Science Symposium

"Where Creativity Meets Innovation"

ABSTRACT BOOK - 2023

Organized by

NBT Science Symposium Committee

(A Service Project of Agraj Seva Kendra)

Science Symposium

Sincerely thank

https://intellectionnj.com

for their generous support

Intellection's mission is to provide low-income children with the resources to succeed in STEM careers and give back to the community. Intellection works with local communities to provide under-represented and under-privileged students with the tools, resources, and opportunities to succeed in STEM careers

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Federal Bureau of Investigation (FBI) Community Outreach Program, Newark Office

https://fbijobs.gov/STEM

The FBI's Community Outreach Program supports the Bureau's investigative mission by working to address multiple interrelated societal problems.

NBT SCIENCE SYMPOSIUM 2023

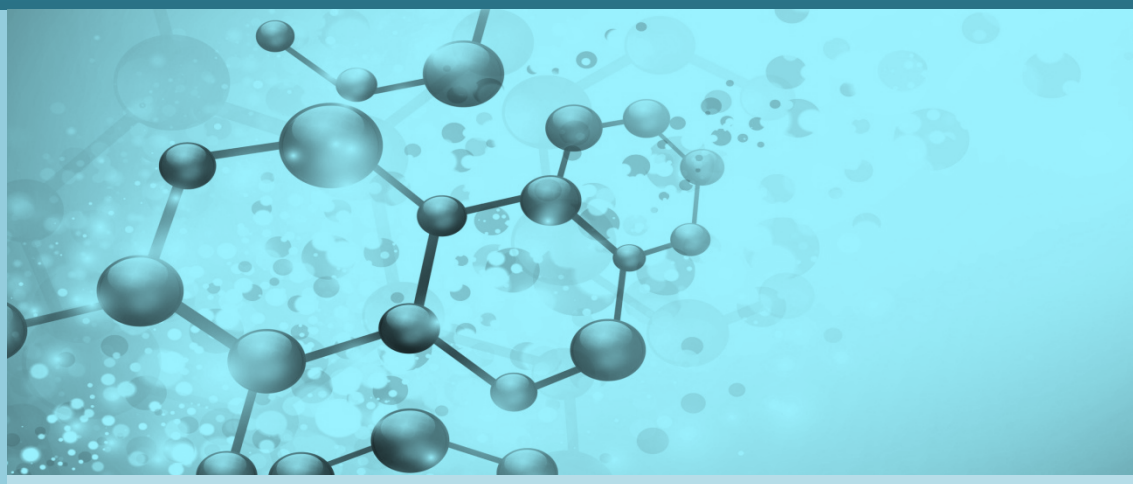
NBT
Science Symposium
Executive Committee Team

Gangadhara Rao Vakkalagadda
Chairperson

Surendar Reddy Revuri
Co-Chairperson

Kishore Mitikiri
Content Coordinator

Govinda Rajan
CEO-Agraj Seva Kendra



Message from Chairperson

Dear Friends,

It's my privilege to welcome you all for our 7th Annual NBT Science Symposium. NBT Science Symposium is designed to provide a platform for children Grades 3rd-12th in North Brunswick Township, an opportunity to present a scientific concept that they have explored and encouraging them to pursue science, keep seeking answers to difficult questions, continue learning and having fun.

The buzz topic in the recent past is "Artificial Intelligence or AI". The future of AI is incredibly promising and holds great potential for transforming various aspects of our lives. It has already started to disrupt the norms. For example, AI continues to automate routine and repetitive tasks across industries, leading to increased efficiency and productivity which frees up humans to focus on more creative and complex problem-solving activities. However, looking at the not so brighter side, this may lead to job loss and unemployment for individuals who were previously employed in those roles. There are always the secondary and tertiary effects to any scientific discovery, and AI is no exception. As AI becomes more commonplace, there should be an increased focus on ensuring its ethical and responsible development. This is the perfect time for the government to step in and provide framework and ascertain boundaries for this technology, so that this does not get out of hand and the adverse effects outweigh benefits. As scientist you should always keep in mind "science for humanity and humanity for science" Issues such as bias in AI algorithms, privacy concerns, and transparency in decision-making will need to be addressed to build trust and mitigate potential risks.

