising sea levels basically evaporate their homeland. The islands which are about four inches above sea level are a dramatic representation of climate change and global implications.[7] According to the National Climatic Data Center, 2008 had the second highest number of tornadoes with a total in the high 1600s.[8] Migratory patterns of most animal species have accelerated on average four miles north. Seasonal changes have become muddled and irregular as seasons come later, swifter, or stronger. The planet is communicating with us; it is just not in English.

Additionally climate change has many adverse effects on human life. According to the US National Oceanic and Atmospheric Administration (NOAA), as the Earth's average daytime temperature increases the nighttime average lows have raised almost twice what the daytime temperature has.[12] As carbon levels in the atmosphere rise this traps heat in the atmosphere that otherwise would have escaped. For example, in 2003, heated summer nights in Europe allowed no time for victims of heat stroke time to recuperate from the daytime radiance. Ross Gelbspan quotes in his book Boiling Point that in August of 2003, alone more than 35,000 people died from heat related illnesses.[10] Gelbspan also notes effects on humans in 2001. Northern China faced twenty-two blizzards in two months. 100,000 herders were stranded and many died. In May 2001, the unseasonably high temperatures caused the deaths of forty people. In August, Iran's worst drought was briefly interrupted by massive flash flooding that caused 500 casualties. November flooding killed 1,000 in Algeria. The following spring brought a heat wave that killed another 1,000 individuals in India.[10] Climate change not only impacts human casualties, it also impacts human quality of life.

At the forefront of these health issues in urban situations is air quality. According to One commonality of all living organisms have is the use and need for clean air. Yet the air we breathe and live off of is often ignored and under evaluated. John Wargo's book Green Intelligence Creating Environments that Protect Public Health, in the United States air pollution kills as many people as those who perish in traffic incidents.[11] The Environmental Protection Agency (EPA) regulates acceptable levels of atmospheric gases. They monitor the levels NO_x, carbon monoxide, lead, sulfur dioxide, ozone, and two sizes of matter usually in smoke. The

individual that sets the appropriate standards is the EPA's Administrator, appointed by the President and confirmed by Senate. The EPA also determines the acceptable average air quality for all US citizens. The EPA reevaluates these standard levels every five years. The levels are set for the average healthy adult, but fail to consider children whose body mass per particulate would have a much lower threshold for exposure. According to Rena Sterinzor, an outspoken environmental activist, asthma cases have jumped 75 percent from 1980 to 1994; forty percent of these sufferers are children.[12] Areas with poor air quality have a higher prevalence of asthma and other respiratory diseases. The people most predisposed to respiratory illness are children and the elderly. Many cities have instituted a Code Red air quality rating which warns those most susceptible to stay indoors during the worst air quality days.[12] Instead of cleaning or regulating our air we have instituted a system that encourages people to remain indoors. However, indoor air quality is not regulated at all.

Indoor air quality is also impacted by energy consumption, smog, and carbon monoxide; it however is complicated further by pesticides, cleaning chemicals, fragrances, and plastics. The EPA does nothing to monitor indoor air quality. Hospitals filled with chemical components, plastics, germs, disease, bleaches, and disinfectants answer to no one about the quality of air patients and employees breathe. Even school systems with registered asthmatic students are under no jurisdiction to control or even monitor indoor air quality. This lack of consideration must dramatically impact human health. This must be a front running concern, however unlike most other western societies the US has done very little to address these concerns.

Other nations have managed to hear the planet's cries, and have responded. Germany has committed to cutting back fifty percent of emissions in just as many years. The United Kingdom has vowed sixty percent in fifty years. Holland promised eighty percent in forty years. Western countries aren't the only concerned. China's thriving economy didn't stop it from making emission cuts; they cut back 19 percent in five years.[10] In personal travels to India, remote deserts include mass biomass plants, homes have mini energy producing "dung holes," and solar panels are abundant. Yet the United States seems to live in denial.

