

# **A Brave New World: Creating Solutions for Sustainable Global Development**

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## **Overview**

This unit is designed as enrichment for a 10<sup>th</sup> grade chemistry class for gifted students. The purpose is to raise awareness among students about the rapid economic and technological growth that is occurring in many areas throughout the world. While this growth in sophistication and skills will mean competition for jobs that are just skill based, there will be many opportunities for innovative problem solvers. Despite this growth in third world countries, the disparity between the very poor and the very wealthy of the developed countries is extreme. Technology has only made this gap in wealth obvious to the poor of the world. For peace and for the justice of equity this gap needs to be shortened. The problem is that the environment cannot afford for even one half of the world's four billion poor to consume at the rate of the U.S. The challenges ahead for sustainable development are significant and again require creative solutions. During this unit students collect data to give them more information and a better perspective of the size of the world's populations, the distribution of wealth and poverty, the consumption of energy and other resources. Applying U.S. consumption rates to the population data of the third world countries, predictions are made for the future. The courage to be creative and try new ideas will be critical to changing such gloomy predications. Furthermore if the innovative solutions can make entrepreneurs from the locals then poverty can also be reduced. So allowing students to experience several creativity exercises is key to the unit. Following these activities, students working in groups design solutions for an anticipated environmental problem or design a product that will meet not only a need of a third world consumer but will meet the other requirements of price and minimal environmental impact.

## **Rationale**

Thomas Friedman proposes that the world is now an even playing field and that anyone can join in and compete for economic benefit. He argues that technology has given us the tools such that while we in America sleep, people on the other side of the world can be preparing tax returns, writing code or preparing accounting audits for the meeting the next day. For our students technology is not a big deal as they have been using this technology all their lives and take for granted these tools. They listen to their

downloaded music as they search the web on their computers and text message friends on their cell phones. What the students don't appreciate is that these highly trained workers will be their competition when they graduate from college and enter the workforce. We need to prepare our students to compete in this global pool of highly skilled, eager to work and less expensive job applicants. The global marketplace while creating competition also offers many opportunities as the third world starts to prosper. This unit is designed to make my students aware of this larger marketplace for labor and innovative products and then to develop skills which will put them at a more competitive advantage.

### It's a Global Workplace

Friedman gives many examples to show that it is not just manufacturing or call center jobs which have been outsourced, but jobs which require a higher level of skill. In 2005 roughly 400,000 tax returns were done in India. Through data transfer and a secure computer system the accountant in India processes the return and transfers the completed work via optic fiber lines back to the accountant in the U.S. This leaves the accounting firm free to use their specialized expertise to give to the more sophisticated and complicated cases, which also generate more revenue. The job normally done by the average accountant is outsourced, but the job done by the expert accountant stays in the U.S. and this person is able to devote all their time to being creative and valuable to the client. To save staffing night shifts, many small hospitals take advantage of the time differences and send copies of their X-rays to India and Australia where they are read by trained radiologists, with the results sent back by morning, to be discussed with the patient. Again the more complicated X-rays are saved for the specialists to review along with the patient's medical history. Even a personalized tutoring service may be purchased on-line with the tutors located in India. So jobs which require professional training and were traditionally safe and desirable are being outsourced. The jobs that remain are those where the person is providing added value by handling a more difficult task, offering creative and unpredictable advice, providing services which must be delivered locally and in person. Friedman predicts that with the availability of the internet world-wide it will not be knowledge workers that are needed, but people who can collaborate, explain synthesize information, be creative, who will be the employees in demand. There is a limit to the number of good factory jobs in the world but there is no limit to the idea-generating jobs in the world. America has been known for providing creative people who have generated innovative products and solutions to problems. With a flat playing field, Americans more than ever will need to provide the 'added value' as the labor will be cheap in other countries for the more routine tasks.

### U.S. Losing Edge in Science & Engineering

India, China and Russia culturally have always valued education. In 1951, India's first prime minister invested in creating Indian Institutes of Technology. According to Friedman, the intensely fierce competition to gain admittance to these Institutes has produced gifted and highly competent engineers, scientists and other technicians. The sheer numbers from China are overwhelming. With a population well over 1.2 billion and assuming that 5 % have the necessary education, China can provide skilled workers

equaling the total workforce of the U.S. Much publicity has been given to the dismal performance of U.S. students on mathematical and science tests compared to their peers in other countries. Even our brightest students do not shine as strongly in the global arena. There has been a steady erosion of America's scientific and engineering base as the older engineers and scientists retire with fewer younger people trained to step in. Enrollment in engineering and science programs peaked in 1993 and has dropped since. Foreign trained specialists are now staying in their own countries and not available to buffer the short-fall. In Asia alone eight times as many engineering degrees are awarded than in the U.S. As a science educator I must make my classes challenging so that students develop strong skills and also stimulate interest so that students will continue in science. Students also need to be aware of these job opportunities as many times they are undecided on a career choice.