Let me conclude by acknowledging the efforts of everyone who helped make this event possible. The NBT science symposium committee members Mr. Surendar Revuri and Mr. Kishore Mitikiri have worked tirelessly, to plan and organize this event and I thank them sincerely for all their support. I would like to proudly acknowledge the partnership with Intellection to support this Science Symposium. I would also like to thank Agraj Seva Kendra for taking up such novel initiatives to support the community. I also want to recognize the continued partnership with the North Brunswick Board of Education, North Brunswick Township High School and the North Brunswick Township, because their support makes this event unique and experience possible.

I take the opportunity to convey my congratulations, thanks and good wishes to all the participants and their supporters for making this a successful event.

Good Luck and all the best!

Gangadhara Rao Vakkalagadda
Chairperson, NBT Science Symposium Committee

Messages

Govinda Rajan

Dear Brothers & Sisters,

On behalf of Agraj Seva Kendra and NBT Science Symposium Committee, I welcome you all to this Eighth Annual NBT Science Symposium.

According to New Jersey STEM Pathways Network, New Jersey students have not made statistically significant gains in fourth or eighth grade science since 2009. Also, students expressing interest in STEM show higher levels of college readiness.

Our goal is to provide an opportunity for students to apply creativity and critical thinking to the solutions of STEM beyond the confines of the classroom and excel. With that in mind, we have been conducting the Science Symposium for the past several years.

I thank the parents and students for their support and participation. I extend my gratitude to the Board of Education for their help and support in making this event a success. I thank the sponsors, judges, and the volunteers for their support. I congratulate the NBT Science Symposium Committee for their efforts in bringing out this event.
Sincerely,

Govinda Rajan
CEO, Agraj Seva Kendra

Janet Ciarrocca

Dear Friends,

On behalf of the North Brunswick Township Board of Education, it is with great pleasure that I welcome you to the 2023 NBT Science Symposium. NBTSchools supports and encourages exploration in scientific study, and more specifically in the areas of STEM: Science, Technology, Engineering and Math. We fully support wonderful community events such as the NBT Science Symposium. Such events allow our students the opportunity to explore their wonderings and expand their curiosity through scientific study. A huge thank you to the NBT Science Symposium Committee for continuing to encourage our students to explore various areas of science and for their consistent support of this annual event. Congratulations to all our NBT students for expanding their horizons through their science explorations
Sincerely,

Janet Ciarrocca
Superintendent of Schools
North Brunswick Township Public Schools

Dear Friends,

On behalf of North Brunswick Township High School it is my pleasure to welcome the greater North Brunswick School Community to the 2023 Science Symposium! We are very excited to host this wonderful event that gives North Brunswick students an opportunity to show off their creativity and interest in science across the school district! It is the students' interest in science at an early age that continues to shape our science department which has enhanced its course offerings over the past few years because of the large student interest in the sciences. We hope to continue to work together with the community to challenge students to explore science through events such as this and to consider future careers in the field upon graduation from NBTHS!

Sincerely,

Michael Kneller
Principal, North Brunswick Township High School

Michael Kneller

NBT SCIENCE SYMPOSIUM 2023

Program Schedule

Time	Activity
9 AM to 10 AM	Participants to pick up the registration packages and setup displays
10 AM	Judging Sessions begin **Room 1 Judges** • Frank Sweeney • Sachin Desai • Krystina Valdes • Barbara Wendell **Room 2 Judges** • Dr. Lucille O'Reilly • Abhay Navale • Todd Lanphear • Kabir Rekhi
10.30 AM	STEAMTank Presentations in the Commons
12.30 PM Program Moderator: Blisse Vakkalagadda	• Welcome address by Gangadhara Rao Vakkalagdda • Address by Mrs. Janet Ciarrocca, Superintendent of Schools • Address by Dr. Frederick Johnson, Director of Curriculum • Address by Intellection NJ Representative • Address by Abhay Navale • Address by Mrs. Krystina Valdes, NJ STEM Educator of the Year, NBTMS • Presentation by Community Outreach Team, Federal Bureau of Investigation, Newark Office, NJ • Vote of Thanks • Awards Distribution