The US media downplays these dramatic issues. Our previous administration did many things to play into public uncertainties. Government purposely allowed citizens to believe that there was no scientific consensus to global climate change.[10] Ecology is not a fuzzy unpredictable science. Real observations, real testing, and real data exist to testify to these vivid changes and environmental consequences. There should be no doubt in the public's mind that our actions and continued use of coal and petroleum are negatively affecting our surroundings. This is not just an issue in the back of environmentalists and tree huggers' minds. This is a paramount issue for civilization; excuses of ignorance are no longer acceptable.

Key Ideas and Essential Understandings

Ideally every student will walk away from this unit with a sense of responsibility, a responsibility to the Earth, to their community, to the school, to future generations, and to themselves. Students should understand that each individual plays a vital role in the planet's future. They will be able to look towards the data of the past, and recognize that past actions have created today's problems. They should also see that today's actions will result in tomorrow's problems if solutions are not found and followed forward. For every action there is a reaction, an effect. This unit will build globally conscious, yet actively engaged conversationalists, who are

environmentally literate, who question their surroundings, and seek to explore efficient and effective change.

Objectives and Strategies

We are more often than not completely aware of our impact to the environment. There is almost a sense of entitlement to the Earth's resources. This feeling of entitlement may be imbedded in culture, it might be an effect of the media, or some might argue it simply part of human nature. However, this ignorance to impact, this sense of privilege is damaging to our homes, communities, cities, nation, planet, and future. We must become cognizant of our actions, the causes of our actions and the effects of our actions.

In order to get students thinking about the actions of both themselves, and their families this unit will begin with an introduction to data. We will collect data on our own transportation habits, customs, and methods. We will build our own data sets and analyze our own. Additionally, we will look at and evaluate available national and local transportation data. Transportation was chosen because it is something students are very familiar and comfortable with, but not something they necessarily consider as harmful to anyone or anything. This will open the door for consideration of other influences (both positive and negative) that students have on the Earth.

Objective #1 - Organize, describe, and make predictions from existing data.

Students will be able to construct, read, and interpret tables, graphs and charts, to organize and represent data. Students will begin by collecting data on all the transportation methods they utilized in one full day. From sun up to sun down students will track all the places they went, the mode of transportation used, and the time spent in transit. Students will utilize stop watches throughout the day to calculate their time in rides and steps. After their data is collected we will calculate the energy exerted in their transiting. This is to get them thinking consciously about their personal and their family's energy usage for transportation. We will use this data to create line, bar, and circle graphs of their individual data. This construction will allude to conversations of usage, energy exertion, and multiple methods of transportation. This hands on construction approach will allow the students to explore their own methods of transit, collect data, and construct results of their own data. (Activity #1)

After we've made graphs and charts of our personal transportation we will begin to analyze the energy usage specifically of each. We'll compare burning calories in our bodies and excreting carbon dioxide, to the emissions of a vehicle. In small heterogeneous ability groups students will discuss their preferences for transportation and the reasons for their preferences. They will then list the potential environmental effects of their preferences. Groups will estimate the amount of pollution their preferences cause the community. Then each group will be presented with a different set of data. The data will consist of an individual's commuting distance, their method of transportation, and the amount of air pollution their commute creates. Small groups will then calculate the environmental impact of their commuter, on a weekly, monthly, and yearly basis. Groups will share their individual calculations and we will create a class commuter line graph. This is to key students into their usage and effects of transportation on the environment. From their calculations and descriptions of the data students should glean an understanding of their action's impact. Working in small heterogeneous groupings allows students of higher ability to assist lower while including every student in the conversations. (Activity #2)

Additionally, students will be able to calculate and compare mean, median, mode, and range. As an ongoing project students will be collecting data on indoor outdoor air pollution and graphing it on a daily basis. They will be using a handheld particle meter that measures airborne particles in parts per million (ppm). Keeping with the current theme of air pollution students will now begin to examine the air quality around them. Using the particle meter students will gather data of time, relative location, and parts per million of air particles in a variety of locations at varying times. The single classroom particulate meter will be rotated around to groups which will be allowed to measure the indoor and outdoor air quality at different times of day. The meter will join us at recess, during electives, and on field trips. As each group completes their data gathering they will add it to the classroom compiled listing. As a daily exercise the class will then compute the new mean, median, mode, and range of the data received. There will be a class bulletin board that tracks this data. The data gathering group will in written form respond to the data suggesting reasons for rises and falls of particulate matter, and describing the mathematical functions of each calculation. This hands-on approach allows students to utilize real life data, relative to their community and health. By making this information relative to their lives not only are they calculating the mathematical concept their analyzing the quality of the community's air that surrounds them. (Activity #3)

Objective #2 - Formulate questions design data collection methods gather and organize data and communicate findings.