Our students see the student sitting next to them as competition to set the curve on the next test. As they approach their senior year they become more aware that their SAT score is going to be compared with those from around the country. But with a surplus of colleges eager for tuition dollars, students still get a false sense of security and are blissfully ignorant of the potential competition from around the world. America has always had an immigrant population who strived to make it financially in this prosperous country. The political climate and the opportunities abroad mean that this group providing energy and competition is missing from the local community for the American student. Often the urge in schools is to make sure that students are current with technology as if this will be their ticket to a good job. This reflects an unrealistic viewpoint, as the technology skills are cheaper and better outside the shores of the US. Even if they were not better they are substantially cheaper and so more attractive to any corporation. Our students need to be aware of the potential competition and stirred from their complacency. I teach gifted students who stand out among a group of average students. We group them together so that they are more aware that there are others who are very bright and have a little more perspective. But within their homes many of these students have been given the idea that they are very smart and that is sufficient for them to be successful. In fact Dan Goleman suggests that your IQ only accounts for 4-10% of your career success. Daniel Pink also suggests that a different set of skills are needed in the future.

### Developing New Skills

In "a Whole New Mind", Daniel Pink proposes that we are moving from an economy built on logical, linear, computer-like thinking capabilities of the "Information Age" to an economy and society built on the inventive, empathetic, big picture conceptualizer or the "Conceptual Age". The high concept person has the ability to recognize patterns, opportunities to create artistic and emotional beauty, to craft a satisfying narrative and to combine seemingly unrelated ideas into something new. High touch skills involve the ability to empathize with others, to understand the subtleties of human interaction, to find joy in one's self and elicit from others, and to seek meaning in one's life. He accuses the educational system of training test takers to zero in on a single correct answer. This exercise is linear, sequential and bounded by time, which he has categorized as typical

left-brain thinking. The Rainbow Project is a group creating an alternative to the SAT. It includes 5 New Yorker cartoons and asks for the addition of humorous captions. Students must also narrate a story with a quirky title. They must also respond to some real-life challenges. This test has been twice as useful as the SAT in predicting success in college. I feel that it is important as a teacher of gifted students, who are often multi-talented that I encourage them to use all their talents and become more creative and not just good exam takers and receptacles for knowledge.

How do you teach creativity? For a long time it was thought that some people were just naturally creative and that it could not be taught. It is a process and students can become aware of the process and experience it while being forced to solve a problem which has no “correct” solution. They are not used providing more than one solution, or having problems which no mathematical algorithm will solve, much less being given permission to put forward a fanciful solution. Most students are content when they think of one idea and they need to be really pushed to keep generating more ideas. My gifted students fall into two groups. There are those students who want only to please the teacher and find the “correct answer” or what they think I want. Many times they do not even trust themselves to think. When asked to generate possible ideas they will say that they can’t think of anything or that the assignment is too hard or that they just “don’t think that way”. There are other students who relish having limitations removed and enjoy being able to think of their “own” method and not having a set procedure. It is important then to provide problems that require creative thinking to give confidence to the first group and to keep the second group motivated and stimulated.

### It’s a Global Market Place

Adolescents are a very self absorbed group. Their friends are their world. Their school, their homes and communities are their focus. Students then are oblivious to the world wide competition that they will experience and it is imperative that we give them a more global perspective. Many see the U.S. as the world leader and dominant player in the world economy. But this success makes it difficult to adapt to change. Since so much is already in place, change is expensive, difficult and cumbersome. Students need to become aware of the populations, the education, the sophistication and economies of other countries. Whatever career that they might choose they need to see that the opportunities are not just in the U.S. but world-wide. This is not just limited to the idea of exporting American goods to a larger consumer market. The global market offers more and different problems to be solved and so creates more opportunities than those within our borders.