Judging Time	Room 1		Room 2	
	Team #	Team Name	Team #	Team Name
10.00 AM	ES1	Inquisitive Minds	IMS1	Rocking Scientists
10.10 AM	ES2	GoGreen	IMS2	Hydroelectric Engineers
10.20 AM	ES3	Curious 4	IMS3	RAP Science Guys
10.30 AM	ES4	Acid Girls	IMS4	Science girls
10.40 AM	ES5	Magic Makers	IMS5	Science Nerds
10.50 AM	ES6	The Future Einsteins	IMS6	Sisters N' Science
11.00 AM	ES7	Rock Girls	MS1	Innovative Thinkers
11.10 AM	ES8	Soil Saviors	MS2	STEMinists
11.20 AM	HS1	Bio Bosses	MS3	Contributors to Science (C2S)
11.30 AM	HS2	JayPat	MS4	Brainy-Badgers
11.40 AM	HS3	The Ionic Innovators	MS5	Math Cubers
11.50 AM	HS4	The Genetic Geniuses	MS6	Geo Engineering Minds (GEMs)
12.00 PM	HS5	Algae RANGers		

Abstracts

Elementary School Projects (Grades 3-4)

Team: Inquisitive Minds (ES1)
Title: Can the water flow up?
Participants: Ananya Meda, Aryan Vuggini, Dhruva Yarlagadda, Siddharth Oza and Taksh Patel

Objectives/Goals: Is it a trick or is it magic? No…. Its Capillary action, the amazing science that causes liquid to flow upwards. Capillary action can be defined as the movement of water within the spaces of a porous material.

Materials/ Methods: Place the plastic cups at the same distance from each other. Fill alternate cups with equal amounts of water. Add 3 drops of different food color into the alternate cups with water. Take the tissue and fold it lengthwise. Place one end of the tissue in the colored water cup and the other end into the empty cup next to it. Repeat this until you have placed the last tissue that drapes over from the 6th to 7th cup.

Discussion/ Conclusion: What do we think will happen next? The water moves up to the tissue through a process called capillary action. The water can move upward against gravity because of properties of water like cohesion, adhesion and surface tension. The gaps in the tissue act like capillary tubes and pull the water upwards. Soon you will be able to see that the water has crawled all the way up to the paper towel and is beginning to walk back down into the empty cup next to it. Since the cup on either side of an empty cup has colored water in it, the two colors begin to mix in the empty cup.

Summary: This project helps us understand how water can not only flow down but also flow up against gravity with the help of other supportive forces. Capillary action occurs in plants, body parts, natural formations etc.

Team: Go-Green (ES2)
Title: Sustainable Development
Participants: Divyansh Sharma, Varun Mandava, Ishan Shrivastava and Trisha Chourasia

Objectives/Goals: To learn different aspects of sustainability, including waste reduction, energy conservation, clean energy generation, environmental protection and contribute positively to the environment.

Methods/Materials: The common materials used for this project include things that can be easily recycled, like cardboard boxes, popsicle sticks, plastic straws, and paper. We also used natural materials such as cotton which is biodegradable and can be sustainably sourced.

To demonstrate the idea, we used model solar cells and model windmills as sources to generate clean energy. We attached solar panels to each building and placed windmills alongside highways which can generate clean energy. We also modeled a green area to show the importance of greenery. We should plant many more trees to keep our environment clean. We also modeled the idea to reuse carbon dioxide for energy generation which is emitted from factories.

Results: Using the model, we learn and educate the ways to use natural sources for clean energy. It will protect natural resources by recycling waste, conserve energy, and reduce pollution footprint. It will help sustainable economic growth as it reduces pollution and waste generation. It will ensure a better life by promoting clean air, water, and soil to our future generations.

Conclusion/Discussion: This work presents a model for sustainable development and different requirements to keep our earth clean. It showed how we can reduce waste, use natural resources for clean energy, recycle waste and plant trees for clean earth. Using the approaches described above for each community, we can model the whole city and stay clean and healthy.

Summary: This project attempts to reduce waste, reduce pollution and increase the use of renewable energy. These are building blocks for sustainable development.

Team: Curious 4 (ES3)
Title: Water Filtration with Activated Charcoal
Participants: Naman Venugopal, Kabir Gupta, Ranvir Gupta and Nityam Porwal.

Objectives/Goals: The study is aimed at understanding the method of water filtration using activated charcoal.

Materials/Methods: Cut open the bottom of a large plastic bottle and keep it inverted on the bottle base. Put in, first layer of coffee filter followed by a layer of cotton cloth. Add some chunks of activated charcoal. Lastly, put a layer of sand/ pebbles. Pour some dirty water/ vinegar through the funnel. Put the clean water/ less odor vinegar into the bottle base.