Students will be able to formulate questions and conduct experiments, gather data, draw conclusions, and communicate results. Continuing our data collection with the particulate meter students will in small groups create a list of situations which promote predictions of ppm changes in the atmosphere. For example, students might ask how the outside air ppm differs on a cloudy over cast humid day versus a clear windy day. At this step students will not make predictions must merely consider the situations for comparison. This will allow students to begin to draw correlations between the air quality and environmental circumstance. Connecting these two concepts indirectly will encourage students to naturally draw cause and consequence parallels in habits and end outcomes. Each group will be responsible for setting up five hypothetical situations.

Next groups will trade situations. With the new situations each group will brainstorm a hypothesis for each circumstance. They will justify their hypothesis in writing with a rational explanation detailing why their predictions are correct. Then they will begin to gather and collect data to simulate their assigned settings. These simple experiments will allow students a simple controlled exposure to the scientific method while working on their ability to assemble and analyze data. The final step of this assignment will be a written analysis of their data, including an explanation supporting or rejecting original hypothesis. (Activity #4)

Objective #3 - Determine, describe, and apply probabilities.

Students will be able to analyze problem situations and predict results. Nothing gets your point across more than opportunities to touch, feel, move, and manipulate. Students need to see and feel to fully comprehend and articulate ideas and feelings. In order for students to really understand the amount of pollution a vehicle truly contributes to the Earth they must see and discover all the components of a vehicle. Students will be presented with the questions of: What happens to an unusable car? Where does it go? What is biodegradable? Students will begin to tackle these problems with a brainstorm name all the parts of a car you can think of. We will list the parts they can think of on the board then consider what fluids are used with or contained in these parts? Again we'll list these items on the board. Once the list is as complete as possible we'll head to the parking lot to actually visually dissect the anatomy of a vehicle. Here we'll compile a more complete list of the actual components of a vehicle and the fluids. When we return to the classroom each group will receive a

bottle of one of the car fluids we listed (antifreeze, brake fluid, transmission fluid, power steering fluid, oil, etc.). Each group will read the warning labels for their product aloud. Finally we'll discuss the biodegradability of the vehicle. Students will estimate the lifecycle of a vehicle, the weight of waste, and they will list the environmental impacts.

The following day students will look at the DOE's data of vehicle waste, and vehicle lifecycles. Using their knowledge of the actual anatomy of a vehicle, students will predict the amount of vehicle solid waste will exist in five, ten, and twenty years. Students will then analyze both the data and their predictions and make five suggestions for lessening this enormous waste. Combining such a hands on physical activity with simple data allows students to realistically visualize our physical impact on the environment, evaluate their surroundings, and contemplate change. (Activity #5)

Objective #4 - Know and apply concepts that describe the features and processes of the Earth and its resources

Now that students have seen the damaging effects of petroleum usage in transportation and transportation waste, they will need a background in cleaner fuel sources. Students will be completing an individual research project on a renewable resource. This individual project will provide students an opportunity to break from the constant group work to perform some individual knowledge. Students will choose between solar, wind, hydro, biomass, or geothermal power resources and perform individual research. The projects will be completed over a two week fall break at home with parental support and a required library research trip. By creating a home research project that requires adult support students will be forced to concern their families with our current projects.

Projects will have a science component, how does it actually work? An analysis section will require students to consider both the positive and negative components of their resource. A technology section that would require a list of needed infrastructure to make the project successful. Additionally the research will include a viable opportunity section in which students will consider where in our country this resource would be most conceivable and why. Projects will have both a written and visual component; additionally they must include at least two text sources and two web sources. This individual research allows students a choice of direction and also opens them up to looking at energy in a positive platform. The teacher will have sequestered several kid friendly texts and websites for research at the library. (Activity #6)

Objective #5 - Know and apply the concepts, principles, and processes of technological design.