In fact the 4 billion poor who are at the bottom of the economic pyramid and live on less than \$2 a day, suggest great opportunity, with their sheer numbers. Innovative products will be needed to meet the demands of this value conscious consumer. Despite the outsourcing to India it is still home to over 400 million people, who qualify as being very poor. Eradicating poverty remains the number one UN goal for the Millennium. C.K. Prahalad suggests that the poor pay a premium for basic services, often five to twenty five times the rate that the rich pay. Some of these expenses are due to corrupt

governments, remote locations, monopolies and access to capital. This unmet market provides opportunities for the poor themselves to become entrepreneurs and participate in the economy and eventually become more self supporting. Products to reach this market will have special constraints. The products will need to be in very small single-serve packaging so that the daily income can cover the cost. In tons the Indian shampoo market is as large as the U.S. Small packaging though means enormous impacts on the environment unless innovation is added. Many products can also meet health needs. For instance the marketing of soap requires education to promote need and value. Ice cream can be both a treat and a valuable safe source of milk nutrition. The profits on these products will come based on volume but will need to have very low margins in order to be affordable. This implies great efficiency and reduction of resource intensity while maintaining high quality. In India cataract surgery is offered for \$50 to \$300, with only 40 % paying the cost. The quality is comparable to similar surgery offered in the US for \$2,500 to \$3,000. Other restraints include access to rural markets, a need to deskill usage for an uneducated user and hostile environments – dirty, unsanitary and rough usage. Finding solutions to designing successful products will provide innovation that is useful to all consumers in the global market place. These innovations will also hopefully reduce environmental impacts as the poor become more active in the global economy.

#### Environmental Clash With Economic Development.

Sustainable development is a compromise between providing immediate relief to the poor of today and the obligations to provide for future generations. 'It would be reckless of us to successfully reach the Millennium Development Goal in 2015, only to be confronted with dysfunctional cities, dwindling water supplies, more inequality and conflict and even less cropland to sustain us than we have now.' Ian Johnson, Vice –President of the World Bank Environmental and Social Sustainable Development Project. Up till now development has managed to stay ahead of degradation of the environment but only at the expense of extreme poverty for much of the world. This often appears as a conflict between the third world countries who see that their growth is being limited by the wealthy nations who were extravagantly careless with resources. Technology and consumption are not the only culprits for environmental damage. As noted by Vijay Vaitheeswaran in the article 'How Many Planets', poverty also causes extreme pollution. Every year a million poor people die from urban air pollution and twice that number from exposure to stove smoke inside their homes. Three million die from water-related diseases and premature deaths from environmental factors account for about on fifth of all disease in poor countries. Obviously there are huge incentives for these countries to tackle some environmental issues. In the long run it might be cheaper for rich countries or companies to pay for such things as reforestation rather than the more costly clean up of the environment. It would seem that the wealthy nations need to take responsibility for the problems that they have caused and lead the way and provide lessons and incentives to the poorer nations to develop in a more sustainable way. My students are generally very aware of environmental issues as they exist in the U.S. but are less sensitive to the compromises needed. Creative solutions that are attractive to both groups will in the long run be the ones that are acceptable.

As much as the increase in posterity in many parts of the world is encouraging, the earth just cannot survive if all its inhabitants consumed at the U.S. rate. As of 2002 six of the top 15 energy users were low income countries, including India. S.K. Sharma forecasts in *The Tribune*(India), 9/24/2005 that if the energy consumption of India were to grow to the level of developed countries then the domestic commercial oil energy reserves would be three years for oil, five years for gas and only 15 years for coal. The window of opportunity to stem the course of global warming, at current levels, is only a few years but if it were to keep increasing at high rates then the effects will really accelerate. The scarcity of fresh water will be at disaster level before energy sources run dry. China, although the most populous nation, has historically always been able to feed itself. But today, increasing water shortages are pushing China to import food in a big way. Australia is in its seventh year of drought with reserves at 25 % of capacity( World Bank Report) If there is no improvement then there will be no water for irrigation in the largest food growing area of the country. The global impact on the environment will continue to be devastating.

New technology has decreased the rate of impact on the environment. As third world countries prosper their environmental impact will not be on the scale of America. We have not eliminated permanent loss of resources or degradation to the environment however technology can slow down the impacts and allow more time for more improved technology while allowing prosperity to grow. Again the threat to the environment gives an immediate impetus for creative solutions.

