Siemens We Can Change the World Challenge
Grades 6-8
First Place National Winner – NORTH CAROLINA

Team Name:
Trash Terminators

Location:
Chapel Hill, NC

School:
Phillips Middle School

Students:

- Rohan Deshpande
- Helen Jiang
- Joshua Zhou

Teacher/Mentor:
Ed Baruch

Project Title:
Zero Waste: iRecycle and iCompost

Summary:
Our Orange County landfill is closing in July 2013 and our trash will be transported more than 100 miles away to a new location adding cost and creating more pollution. Our unique approach to this problem is a vision of a zero-waste city which can be achieved by eliminating recyclable and compostable trash going to landfills. Our pilot "Carton Recycling and Tip Your Liquids" initiative at our school was highly successful in reducing liquid and recyclable waste by 80%, which when replicated at the 18 CHCCS schools will reduce 117,000 lbs of school waste going to landfill per year.

Step 1: Choose It!

- Which environmental topic did your team select?
- How does this topic affect your local community? Explain how this topic is important or meaningful to your team. Clearly state the negative effects of the issue/problem and how it affects the local environment, if it is replicable to other communities with similar problems or issues and if it is unique and you will use methods and/or materials not generally used or described by others.
- Explain how the issue can be solved through changes in the behavior of the community and/or through physical changes.
- If this is a continuing project, please describe any work done previously and the results.

"A man sees in the world what he carries in his heart." ~ Johann Goethe

Americans generate 250 million tons of garbage per year[1]. 21% of Americans' food waste goes to the landfill[2]. Trash in landfills creates methane gas which contributes to global warming at a rate 20 times faster than CO2. Landfill methane is produced when organic materials are decomposed by bacteria in the absence of oxygen[3]. More than one-third of all waste entering landfills can be composted [4].

We selected the topic reduce waste from going to the landfill because Chapel Hill's landfill is closing in July 2013 and our trash is going to be transported to a location more than one hundred miles away, costing approximately $500,000 for gasoline and emitting additional 3.1 million lbs of CO2 per year[5].

Trash audit performed for Chapel Hill in 2010 shows 22.7% of paper waste and 26% of food waste which can be easily diverted going to landfill[6]. Staff at the Orange County Waste Department indicated that there is no municipal composting to help divert the compostable waste. Reducing the amount of trash would be the top priority for Chapel Hill residents now that shipping our trash is going to be expensive and polluting. The most effective approach would be to recycle and compost.

To show that this goal is achievable through changes in community behavior and legislation, we researched cites in the United States where recycling and composting is performed effectively. We found out that San Francisco is the first major U.S. city to mandate composting. One million tons of compostable organic waste has been collected in the last 15 years. Between composting and recycling, SFO diverts 78 percent of its waste from landfills4.We want to drive Chapel Hill and North Carolina to be greener. Our vision is for Chapel Hill to be the first zero-waste city in North Carolina. It makes both economic sense and environmental sense. It is cheaper and less polluting to compost or recycle than dump garbage.

As a first step, we decided to promote recycling and composting in our school to make it a zero waste school! Previous year's cafeteria trash audit showed that 55% of trash was compostable, 17% of trash was liquids and 13% of trash was recyclables (bottles, cans and milk cartons)[7]. Hence we decided to work on reducing these three sources of waste through recycling and composting.

Citations:

1-EPA Municipal Solid Waste http://www.epa.gov/epawaste/nonhaz/municipal/index.htm

2-Reduce food waste going to the landfill http://www.epa.gov/foodrecovery/

3-Landfill Methane http://www.uspowerpartners.org/Topics/SECTION6Topic-LandfillMethane.htm

4-Elizabeth Daigneu. "Curbside Composting Added to a Major City: Is It Yours?" http://www.governing.com/topics/energy-env/gov-curbside-composting-added-to-major-city.html

5-Online Carbon Calculator http://www.roadnet.com/pages/products/carbon-emissions/index.aspx

6-ORANGE COUNTY WASTE CHARACTERIZATION STUDY - http://www.co.orange.nc.us/recycling/documents/WasteSort2010/Summary_by_geographic_area.pdf

7-See Excel spread sheet for 3 the cafeteria trash audit data.

Step 2: Research It!

- Describe the inquiry-based research your team did to identify the focus of your project. Include below a clearly defined problem statement that defines the issue and shows evidence of how it is a problem in your community. State whether the issue or problem could be found in other communities. The problem statement should be developed using both personal observations and collected data. Be sure to include citations for researched data.