Students will be able to identify a design problem and establish criteria for determining the success of a potential solution. Nothing motivates more than the sheer human desire to catapult a competition. Students will be using multiple learning modalities to fully master these objectives in a friendly classroom competition entitled Kessinger's Apprentices. Based on the Donald Trump reality television show students will be fully engaged as their group competes to build a natural resource powered method of transportation. The project allows students to show off their new knowledge and apply it in an innovative way. Allowing students the freedom of some creativity while cultivating their knowledge in a structured format it is best done as a group activity so that students can learn from one another and utilize each other's strengths. This project is meant to be a cumulative project heavily weighted and graded on a rubric.

The challenge is to conceive, sketch, build, promote, and justify a prototype transportation method that people will use for business and leisure. The rules are simple. First, the energy used to power your transportation must be a renewable resource. Second your method of transit does not have to be a vehicle;

however it must be useful in Chicago's urban environment. Third, your transit method must be user friendly; people should want to own/ride it. Finally, all team members must fulfill a role in the success of your vehicle.

Groups will be conceived based on the previous research project. One person from each renewable resource will be included in each group. Each member of the group has a role. This allows students to fulfill a specific function and duty in the whole project. However, they are each equally responsible for the final outcome. This type of project builds morale and cooperative learning teams that must focus on the task at hand and learn to work with, not around, each other's personalities and strengths.

The challenge will take place in six steps beginning with a brainstorming process. Here they will choose the method of transportation and renewable resource. The group's consensus and ideas will then be transferred into sketches of their concepts. These sketches will be submitted for approval of concepts. The ideas should be conceivable, not fantasy based, and possible to create. Teacher will provide constructive criticism in a "push back" meeting so groups can reflect on their ideas, interpret potential setbacks, and overcome impending obstacles to their sketching.

After their sketches have been approved groups will begin the researching phase. Students will submit a list of materials needed to build their prototype. Additionally, they will begin researching the technology needed to build a real life model of their concepts. Students will list the positives and negatives of their resources, and alternate options/additions that could be offered. They will analyze the environmental impacts and costs of building and replacing current methods of transportation. This critical research will afford students the opportunity to search for existing resources and extend contacts to professionals in the alternate energy industry.

Next they'll receive the materials to build their projects. However, in the first Kessinger's Apprentice twist students will only receive a limited quantity of the resources they requested. This will require that groups work together closely to consider alternatives. Students need the opportunity to readjust plans and ideas when things do not go quite as originally planned.

After building a functioning prototype, students will promote their method through both print and audio visual advertising. Student groups will create a promotional video to highlight the new method of transit and help change current mind sets. As common perception is a major obstacle to creating social change, and modifying existing habits.

Finally, students will face the board for review of their project. The board will grade the group on the provided rubric focusing on innovation, design, promotion, research, and collaboration. Students will face the board in a meeting to justify their product. They'll be held accountable for their time and effort. They'll also face each other and themselves in group/self assessments. This method of assessment allows students to justify their actions, results, and products. It allows them to show off their work and verbally explain the rationale and motivation of their project. It also allows each group member some reflection as they hear from the others about their contribution to the finished project. (Activity #7)

Conclusion

Students must be consciously aware of their impact to the global environment. They must be aware of the causes and effects of their actions and intentions. We must build globally minded citizens who take seriously the care giving of the planet. In order to build globally conscious individuals focused must be given to the impact of human actions on the environment, current changes, and sustainable implementation of new energy resources.

Activity #1

Materials Needed:
Tracking sheet (one per student with extras for each group)
Stop watches
Construction paper
Markers or colored pencils
Overhead transparencies
Overhead Markers
Overhead Projector

Time Needed:
Assignment (step one) given one full day before Steps 2-3.
One full class period spent on steps 2-3.

Step 1 - Bell ringer: List all of the ways you transport yourself from one place to another in a usual day. Have students share their results.

Step 2 - Provide Students with a tracking sheet and stop watch to track their movement and time spent in transit.