### Some Creative Solutions

Here are several ideas that have been generated and show a variety in levels of technology and sophistication. These are a few solutions to the problem of obtaining clean water in third world countries. The web site of “Nano Technology Group” describes an engine which will run on cow dung and was designed by Dean Kamen. This engine can then be used to power a water purification system which evaporates the water. It is even possible that the waste heat from the engine could be used to purify the water and the energy generated to power local homes. He has also devised this product at a price that entrepreneurs from each village could operate and also generate revenue. A much less sophisticated method of purifying water was developed by a group called “Potters for Peace.” Local potters can be taught to make filters by combining clay and saw dust. When fired the saw dust burns away and creates tiny pores which allow water but not bacteria to pass through. Next the filter is soaked in colloidal silver to provide even more protection from bacterial growth. Again this innovation gives local residents the opportunity to sell this product to their neighbors. An even more low-tech system for obtaining pure water is to use the universal energy of young children as they play. A pump is connected to a roundabout that children push and play on. The design allows up to 1400 liters of water per hour to be moved to a communal tank. This far exceeds the 25 liters per 10 minutes that each household would take using a hand pump. The women are spared the time it takes and the heavy burdens they carried when compelled to maximize their turn at the well. At the time that this unit is being written the Sundance channel is airing a program called ‘The Green: Big Ideas for a Small Planet’ which focuses on

innovations for environmental problems. My guess is that the programs will be archivable and/or repeated for many years to come. Currently there is an exhibit at Cooper Hewitt gallery in New York, titled “ Designing for the Other Ninety Percent.” A catalog of the exhibit is available. The website also has videos of presentations of several groups responsible for the innovations.

### Context of Unit

I teach 10<sup>th</sup> grade chemistry for gifted students. These students have been identified through testing to have very high IQ’s. They do not have to take all classes at the gifted level but may select to take a few or all their classes at the gifted level. These classes are expected to provide intellectual stimulation as well as enrichment. In chemistry we cover more topics and tend to have more challenging problems. Due to the high ability of the students, classroom discussions are rich and students can offer much due to their own extensive reading and discussions in their homes. They are highly motivated, although sometimes more to college entry with very little thought of what they would do once they are out of college. Most of them have been encouraged, especially when younger to think creatively. Somewhere in between elementary school and high school the focus becomes more on the grades and being prepared to take a SAT II exam. So with this in mind this unit is planned to give students a better sense of the bigger world and some of the environmental problems ahead but at the same time assuage a feeling of “doom and gloom’ by giving them opportunities to flex their creative muscles and see that solutions are possible.

Each quarter I give my students a project which is usually focused on the interdependence of technology and science. This unit is planned as one of the quarter projects. The project allows students to be creative and innovative while focusing on some world wide environmental problems. Before they begin their projects, they will research and present data about India’s and China’s populations; the average needs of food, water and energy for such numbers; the availability of fresh water, good soil and energy; average incomes, average life span; the level of American business which is outsourced. These facts would help them develop a perspective and appreciation of the magnitude of both progress in global development and the amount of work still to be done. Using the numbers and providing comparisons to show their meaning and implication is an excellent skill for any one who needs to present technical data. By analyzing the data students will be encouraged to see that there are opportunities to solve many problems. They will select a problem and then work in teams to solve that problem. Finally they will make a presentation which will outline the problem, its scope, the needs that must be met, their design and how it will meet those needs, the obstacles to implementation, who will be responsible for implementation and the barriers to implementation and suggest a next step. This fits into my curriculum as students now have to take a state science assessment in eleventh grade and this includes a section on environmental science. Since these are gifted students it is only fitting that they are given opportunities to be creative.

### Objectives

The following are the specific objectives for this unit.

1. Students will gather information about world facts and trends. They will present them in such a way as to give a historical perspective and show the growth. The information is to be presented such that an audience will have a sense of the magnitude of these numbers. Students will also use comparisons to help make this possible.
2. Through the number gathering students will be more aware of the magnitude of poverty and wealth in the world; education levels in the world; illness in the world; poverty in the world; jobs outsourced; populations. All of this data will hopefully give students a better global view and the realization that the U.S. does not have all the answers and maybe is losing ground in terms of having all the opportunities.
3. Students will use factor-label (a common method of problem solving) to take US consumption rates and other practices with population projections to forecast world consumption, needs and trash production. Again using factor-label students will create an analogy to make the consumption more meaningful. For example the students may project how much of the U.S. could be covered by the world's trash.
4. Students will experience some exercises in creativity. Situations will be provided so that students are pushed to develop many ideas and to expand or enhance some novel ideas.
5. Students will read and/or see video stories of some innovative approaches to problems so that they will understand some approaches to creative solutions.
6. Students will work in teams and be held accountable for their contributions to the solution generating process.
7. Students will use Power Point presentations to explain their innovation to the class.