"If we knew what we were doing it wouldn't be research." –Albert Einstein

There is a big need for increasing awareness about recycling and composting in our society. Recycling is reusing certain materials, such as paper, to create new products, instead of throwing away the materials in trash[1]. Composting is the natural breakdown of organic material into a rich fertilizer[2]. In 2010, 12.4% of the trash generated by the United States was plastics, having increased from less than 1% over fifty years ago[3,4]. Plastic bottles can take 450 years, aluminum cans can take 200 years, and glass bottles can take 1 million years to decompose[5]. This means that once a landfill is filled with recyclable materials, that area will never be used for anything else for many centuries. 14% of the trash generated by the United States is compostable food waste, meaning food waste occupies more of the landfills than other materials[5]. Just transporting and dumping food waste in the landfills cost $1.3 billion.4 Methane gas, which heats the world 20 times faster than carbon dioxide, is produced by compostable food waste in the landfill, accounting for almost 25% of all methane gas emissions in the US[5,6]. At this rate, southern Florida may be underwater by 2100; there will be an increased chance of getting a disease, such as dengue fever; extreme weather, such as droughts, will happen more frequently; and ocean-life will die out at an alarming rate[7].

In our city Chapel Hill, in 2010, more than 37% of the trash we sent to our landfill was recyclable. 26% of our city's garbage was compostable food waste[8]. While we were talking with representatives from the Orange County Solid Waste Department, our team learned that Chapel Hill landfill was moving more

than 100 miles away in July 2013. Using a carbon footprint calculator, we found that for every ton of trash that our city will generate and ship to the new landfill, we will be releasing 57 pounds/ton of CO2 and spending $55/ton[9].

We knew that the only way to reduce carbon emissions and save money for our city was to reduce the amount of trash. Therefore we started off by performing a classroom trash audit at our school. We did this to measure how much of trash at our school could be diverted by composting and recycling. Our results showed that a majority of our school's trash could be diverted by recycling and composting: only 23% of our school's classroom trash was pure trash. The rest was recyclable (15%), compostable food waste (16%), compostable paper waste (24%), reusable (1%), or liquids (21%)! We got data from a 2011 cafeteria trash audit performed at our schools which showed that 55% of trash was compostable, 17% of trash was liquids and 13% of trash was recyclables (bottles, cans and milk cartons)[10].

We decided that we needed to address each major portion of our classroom and cafeteria trash that could be diverted from entering landfill. We researched about ways we could do this. We found an organization called the Carton Council, which promoted the recycling of milk and juice cartons around the country. We used their Recycling Impact Calculator and Potential Impact Calculator to find out the impact of recycling cartons. What we found was phenomenal. Given that approximately 400 students eat school lunch at our school every day, we would be able to save around 8 trees, 85413 sheets of paper, 1708 Kilowatt-hours (kWh) of energy, 2135 pounds of carbon dioxide from being released in the atmosphere, and 2989 gallons of water by recycling cartons in our school[11]! This will help us to reduce the liquid trash and increase the recyclables.

We had an expert in our group, Rohan, whose family has been composting for last 10 years, and for a year he has been worm-bin composting as well. We also learnt hands-on from Murriel Williman - Orange County Solid Waste department - about the science behind composting. We learnt about how much nitrogen, carbon, oxygen and water are needed to form a perfect balance for composting. During our research we found out that composting on school grounds is not recommended due to health reasons, since backyard composting cannot handle meat/dairy etc. which needs to be monitored very carefully when starting a school cafeteria composting project. However, we found a private firm that can come to the school to collect compostable materials and compost them for the school.

During our research, we also found a company named TerraCycle which collects non-recyclable materials, such as chip bags and Elmer's glue bottles, and uses them to create new products[12].This will help us to divert the classroom/cafeteria trash which is neither compostable nor recyclable.

Citations:

1. http://epa.gov/recycle/recycle.html
2. http://www.epa.gov/compost/basic.htm
3. http://www.epa.gov/osw/conserve/materials/plastics.htm
4. http://curiosity.discovery.com/question/plastic-thrown-away-year-us

5. http://www.greenlivingtips.com/articles/waste-decomposition-rates.html

6. http://www.businessweek.com/articles/2013-01-10/living-in-the-united-states-of-food-waste

7. http://www.nbcmiami.com/news/local/Florida-Keys-disappearing-by-2100-Nothing-new-for-climate-scientists-126299303.html

8. http://www.co.orange.nc.us/recycling/documents/WasteSort2010/Summary_by_geographic_area.pdf

9. https://docs.google.com/document/d/1s3z5ZpPJYTBeMgP-3wVVCprlhlFX_geVopEwKIUbtKY/edit

10. "CHSchools_Cafeteria_Waste_Audit_DATA_graphs (1).xlsx": Excel spreadsheet of the cafeteria trash audit done for three school in 2011

11. http://www.grownyc.org/images/ee/CartonRecyclingGuide.pdf , Pg28 and 29

12. http://www.terracycle.com/en-US/

Step 3: Plan It!