Directions: For one whole day calculate all of your transportation methods. Remember we move not just by car. Use the provided stopwatch to calculate the time and method used to move yourself from one place to another.

Leaving From *(Home)*	Arriving At *(School)*	Method *(Walk, run, skip)*	Time *(Min:Seconds)*

Step 3 - Group students in collaborative structures of about five to six students per group. Have students compare methods of transportation. Provide one blank tracking sheet like the one above. Have students use it to create a group data sheet, including everyone's data.

Step 4 - Provide each group with a large piece of construction paper for each student, rulers, and markers or colored pencils. Tell students that they will now illustrate their group's data in another way. Assign each group member a different type of data interpretation, (bar, line, circle graphs, plot and wisker boxes, etc.). While groups are working on their assignments, circle for questions but also gather each group's data to create a classroom wide interpretation of the methods of transportation.

Step 5 - After calculating the entire class' usage of transit, provide each group with the new data set and assign them one method to interpret on an overhead transparency. Then allow each group ample time to Explain their method of data interpretation.

Activity #5

Materials Needed:
Access to a vehicle
Picture of a junk car site (one per group found at Google Images)
One empty bottle of each of the following: brake fluid, anti-freeze, engine oil, power steering fluid, and transmission fluid, wind shield wiper fluid (look for an all natural compound for this one).
3x5 cards (one for each student) with used car profiles on them.

Time Needed: Two full class periods

- Step 1 - Bell ringer: What happens to an unusable car, one that cannot be repaired? Where does it go? What happens to it?
- Step 2 - After students have had an appropriate amount of time to answer the Bell ringer questions, ask for an oral response. Have students share their thoughts and feelings aloud. Try to find some consensus to their ideas about the topic. Write a summarizing sentence on the board.
- Step 3 - Underneath the summary write the word BIODEGRADABLE. Ask students to define the word. When an appropriate description has been explained, ask students to convene as a small group and estimate the percentage of a car that is biodegradable. Have groups share out their responses. Write their responses on the board around the word biodegradable.
- Explain to students that you are going to be going on a mini field trip, but before you go they will need to create a three column chart. Label each of the three sections as follows: Under the Hood, On the Outside, and the Inside. Have students label all the parts they can think of on a vehicle in each section.
- Step 4 - Next organize the class for a mini field trip; students will need to bring their three column charts. Divide the entire class into three groups. Take the class to the location of the vehicle you've gained permission to inspect (it might be easier to have three vehicles, one for each sections). Each class will be examining one component of the vehicle at a time and will then rotate. Give students time to go through each section and write down all the different parts they see, feel and touch (for example indoors: seats, steering wheel, vents, buttons, odometer, gear shift, carpet, mats, cloth, etc.). Allow them time to ask questions for parts they're unfamiliar with. After each student has had the opportunity to see all three sections, bring them back inside to share and their findings with each other and create one master list.
- Step 5 - Return to the idea of biodegradable. Ask students to highlight on their parts sheet any component they believe matches the definition they created of biodegradable. Share their findings. Discuss the difference between recycled (which many parts are) and biodegradable. Then explain to students that less than one percent of a vehicle is biodegradable. The only thing that is is a liquid.
- Step 6 - Pass out the bottles of vehicle fluid listed above. Ask one volunteer from each group to read aloud the bottle's ingredients, and the bottle label's warnings. After each reading ask students to guess what effects that fluid might have on the environment if left leaking out of a broken vehicle. Then ask if they believe the choice was the biodegradable fluid (all natural windshield wiper fluid usually made with water and vinegar is the only option).
- Step 7 - Return to the bell ringer question, do students feel the summary on the board is still correct,

why or why not? Discuss in groups. Then pass out the pictures of a car junking site. Ask students to describe in words what they see in the photos on the back of their three column charts.