### **Strategies**

For each quarter I assign a project which involves students looking at the impact of science and technology on society. The purpose of these projects is two-fold. First, not all my students will become scientists but the ever increasing developments in science and technology mean that as citizens they will need to make tough decisions about restraints or uses of technology. I feel that it is important that they learn to look critically at the implications and impact of technology on both society and the environment. Our past has shown that when this was not done there has been devastation to the communities and environments. We have enough history to show that pre-planning and risk analysis is necessary. Concerned citizens need to become watch dogs and challenge or probe to see if the homework has been done. Secondly, the quarter projects are also designed to develop skills that are important to scientists such as: the ability to communicate scientific ideas to a lay audience; the ability to stimulate people to change

behavior; ability to debate; ability to see the other side; ability to present data in an interesting and informative way; ability to be creative. These quarter projects are valued at half a test grade and the expectation is that students will invest at least the one-half the work required for a unit test. Most units represent at least three weeks worth of work. Some class time is devoted to preparing students for the quarter projects but much of the work is done outside of class.

The first quarter project requires students to read a chapter from “Ariadne’s Thread” by Mary Clark, about energy consumption and availability. This is an excellent article which gives the limitations of the resources available on earth and what exponential growth implies. This fits within my curriculum as I spend much time introducing students to the role that energy plays in causing chemical change and how chemical change produces energy. The article gives a practical application of these ideas. It also is a long and fairly sophisticated read which presents scientific information in a way that students can understand. The students are then required to research one form of alternative energy resources and describe in a report the advantages and the hindrances to implementation of these forms. This project helps students realize the limitations on resources and the need to plan alternatives or wiser use of energy.

The second quarter project requires students to debate, one-on-one, some tough issues, such as “Should local communities decide on the use of the rain forests or should an international group be in charge of protecting the forests?” “Should we use pesticides and genetically altered crops to increase agricultural output?” The purpose of these debates is to show students that most of the time there are some very valid points to both sides. Many of my students have a very idealistic view towards the environment but have never really thought about other, especially third world needs or impacts on the environment. These debates are designed to show students that the view held by someone living a privileged life in the U.S. has a very different point of view to the hungry Chinese person who needs food and fuel at the basic level. These debates have been very popular with my students and are now a tradition. Normally when I have given the evaluations back to students we have discussed some of the conflicts. During the debates the audience is not allowed to give their view point so the post debate discussions are often lively.

With this new unit in mind I would see the debates providing a spring board to discussing global view points and looking at some hard global data. This is when I would assign students to collect different pieces of data and present them in graphical form that will instruct their classmates. The data that I would like to be presented will be population data and projections, average income in several countries, the extremes of income, the types of daily work, typical living conditions, the percentage of deaths and typical causes. As part of the discussion I would also like students to see how affluence changes some of the statistics, how technology can change some of the statistics and realize that projections can and have changed. I would also like to offer the cautionary idea that although population growth can be turned around there is a limit to certain resources. So at the same time we will also look at some of these projections and students will generate data to show the trash size, water usage, land usage, energy needs etc.

Students should see that current modes of consumption are too extravagant for everyone in the world to practice, but at the same time the 4 billion poor cannot be left in abject poverty and disease. Students need a sense of our interdependence and the need for cooperative solutions.

Another assignment that students have in the first quarter is to design a special effect for a scene in a movie. The students write a scene for a movie and the special effect that they would like to make the scene more realistic and more exciting, while at the same time maintaining safety. At this point students do not know a lot of chemistry. They have been exposed to a series of labs which support the particulate nature of matter and explore the idea of changes in matter. These experiences give the students ideas which they use to create their special effect. The students are encouraged to develop criteria for their special effect and use this to decide what improvements are needed. As part of the exercise they are encouraged to try several approaches and not to get stuck with just one idea. Their creativity comes in how well they are able to deliver the effect. That is they must design a way to have the reaction or reactants invisible to the audience or make the effect part of the scene so that it seamlessly fits the scenario. The students enjoy the freedom to experiment and find their own answers. I would see a series of creativity exercises as a way to build on this experience and prepare the students for the assignment connected with this unit.

## Creativity Theories

Michael Micalko in his book “Cracking Creativity” looks at the thinking strategies of creative giants such as: Charles Darwin, Albert Einstein, Thomas Edison, Leonardo da Vinci, Richard Feynman and Walt Disney. He found that they were able to “see what no one else is seeing” and “thinking what no one else is thinking”. “To see what no one else is seeing”, you need to find a perspective that no one else has taken. Leonardo da Vinci believed that to gain knowledge about the form of a problem, you begin by learning how to reconstruct it in many ways. This can mean looking at the opposite view or rephrasing the problem with the words in a different order. By not settling for one perspective geniuses do not merely solve existing problems, they identify new ones. Making your thoughts visible is another way to gain a new perspective. Galileo revolutionized science by making his thoughts visible with diagrams, maps, and drawings while his contemporaries used conventional mathematical and verbal approaches. Einstein also had a very visual mind. He thought in terms of visual and spatial forms, rather than thinking along purely mathematical or verbal lines of reasoning. In fact he believed that words and numbers, as they are written or spoken, did not play a significant role in his thinking process.