- Share your team's action plan, including project steps, roles of each team member, timeline for completion, necessary resources, and you plan to measure whether your potential solution is working to impact or fix the problem. Explain how the community will be made aware of the problem and how community members were involved in the data collection, analysis or solution. Explain how the solution you propose is unique and will use methods or materials not generally used or described by others. Be sure to incorporate sustainable items/processes/materials into your action plan.

"To think is easy. To act is hard. But the hardest thing in the world is to act in accordance with your thinking." ~ Johann Goethe
In September 2012, we set goals for raising awareness of sustainability in our school and community. We decided to focus on reducing liquid waste, recycling cartons and bottles, reducing food trash, reusing & recycling school supplies & materials.

We met 2-3 times a week designing survey questionnaires, generating PowerPoint presentation, making posters & fliers, conducting trash audits and setting up demonstrations. All team members contributed to the survey questionnaires, trash audits, posters, PowerPoint development, presentations and the final write up.

- Rohan is our "IT" or "the Brain". He loves anything that involves technology and designed our webpage. He also modified graphs, videos and extracted data from both trash audits and surveys.
- Helen is our Public Relations person. She created our recycling Facebook page, prepared weekly reports for school's update, communication emails to staff.
- Joshua (Mr. Perfectionist!) is our tall "research guy". He loved doing research on landfills and methane gas emission, composting and carton recycling calculations.

Our planned action items:

1. School
    a. Conduct trash audit (October 2012)
    b. Student online surveys to promote recycling & composting. (November 2012)
    c. Prepare Videos & PowerPoint's to raise awareness in school about important facts of sustainability (November 2012)
    d. Working with school district and custodian administration to put carton recycling initiative in place, tipping liquids. (Dec-Jan 2013)
    e. Prepare presentation to bring our school staff on board with this recycling project (Dec-Jan 2013)
    f. Start initiatives
        i. Carton recycling and tip your liquids (Jan-Feb 2013)
        ii. Recycle paper in classroom (Jan-Feb 2013)
        iii. Reduce compostable paper in bathrooms (Jan-Feb 2013)
        iv. Terracycle (Mar-May 2013)
    g. Start ECO club at our school (Feb 2013)
    h. Composting demos at school for staff/students and parents (Jan-Feb 2013). Prepare presentation to share our knowledge and lessons learnt with sustainability director (Feb 2013)
2. City
    a. Put out a community survey to get a grasp on how much our community knows about the situation (Jan-Feb 2013)
    b. Composting demo at local stores (Jan-Feb 2013)
    c. Demo on Earth day at UNC (April 2013)
    d. Sharing research with the UNC sustainability club and high schools (Mar-April 2013)
    e. Convince the Mayor (Mark Kleinschmidt) & council members to approve municipal composting (Feb 2013)
3. State Government initiatives
    a. Request NC Senator Ellie Kinnaird to write a bill to ban food waste from the landfill (Jan-Feb 2013)
    b. Meet the State Senate to get momentum for the bill (March 18, 2013)
4. Conduct follow up Trash Audits to measure success of our initiative (March, 2013)

Citations:

N/A

Step 4: Do It!

- What did your team do? Share how your team went about collecting data, keeping thorough and accurate records, testing your ideas and hypotheses and making systematic observations about whether or the solution worked. Explain how community members were involved in making the solution happen and what specific tasks they took on. Be sure to discuss how your solution is original and creative using various outlets in the community.
- Share descriptions of any written notes, data tables, sketches, photographs or video captured during the data collection step; attach these supporting materials in Step 7. Be sure your procedures outlined are detailed and sequential.

"There is nothing impossible to him who will try." - Alexander the Great

1. We created a website which we update weekly with our research findings.
2. We created a recycling and composting awareness video for our school faculty to show to the student body.
3. We created an online survey which students took after watching our awareness video.
4. We posted signs all over our school to promote our efforts and increase awareness about our research.
5. We executed our first Initiative at our school: "Carton Recycle and Tip Your Liquids" (CRyTipLiq). We created a video which has been aired on our school's TV multiple times.

   We met our cafeteria and custodial staff so we could work as a team. We got good cooperation from them for setup, cleanup and hauling of the recyclable trash. We set up a bucket and a funnel to tip the liquids that students don't finish during lunch. A big recycling bin is setup now near the trash can for milk cartons, aluminum cans, and plastic bottles.