The following day -

- Step 8 - Bell ringer: Congress has announced a federal tax of $ 2,500.00 to anyone who junks a car, like the ones we saw yesterday. Is this a good idea, why or why not? Discuss student ideas.
- Step 9 - Give every student one used car profile card. After students have read their cards they must decide if they are willing to make the required repairs and safe their car, or junk it and pay the Federal tax. Have students write their decision, and the reason for their decision on the back of the card.
- Step 10 - Separate the class into the car savers, and the car junkers. Have the car savers calculate the total amount spent in dollars to repair their cars. Then they must calculate the total space saved from the landfill. Have the car junkers calculate the total savings in dollars they made by junking their vehicles. Then they must calculate the total space their cars take up in the junk yard. Afterwards each group will share their findings. We'll discuss the impact of this hypothetical tax and see if any opinions have changed based on the data they've seen and calculated.
- Step 11 - Students will now examine The Department of Energy's Data Book Table 3.7 available at http://cta.ornl.gov/data/index.shtml. They will use this data to answer the following questions:
    1. What trends do you see in American car usage?
    2. Are newer cars driven more or less often than older cars? Why might that be?
    3. What do these statistics tell us about the cars in landfills?
    4. How might we change the current state of car usage/recycling?

Activity #7 Kessinger's Apprentices

The Challenge:

Conceive, sketch, build, and justify a prototype transportation method that people will use for business and leisure.

The Rules:

1. The energy used to power your transportation must be a renewable resource.
2. Your method of transit does not have to be a vehicle; however it must be useful in Chicago's urban environment.
3. Your transit method must be user friendly; people should want to own/ride it.
4. All team members must fulfill a role in the success of your vehicle

The Steps:

Step	Explanation	Members Involved

1 Think	As a group begin to brainstorm. Open up your notes from the previous 8 week's lessons and begin to contemplate exactly what type of transportation method you'd like to create. Following the four rules above first choose the method of transportation. Next choose the renewable power source as each will greatly impact your design. Consider your source carefully, as each has different advantages and disadvantages. Once you've chosen a primary source, consider including a back up energy source (perhaps as optional additions).	All
2 Sketch	After you've chosen your method and energy type. Discuss what you want your design to look like. Do you want it to look like a current mode of transportation? Or should it be something completely original? How will your resource work? Is it something that must be located on the outside and is therefore part of the design? Or is it located inside? Will you consider aesthetics in your design? Is there a color scheme? Everyone's ideas will be considered in the design. The designer will however sketch the ideas. The sketches should provide a 360 degree view of the transportation system. The sketches should include explanations and key features including: *energy resourceselling pointsluxuries (additional options)climate friendly advantages*	All
3 Research	After you've chosen your methods and energy types the research should begin. You'll need to research the following: 1) Materials needed to build prototype 2) Costs involved in building prototype 3) Material costs in building real thing 4) The mechanical operation of your resources 5) Positives and negatives of using this energy resource 6) The impact your transit method would have on the environment	Researcher, Mathematician, Leader
4 Build	Once the materials have arrived you will build a model of your prototype using the available materials. Your model should look as similar to your sketches as possible and should be functional, either by human modeling or powered by your alternate resource method.	Engineer, Leader
5 Promote	Given the sales price of your product, consider who you would market it to and create an advertising campaign designed for your buyer. Create a print campaign to be displayed throughout the school and an audio visual advertisement to be played during the Board meeting.	Promoter, Leader
6 Justify	Boardroom conversation. All group members will face the board to justify their prototypes to the Board. All members should be able to communicate their contribution to the final product. They should also be knowledgeable on the costs associated and environmental impact of their method.	All

The Roles:

The Leader	The leader communicates with all fellow team members to ensure that all the roles and rules are followed. They act as a liaison with the teacher and are the only group member allowed to ask questions of the teacher and will submit requests for materials. The leader is ultimately responsible for the work of the finished product. The leader picks up the job when someone else is absent or has too much work. They have power of veto in a deadlocked decision. This person should be a motivator, someone who can get their group in line and working together.
The Designer	The designer is the artist. They are the person that is going to sketch everyone's ideas into one set of sketches that depicts the group's ideas and methods. The designer must consider both function and appearance. This person should be a good artist, but must also be a good listener. They must listen everyone's collective ideas and choose a common theme. The designer's main role is in the sketching, however they are responsible for the end product, and should be helpful to their teammates in any method possible after their sketching is complete.