There are seven strategies to “think like no one else is thinking”. Micalko describes these in part II of his book. These are:

1. *Thinking Fluently*. A distinguishing characteristic of genius is immense productivity. Thomas Edison held 1,093 patents, still the record. He gave himself and his assistants idea quotas. In a study of 2,036 scientists throughout history, Dean Keith Simonton found that the most respected not only produced more great works but also more “bad” ones. Out of this massive quantity comes quality. It took Edison nine thousand

experiments to perfect the light bulb and fifty thousand to invent the storage cell battery. Once when questioned why he persisted after so many failures, Edison explained that he had not failed, instead he had discovered thousands of things that didn't work

2. *Making Novel Combinations*. In his 1988 book, "Scientific genius", Dean Keith Simonton, suggests that geniuses are geniuses because they form more novel combinations than the merely talented. They are constantly combining and recombining ideas, images and thoughts into different combinations in their conscious and subconscious minds.

3. *Connecting the Unconnected*. Leonardo da Vinci forced a relationship between the sound of a bell and a stone hitting the water. This enabled him to make the connection that sound travels in waves.

4. *Looking at the Other Side*. Physicist and philosopher David Bohm believed that geniuses are able to think different thoughts because they could tolerate ambivalence between opposite or incompatible subjects. The chemist Niels Bohr believed that if you held opposites together, then you suspend your thought and your mind moves to a new level. The swirling of opposites creates the conditions for a new point of view to bubble freely from your mind. Bohr's ability to imagine light as both a particle and a wave led to his concept of the principle of complementarity.

5. *Looking at Other Worlds*. Aristotle considered metaphor a sign of genius, believing that the individual who had the capacity to perceive resemblances, between two separate areas of existence was a person of special gifts. Thomas Edison invented the phonograph in one day after developing the analogy between a toy funnel and the motions of a paper man and sound vibrations.

6. *Finding What You are Not Looking For*. Whenever we attempt something and fail, we end up doing something else. This is often known as the creative accident. And should provoke the question what did I just do. Alexander Fleming was not the first physician to notice the mold that formed on an exposed culture while studying deadly bacteria. A less gifted physician would have trashed this seemingly irrelevant event, but Fleming noted it as "interesting" and wondered if it had potential. As we know, this "interesting" observation led to penicillin.

7. *Awakening the Collaborative Spirit*. The collective intelligence of a group is greater than that of the individuals. Creative individuals need to learn to work in groups productively so that they can take advantage of the strategies above.

As mentioned earlier students can be very coy about producing ideas and immediately judge their thoughts and say that they "can't think of anything." Some exercises will be needed to encourage students to think freely and to suspend judgment. This can be very uncomfortable for students. So these exercises will be somewhat fanciful and encourage students to be very free. Students will participate in a storyboard exercise. This was first introduced by Walt Disney when he was creating his comics. This involves brainstorming the purposes of pursuing a particular topic. From these participants develop headers which are the major issues or attributes for your purpose. These are organized in a meaningful sequence and the group brainstorms each part and posts the ideas as they are generated. Judgment is suspended. Many times people will hitch-hike off an idea that may seem improbable and use the concept for a more probable solution. Participants are pushed to keep a steady stream of ideas-the more, the better. Post-its allow the headers to

change as ideas start coming and connections are made or ideas are combined. Finally the group will pass judgment and decide on the best idea(s) and how to make them work.

### **Classroom Activities**

What are The Numbers and What are They Telling Us ?