Results: When the dirty water passes through the layers of the filters added along with the activated charcoal, the water gets filtered with less odor.

Conclusions: This experiment allowed us to see what materials can be effectively used in the process of water filtration at domestic level at a low-cost option and with no extra resources used, like electricity.

Team: Acid Girls (ES4)
Title: Effect of Acid Rain on the Environment
Participants: Shreya Cheruku and Allyson Reyes

Objective/Goals: Our goal is to find out what happens to plants when it comes in contact with acid rains. We did an experiment to find out what happens to plants when they come in contact with acid rain.

Materials/ Methods: In the first glass we poured the water to the top. In the second one we poured water halfway through and then poured vinegar to fill the remaining part. In the third glass we poured vinegar to the top. Next, we put three leaves in each cup. We observed what happened to each cup of leaves over 24 hours.

Results: We found out that the cup that is completely water stayed green, the one that is slightly acidic turned a little black, and the one that had completely acidic turned black all over.

Conclusions: When plants that come in contact with water with even a little bit of acid turn black. This shows that water with acid in it can be potentially deadly for the environment and can destroy the ecosystem.

Summary: This project shows that acid rain is really bad for the environment, and we should avoid acid rain at all costs. We should use more renewable sources like solar energy instead of using fossil fuels to reduce pollution.

Team: Magic Makers (ES5)
Title: Earthquake Experiment
Participants: Maya Saha, Maha Sheikh and Akshaya Kanna

Objective: Our topic is how we can build the sturdiest structures in earthquake areas.

Hypothesis: Our hypothesis was that the smaller building will be stable while the taller building will be unstable. We thought this because smaller buildings have a wider and more stable base than taller buildings. Also, because taller buildings are usually in the air and are more exposed to wind.

Materials/Methods: For the experiment we made red jello and took marshmallows and toothpicks and built houses using these tools. We connected the marshmallows and toothpicks together into cubes to form buildings. We made two red jello pans. The jello represents the ground which moves during an earthquake. In one pan we made a small building and in the other one we made a tall building. We shook the container to show how the "ground" moves.

Results: In our experiment when we made the tall building it looked stable but when we shook the pan it fell. The big building wobbled a lot but the pan with the smaller building stayed intact because it was lower to the ground.

Conclusions: This experiment can help scientists and architects understand that maybe it is best not to build tall buildings in earthquake areas. Also, it can help them build a bigger, stronger base for taller buildings. Our project can help them design buildings in the best way. If we construct buildings, small or big, with a stronger foundation, it can save people's lives.

Team: Future Einsteins (ES6)
Title: Hurricanes vs. Tornadoes
Participants: Bibodh Shrestha and Samay Makam

Objectives/Goals: Our goal is to compare and contrast the different characteristics of hurricanes and tornadoes and find similarities and differences between the two. We will also build models to demonstrate how these natural disasters work.

Methods: Using theoretical research to compare various characteristics like size, duration, strength, etc. as well as building models.

Materials/ Methods:
Tornado:
- One Clear Plastic Bottle
- One Drop of Clear Liquid Soap
- Cap Size Amount of Vinegar

Hurricane:
- One Clear Glass Jar
- Water
- 1-2 Drops of Food Coloring

Shake and swirl the bottle in a circular motion to form the Tornado.

Results: Results of the research will be presented at the science symposium.

Team: Rock Girls (ES7)
Title: Rock Candy Crystallization
Participants: Hawwa Tahir, Isra Naeem, Ayla Naeem, Sara Mortigo and Iniya Ramachandran

Objective: The purpose of our experiment is to grow crystals in a saturated sugar and water solution. Compare the rate of growth between rock candy that is left to grow on its own in the solution, and rock candy that starts off with a sugar seeded coat.

Hypothesis: We hypothesize that the skewer with a coat of seed crystals (or sugar), placed in the saturated sugar-water solution, will aid the solution into forming crystalline rock structures at a faster rate than the skewer with no seed crystals present.