The Engineer	The engineer is the builder. They are the person that is actually going to build the prototype to put on display. They along with the researcher will create a list of materials and needs these will be submitted to the leader. After you've received the materials your job is to build a prototype that matches the sketches and moves. Once your model is built the engineer must test the model. They should make notes of the positives and negatives of their model, then make suggestions for improvement. The engineer's main job is to build, however they are responsible for the end product, and should be helpful to their teammates in any means possible.
The Researcher	The researcher is in charge of researching the materials and technology used in the building of the group's ideas. Researchers will submit a materials needed list to the leader. Additionally they will be researching the positives and negatives of the resource (or resources) they decide upon. The researcher's work will be critical to the justification round.
The Statistician	The statistician is in charge of calculating all costs of building the product and the selling cost of the product. This person should be you're strongest math student. They will be critical to the justification of your project.
The Promoter	The promoter is in charge of creating an advertising and marketing campaign to sell your product. This person should be your most outgoing personality who has the ability to convince others to buy their product. They should have a commercial prepared to present during justification.

The Final Product:

1. Sketches with explanation of original designs.
2. Prototype Model
3. Research Data Sheet
4. Cost Analysis Sheet
5. Pollution Analysis
6. Advertising Campaign - both print and video

The Reminders:

a. No one group member is more important than another.
b. Everyone has a responsibility in the final project.
c. Your entire group is competing for the title of Top Apprentices.
d. Have fun, be creative, and don't waste your learning time.

The Judgment:

At your board meeting your group will receive points from each board member. Each category has a possible 5 points. Each group will have the opportunity to score points in the following criteria:

	Innovation	Design	Research	Promotion	Collaboration
5					
4					
3					
2					
1					

The Extras:

When	What
During Build It	Instead of providing the materials all the materials they asked for substitute everything except their resource. Force groups to think outside the box with this additional challenge, make the best of a new situation and adapt plans, designs, and ideas to available resources.
During Promotion	Require students to provide predictive data for the environmental impact of their system in Chicago with 1,000, 10,000, 100,000, and 1,000,000 riders/buyers/users.

Appendix 1

IL State Standard Implementation:

Il State Standard	Description of Standard	Explanation of how standard is addressed
10.A.3a	Construct, read, and interpret tables, graphs, and charts to organize and represent data.	Students will at multiple times be presented with transportation data that allows for reading and interpreting. The classroom, group, and individual visual representations will address constructing graphs, tables, and charts.
10.A.3b	Compare mean, median, mode, and range.	Activity number three specifically allows students to use their own generated data on air quality to calculate and compare mean, median, mode, and range.
10.B.3	Formulate questions, devise and conduct experiments or simulations, gather data, draw conclusions, and communicate results.	This standard will be addressed throughout activity number seven. Additionally, as students look at data and make hypothesis from data they will clearly be communicating and drawing conclusions as well as environmental implications.
10.C.3b	Analyze problem situations and make predictions about results.	The entire unit is designed to have students ponder the implications in and outside of transportation on the environment. These critical thinking skills will produce predictions and specifications of future problems.
11.B.3a	Identify an actual design problem and establish criteria for determining the success of a solution.	Activity number seven challenges students to rethink the design of their own prototype and determine a solution for any particular problems.
11.B.3b	Sketch, propose, and compare design solutions to problems considering available materials, cost, effectiveness and safety.	Activity number seven specifically allows students to create and build a prototype considering cost and availability of goods.
11.B.3c	Select the most appropriate design and build a prototype or simulation.	Activity number seven specifically allows students to create and build a prototype.
11.B.3d	Test the prototype.	Activity number seven allows students to test their prototype, and rebuild as needed.
11.B.3e	Evaluate test results and suggest improvements.	Students after testing their prototypes will evaluate their results and change the prototype according to new plans.
13.A.3a	Identify and reduce potential hazards in science.	This standard will be addressed throughout as we examine waste and discuss the hazards in both disposing and researching of pollutants.

13.B.3e	Identify advantages and disadvantages of natural resource conservation and management programs.	Students will examine the environmental differences of junking a car for a newer more efficient model and reviving a less efficient car saving it from the junk yard.

Endnotes

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