The first assignment for the students will be an internet search to determine the following for a selected country: population, population density, number of people living on less than \$2 a day, urban population, rural population, population density, average household size, percentage of school age children who finish high school, average life expectancy, major health issue, access to electricity, access to sanitation and safe water, energy sources. They will then be asked to use the data creatively to provide a profile of that country. They may create a hand drawn graphical poster or they may create a combination of graphs and PowerPoint graphics to give a snap shot. The idea is to combine the information rather than list separately. The countries profiled will be: China, India, South Korea, South Africa, Pakistan, Singapore, Ghana, Nigeria, Thailand. The posters/graphical presentations will be shared with the class. At this point we will discuss the UN's Millennium Goals and students will decide which will have the major impact on the country that they researched. Students will also be asked to use average energy per capita in the US and apply that number to the countries they have studied and we will develop the percentage increase in energy, greenhouse gases, decrease in soil erosion due to less timber burned, decrease in CO<sub>2</sub> from wood burning. China is developing at a great pace and so projections will be made if 20 %, 40 %, 50% and 60 % of the population were to own and operate an automobile, for annual gasoline consumption, for CO<sub>2</sub> emissions, income from sales. These projections should highlight that we can't afford environmentally for this to happen although it might be very profitable for some people if this were to happen. From these projections students will realize that the same approaches will not work and that creativity is needed.

### **Learning Creativity Strategies**

At this stage we will discuss creativity strategies. As a first assignment students will be given five cartoons from the "New Yorker" and they will be asked to supply the captions. I will share with them that this as an alternative to an SAT exam. Hopefully when these are shared the students will see how many different interpretations there were. We will discuss the seven strategies for improving creativity and use many examples from science.

Next the students will be asked to apply SCAMPER technique developed by Alex Osborn and Bob Eberle. These 9 creative thinking principles are used to elaborate an idea that you might have.

S= substitute

C = combine

A= adapt

M = magnify, modify

P = put to other uses  
E = eliminate  
R = rearrange, reverse

SCAMPER is based on the notion that everything new is some addition or modification of something that already exists. The general process is to list the attributes of your subject and then focusing attention on each attribute and asking the SCAMPER questions provides a means to improve each attribute or combine them differently. Students will work in groups of 5 and using the technique will find ways to improve the common toaster. We have developed many products this way. The self cleaning oven has the attribute without the need of a product. The cell phone has connectivity without the wires. Roller sneakers added a fun component to necessary footwear. From this activity students will see that the more ideas that are generated the better the final outcome.

As a follow-up activity the class will participate in a story board activity. We will analyze the problem of village women in rural areas having to collect water from a river, often far from the village. Many times this same river is used as the place for bathing humans and animals and contains human and animal waste. There are 1.3 billion people without access to safe water. Every person needs 50 liters of clean water per day to keep healthy and avoid water related diseases such as dysentery and cholera. In over 50 countries around the world, people have less than this critical level. In the U.S. we consume 500 liters per day per person. The students will brainstorm what are the major problems and these will become the headers. For each header the group will develop ideas to overcome that problem. If anyone begins to judge an idea they are tossed the “wet fish”, and so judgment is discouraged. After all the ideas have been generated they are then looked at to see if they can be combined or altered to cover more than one issue. Each person is then given three dots to vote for the ideas which they feel are the best solutions to the problem. The final set of ideas is then further examined using the SCAMPER method to see if they can be improved on. A final set of three strategies will be produced. At this point I do not know if I would share some ideas that have already been developed to meet this problem or if I would just let each class see what their peers have developed.

### Final Assignment

As a final assignment students will be divided into groups of four and given the challenge of developing a product for a third world country or a solution to an environmental problem in a third world country. If students are tackling a product to be marketed in a third world country then they must be made aware of price, packaging and distribution challenges. An environmental problem will also have price, education and availability concerns as well. Each group will then make a presentation of their solution. This presentation will include the evolution of the idea, the feasibility and a cost estimate.

## Bibliography

Clark, Mary. *Ariadne's Thread: The Search for New Modes of Thinking*. St Martins Press. 1990. A comprehensive look at environmental problems in their social and cultural context and how solutions will also need to keep these contexts in mind.

Diamond, Jared. *Collapse. How Societies Choose to Fail and Succeed*. Penguin Books, 2005. Describes past collapses of communities caused by environmental disasters and human decisions about these. Present communities in a fragile balance with their environments are also discussed along with the decisions that need to be made.

Florida, Richard. *The Rise of the Creative Class*. Basic Books. 2002  
Describes the new creative class – people who create for a living- and their needs.

Freidman, Thomas. *The World is Flat*. Farrar, Strauss and Giroux. 2006.  
The author discusses the technological advances which have helped to make the world more open and access possible from any location. He also discusses the implications for jobs and skills needed in the future with this more competitive arena.

Michalko, Michael. *Cracking Creativity: The Secrets of Creative Genius*. Ten Speed Press, Berkley, California. Examines the thinking patterns of acknowledged geniuses and organizes these into a list of strategies to improve your creativity.

Michalko, Michael. *Thinkertoys: A handbook of creative-thinking tools*. Ten Speed Press, Berkley, California. Suggest activities and strategies to approach problems in unconventional ways.