Materials/ Methods: Prepare the wooden skewers. Soak the skewers in water for at least 5 minutes. Remove the skewers from the water. Coat one skewer in granulated sugar and set it aside. Add hot water to glass jars. Boil enough water to fill the jars. Add 2 cups of water to a pot. Bring water to a boil. Turn heat down to low. Add 1 cup of sugar, but gradually while mixing until dissolved.
Turn heat back up until it boils and stir. Continue to add an additional cup of sugar, gradually while mixing. Remove pot from burner, allow solution to cool for 5 minutes. Pour out the hot water from the glass jars. Pour water from the pot into the glass jars. Add food flavoring and food color. Mix well.
Move jars to a place where they will be undisturbed. Avoid areas where temperatures may change such as windowsill or vents. Place seeded skewer into one of the jars and clamp with clothespin to keep it from touching the bottom of the jars. Repeat with an unseeded skewer and clamp with clothespin. Cover jars with a paper towel.
Note down observations from Day 1 to Day 4. Measure the size of the growth.

Results: Seeded Skewer in the supersaturated solution: Day 1 – No growth, Day 2- Sugar crystals began to form. Day 3- Sugar crystals began to grow larger Day 4-Sugar crystals grew even larger as more of the skewer was covered in crystals.
Unseeded skewer in the supersaturated solution: Day 1 – No growth. Day 2- No sugar crystals. Day 3- Minimum growth of crystals. Day 4- Very Little growth observed.

Conclusions: Our hypothesis was correct. The jar with the seed crystal solution grew faster. We saw that by Day Four there was little growth in the non-seeded stick, but the seeded stick had grown so much since Day One.

Team: Soil Saviors (ES8)
Title: Soil Savior
Participants: Satvik Parvatikar, Dravi Jain and Shriyanns Pedditi.

Objectives/Goals:
In this experiment, we create a simple model of the soil with and without vegetation. Observe how soil erodes when water is run through each system. The experiment demonstrates the importance of vegetation in saving the soil from erosion.

Materials /Method: Prepare three large plastic bottles by cutting a rectangular hole roughly 7cm x 25cm along the side of the bottle. Align the bottles side by side.
Fill the first bottle with plain garden soil with grass planted, second with mulch (bark chips, dead leaves and sticks) and last with plain soil. Press down firmly to compact it. Tie 3 small bottles to each large bottle with strings to collect water. Pour water to run down the bottles and observe. Make observations and record your findings about which bottle held the most water, and what the water looks like in each catch bottle.

Results: The water collected in the catch bottles attached to bottles with plants was less and clearer compared to other two bottles and water collected with only soil was more and muddy.

Conclusions/Discussion: The Plant roots hold the topsoil and prevent the soil from getting eroded, the mulch and dead leaves too protect the soil and prevent them from getting into water systems thereby supporting vegetation. The experiment clearly demonstrates how water gets eroded without vegetation.

Summary: Soil erosion is a critical environmental problem throughout the world's terrestrial ecosystems. Erosion inflicts multiple, serious damages mainly in managed ecosystems such as crops and pastures. Erosion reduces the water holding capacity because of rapid water runoff and reduces soil organic matter. As a result, nutrients and valuable soil biota are transported. The experiment proves the importance of plants in our ecosystem thereby making them the "Soil Saviors."

Intermediate Middle School Projects (Grades 5-6)

Team: Rocking Scientists (IMS1)
Title: Hydro Power Generator
Participants: Ishaan Machavaram and Abhinav Malepati

Objective: This study is to determine that electrical power can be produced using the energy of flowing water and to determine the advantages of using clean energy over energy produced using coal, fossils etc.

Materials/ Methods:
- Cardboard/Cardboard box
- Wire, LED lights
- Water tubes / Plastic straw
- DC generator
- Aluminum foil / Aluminum sheet
- Craft paper and paint colors
- Glue / Glue Gun
- Plastic Sheets
- Play dough

Hydropower is the generation of electricity using the energy of flowing water. The steps for generating electricity using flowing water.
- Water is stored in a reservoir.
- Then it is released using a penstock.
- The released water goes through a turbine which is connected to a generator.
- The generator converts the mechanical energy into electrical energy.
- Then electrical energy is transmitted using a transformer, which can be used for multiple purposes.

Results: Our experiment proves that electricity can be produced using flowing water.

Conclusions: Our research concludes that electrical power can be generated using flowing water and as a part of my research we should encourage the usage of clean sources of energy like solar, wind or hydropower which would help in reducing pollution.
The reservoir used to store water can be used for multiple purposes. It can be used to supply water

for agriculture or recreational purposes like for boating, fishing or other water activities.