   We hypothesized that reminding the students about this initiative and monitoring them for the first week will help the students to remember the process of recycling. We then hypothesized that after a period of time, the student body would be able to accomplish this initiative on their own without any reminders or monitoring.

   We kept track of our recycling impact by weighing the liquids and the recyclables for 20 days. For the first and last week, we stood next to the trash can to remind students of tipping the liquids in a bucket and recycling the cartons. In the middle 2 weeks, we didn't monitor the students but measured the liquids and recyclables. We then entered this data into a spreadsheet.

   Our research shows that a written commitment will most likely be kept and so we started a pledge drive for students to commit to the CRyTipLiq initiative.

6. We presented our research to the entire school staff and faculty who now support our efforts to promote our initiatives.

7. We have been updating our progress via school's morning news and weekly e-newsletter.

8. We are starting the TerraCycle initiative in April.

9. We have sent our data to the Sustainability director of Chapel Hill Carrboro City Schools (CHCCS), David Dean, so that he can start this initiative in other Chapel Hill schools. We are meeting the Green Giants from each school along with David Dean on April 4th to replicate this initiative successfully in other schools.

   - Glenwood Elementary school has already started the CRyTipLiq initiative.

10. We created a community survey to increase awareness about recycling, composting and landfill closure in our community. This online survey was filled out by more than 80 residents of Chapel Hill. We found that only 21% of respondents were interested in a food waste composting demonstration, but 63% were interested in a municipal composting program.

11. We presented our research to Chapel Hill Mayor and Council members. We have requested a municipal composting facility in Chapel Hill. Our city's Mayor and Council passed a resolution to discuss about future plans for municipal composting in our city.

12. We have conducted multiple composting demonstrations at our school and our city's major mall, increasing awareness about our research on composting and encouraging others to compost.

13. Our research has been published in local Tar Heel Newspaper and Chapel Hill News, increasing awareness in the community.

14. We presented our research to NC State Senator Ellie Kinnaird. We emphasized the harmful effects of methane gas in the landfill and the benefits of composting. We have proposed to her to write a bill to ban food waste from North Carolina landfills. If this bill passes, we will drastically cut down our state's methane gas and carbon emissions and save money.

Citations:

N/A

Step 5: Analyze It!

- How did it go? What did your team's testing reveal? Did your solution impact the problem it identified? Share what made your plan work (if appropriate); any challenges met along the way; how you overcame those challenges; and what adjustments were necessary. Be sure that your analyses and conclusions are based on quantitative and qualitative data.
- Would your team have done things differently if given the opportunity? If testing is still ongoing, share any results gathered so far. What suggestions do you have to improve the project?

"Be the change you want to see in the world" -Mahatma Gandhi

Immediate Impact:

We started recording the performance of the "CRyTipLiq" initiative by measuring the liquids and cartons recycled at the end of cafeteria period for 4 weeks. We diverted 388.9lbs of waste when monitored, but only 288.2 lbs in the 2 weeks that weren't monitored. We realized that monitoring could have saved an additional 100.7 lbs of waste from going to the landfill!

To overcome this barrier, we shared carton recycling impact data with the students. We also conducted a pledge drive where 176 students signed the pledge and promised that they will recycle the cartons and tip their liquids when we weren't monitoring them.

We estimated that, by continuing this initiative at our school, we will be diverting 6170 lbs of waste from trash every year. This is equivalent to achieving a success rate of approximately 80% for our initiative. A 100% success rate (i.e., zero waste) would divert 7900 lbs of waste from trash due to this initiative. This is equivalent to saving 854136 sheets of paper, 7 trees, 3000 gallons of water, 1708 kw of energy, and 1.07 MT of CO2.

In our second classroom trash audit, the amount of liquids dropped from 21% to 8.5%. The liquid was mainly from afterschool juice boxes. We found only 3 cans and 2 bottles in the trash (not recycled) out of the whole day's trash. Our goal is to have 0% liquids and recyclables in the next classroom trash audit.

Long Term Impact:
We are working with our school district sustainability director to get all 19 schools in our school district to start our "CRyTipLiq" before the end of this school year. We have estimated that if our initiative gets replicated at all of the 19 Chapel Hill Schools we will be diverting 117,000 lbs of school waste from the landfill per year.

Our analysis also shows that 55% of our cafeteria trash and 40% of class room trash is compostable food waste. If we started composting at our school, we can divert 14,400 lbs of trash from our school going to the landfill each year (and more than 230,000 lbs from all CHCCS Schools). Since composting is not permitted on school premises due to health reasons, we have proposed to the sustainability director to use a private firm for composting school waste.