Pink, Daniel. *The Whole New Mind*. Berkley Publishing Group, Penguin, New York. 2006. A more specific description of the skills needed in the workplace of the future. Strategies for developing these skills are also discussed.

Prahalad, C.K. *The Fortune at the Bottom of the Pyramid*. Wharton School Publishing. Gives case studies of successful products that have been developed to meet the poorest of the poor or those at the bottom of the economic pyramid.

Simonton, Dean K. *Scientific Genius*. New York. Cambridge University Press, 1988. Examines the patterns of 2,036 highly successful scientists.

Annual Editions, *Environment 07/08*. McGraw- Hill Contemporary Learning Series. One in a series of over 65 volumes, each designed to provide convenient, inexpensive access to a wide range of current, carefully selected articles from some of the most respected magazines, newspapers and journals published today. A wide perspective is given on important environmental topics. All these article would make suitable readings for students. In particular the first article by Vijay Vaitheeswaran writing for “*The*

*Economist* “gives a global perspective to the balance of development and impact on the environment. The beginning of the book also gives many websites for both global and environmental data.

### **Web Sites**

Sustainable Technology Education Project (STEP)

[www.stepin.org](http://www.stepin.org). accessed 6/16/07

Aims to increase young people’s awareness of sustainable technology. It is designed as a tool to help teachers and is produced by Practical Action, an organization that aims to make a practical difference to the lives of poor people in the developing world. 35 case studies, including the play pump, and ideas for follow-up classroom activities. Teaching suggestions primarily for a middle school student.

Population Reference Bureau. 1875 Connecticut Avenue, NW. Washington DC. 20009-5728

[www.prb.org](http://www.prb.org)

Current population data by country. Population projections, population densities and health statistics are provided as well as environmental indicators such as vehicles in use and CO<sub>2</sub> emissions.

The Nano Technology group is a nonprofit organization in Texas with an international group of partners

[www.thenanotechnologygroup.org](http://www.thenanotechnologygroup.org) accessed 6/17/07

Goal is to support education projects that lead to a better informed public awareness on global issues and solutions. The site gives new releases relating to this area, lessons for formal education, forums for the exchange of ideas. Dean Kamen innovations listed.

The world bank provides financial and technical assistance to developing countries

[www.go.worldbank.org](http://www.go.worldbank.org) accessed 6/17/07

Provides extensive information on global issues. Individual country information is available and annually several world development reports are published. These provide invaluable information about the economic, social and environmental state of the world today.

<http://hdr.undrp.org> accessed 6/17/07

Contains the human development reports which the UN publishes annually to measure progress and obstacles to development goals set by the UN. Many special topics are also addressed. Water access and climate change are some recent environmental publications.

Sundance Channel: “The Green”

[www.sundancechannel.com/thegreen](http://www.sundancechannel.com/thegreen) Supports the program ‘The Green’. There are downloadable videos, resources and a Blog all centered around environmental issues.

India the Tasks Ahead

[www.tibuneindia.com/2005/specials/tibune-125/main12.htm](http://www.tibuneindia.com/2005/specials/tibune-125/main12.htm) Overview of India's energy needs and resources written in the newspaper The Tribune by S.K. Sharma

<http://other.cooperhewitt.org> Find the "Design for the Other 90%" on the main page. Background information on basic topics of water, health, environment, shelter, energy, education are given. Videos can be viewed of some of the innovations and their development history.

## **Appendix –Content Standards**

The following content standards of the Pittsburgh Public Schools are addressed in this unit.

### Science and Technology

- S1. All students explain scientific principals of chemical, physical and biological phenomenon have developed and relate them to real world situations.
- S2. All students demonstrate knowledge of basic concepts and principles of physical, chemical, biological and earth sciences.
- S4. All students explain the relationship among science, technology and society.
- S5. All students construct and evaluate scientific and technological systems using models to explain or predict results.
- S7. All students evaluate advantages, disadvantages and ethical implications associated with the impact of science and technology on current and future life.
- S8. All students demonstrate basic computer literacy, including word processing, software applications and the ability to access the global information infrastructure, using current technology.

### Communications Standards

- C3. All students respond orally and in writing to information gained by reading narrative and informative texts and use the ideas to make decisions and solve problems.

### Mathematics Standards

- M1. All students use numbers, number systems, and equivalent forms (including numbers, words, objects, and graphics) to represent theoretical and practical situations.
- M3. All students evaluate, infer and draw appropriate conclusions from charts, tables and graphs, showing relationships between data and real- world situations.