Citations:

1 - Carbon calculator https://docs.google.com/document/d/1s3z5ZpPJYTBeMgP-3wVVCprlhlFX_geVopEwKIUbtKY/edit

2- 1st and 2nd trash audit results
https://docs.google.com/spreadsheet/ccc?key=0AkUTxx6IsVw1dG5zZ3pjcVpWTlpjN3NENUlld0tBZkE#gid=6 ,
https://docs.google.com/spreadsheet/ccc?key=0AkUTxx6IsVw1dG5zZ3pjcVpWTlpjN3NENUlld0tBZkE#gid=4,
https://docs.google.com/spreadsheet/ccc?key=0AkUTxx6IsVw1dG5zZ3pjcVpWTlpjN3NENUlld0tBZkE#gid=2

3 - Tip Your Liquids Initiative Data
https://docs.google.com/spreadsheet/ccc?key=0AkUTxx6IsVw1dHlRMFZzYlBTbGVNSzkwaHlLQ0NVN0E#gid=0

4 - Recycling Calculator
https://docs.google.com/document/d/1pmdc6qimtWb_lWm0rDz2vf3XeHsqOo7DgVdoUxX7-kw/edit

Step 6: Share It!

- Tell us what impact your project had on your local community and how you got your community involved. Did the project generate interest and action by community members? Did interest and participation increase for the project through the use of social media and other tools? Do you have suggestions to expand the project? What other kinds of communities might benefit from

the team's conclusions? How can your newfound knowledge be shared with others who want to make their communities a better place to live?

- Be sure to explain how much time is recommended to complete the project, how you would share your solution and what sustainable/eco-friendly resources and materials you would recommend.

"The greatest gift is to give people your enlightenment, to share it. -Buddha

Our focus was on three communities: CHCCS Schools, city of Chapel Hill, and the state of North Carolina. We started sharing our knowledge and results by creating a website[1] for our school and local community. We also created a Facebook page[2] to attract students. We worked closely with our school teachers, cafeteria staff and custodians to successfully execute the CRyTipLiq initiative. Our weekly videos, e-newsletters, posters and morning announcements in our school were very useful in spreading the word around. We invited Murriel Williman, an expert from solid waste department, to give demos on worm and backyard composting at our school. This was attended by students, staff and parents.
We shared results of our initiatives with CHCCS Sustainability director David Dean, and will be making a presentation to green giants from other schools on April 4th. Replicating the success of our initiative at 18 other CHCCS schools will require increasing awareness among students through various media, cooperation from faculty, staff and custodians at school, volunteers to monitor the implementation, and an establishment of a green ECO club. We project that the CRyTipLiq initiative can be replicated at each school in a period of 2-3 months.

We created a community survey[3] to increase awareness about recycling, composting and our landfill closing. Our results showed that only 40% of respondents were aware that our local landfill was closing. The local Tar Heel newspaper covered our findings and an article on our research will be published in "The Chapel Hill News" soon. This will increase awareness and the need to act fast reducing the trash going to landfill. We also conducted composting demos at our city's major mall where we got lot of people interested in composting.
We gave a presentation to the city Mayor and the council members at the city hall meeting where we shared our results and requested for municipal composting. Our Mayor and representatives passed a resolution to consider our proposal[4].

We met State Senator Ellie Kinnaird and proposed to her to write a bill that will ban food in landfill in North Carolina[5]. We are excited to host her this week in our school cafeteria where she is going to encourage our school students to continue our initiatives. She took a lot of interest in our project and has invited us on March 18th to be introduced in State Senate by the Lt. Governor. This will help us get support for this bill.

Our project is in full swing and, before the landfill closes in July, we are hoping that we will make a big difference in our school, city and state.

Citations:

1 - http://sites.google.com/site/phillipsrecycleteam/

2 - http://www.facebook.com/pages/Phillips-Recycle-Team/141693719322903?ref=stream

3 - https://docs.google.com/spreadsheet/viewform?formkey=dEJ3cEdBc3RKblNfUlg0TVRUU09sZnc6MQ#gid=0

4 - http://chapelhill.granicus.com/MediaPlayer.php?view_id=7&clip_id=1765&meta_id=77955 (first 12 min of the video)

5 - Presentation to Senator in pdf file

Step 7: Attachments

- You may include attachments to provide more information. You may choose to upload one PDF containing materials to support your application.

  Index of links.pdf

- Additionally, you may include the link to one YouTube video that is two minutes or less.

  http://www.youtube.com/watch?v=FOv6RUKRxlI&feature=youtu.be

- Please briefly describe the information in your attachments

  Attachment contains weblinks to all websites, surveys, excel data, videos and presentations that were created during this project.