Team: Hydroelectric Engineers (IMS2)
Title: Eco-Friendly Hydro Energy Model
Participants: Rishab Patel and Kandarp Porwal

Objectives/ Goals: In order to create electricity on a daily basis and help places that don't have lights, we will be using a renewable energy source, a hydro-generator, which works because of the water flowing through the pipe.

Methods: In this project, a hydro-generator with a turbine will be attached within a pipe used to give water to a faucet. When the water passes through the pipe carrying kinetic energy, the turbine will spin. This will transform kinetic energy into mechanical energy. There is also a D.C motor attached to the turbine. So, when the turbine spins, the motor's rod will also spin and produce electrical energy.

Results: The D.C motor in the generator collects all of the kinetic energy and turns it into electrical energy. Energy is not created within the system; it's transferred from water into electricity. That energy is then sent through a wire and is stored in a rechargeable battery for reuse and can be used to turn on a light with the flick of a switch.

Conclusions: Using hydropower in daily life can allow many people to produce free electricity, reduce electricity bills, and add to the eco-friendly cause against global warming. This concept is similar to using water dams to produce large amounts of electricity. Saving energy and using cleaner energy sources reduces the use of fossil fuels and the production of carbon dioxide and other greenhouse gases to combat climate change. Installing this project around the house, such as in kitchen taps, bathroom sinks, and shower heads can maximize storage of electricity and provide small amounts of power periodically.

Team: **RAP Science Guys (IMS3)**
Title: Smart Irrigation System
Participants: Ajitesh Tiwari, Rivan Ghimiray and Priyansh Patley

Objectives/Goals: The objective of this study is to develop a smart irrigation system using sensors which moisture soil level according to plant requirement.

Materials: Arduino UNO, Power Relay SPDT, SparkFun Soil Moisture Sensor with Screw terminals, Arduino IDE software app, Soldering iron, DC motor, Tweezers.

Method: In an automatic plant watering system we are using an Arduino microcontroller to control and sense or measure the moisture in the soil using soil moisture sensor. The soil moisture sensor is a sensor {basically a resistor} which varies the value when it contacts the moisture.
First, we calibrated the sensor into different moisturizing conditions of the water. We checked it in the water also. Now we have some value from the different conditions. We made the code according to the value and put these values in the if condition of the code and this if condition decides if the pump will work or not. Data of various sensors like- moisture sensor, temperature sensor, humidity sensor will be displayed on BOLT cloud in graphical form but due to limitation of BOLT we have only displayed one sensor data (moisture sensor data).

Results: The smart irrigation system was tested on an artificial small plot with different situations. The moisture value of the soil moisture sensor is set to very low (i.e., 200) in the IDE code of 328P microcontroller and it is functioning properly. In addition to this, the real time data of the moisture sensor is displayed in graphical form on the BOLT cloud page.

Conclusions/ Discussion: The project concludes that automation of irrigation systems will become easy and comfortable for farmers to operate the irrigation at remote locations i.e., from home. Not only this, but it will also prevent water wastage and would help in sustaining productivity, increasing the yield.

Summary: This project attempts to make a self-watering plant system based on the soil moisture level. Also, the future aspect of this

model can be made into an intelligent system, wherein the system predicts user actions, rainfall pattern, time to harvest and many more features which will make the system independent of human operation.

Team: **Science Girls (IMS4)**
Title: Hydraulic Arm
Participants: Mahek Sharma and Sahasra Cheruku

Objective/Goals: This project aims to find a more environmentally friendly machine to manufacture products in a growing and changing environment. As 30% of the U.S.'s greenhouse gases are caused by factories. It's important to find a way to decrease the pollution released into the air by these factories and overall, all oil fueled systems.

Materials/ Methods:

- Cardboard,
- 8 syringes with a rubber piston
- Battery
- 4 pipes
- Popsicle sticks
- Hot Glue
- Water
- Empty Coca-Cola can

First, we cut out all the pieces of cardboard needed. Then, we drilled holes on each end of the specific cardboard pieces. Then, we connected the two rectangular pieces using two skewers and attached two syringes. This step was repeated three times. The structures got attached in an armlike format. We continued to adjust the arm until it could move without any difficulties. The arm of our project is now steady. We then drilled a hole into a 10ml syringe and attached it to the arm. It was loose enough to stick to the cardboard, but at the same time allow the arm to move within its limits. Next, we cut out the arm parts and attached the pieces using popsicle sticks, metal rods, and glue. That later got attached to the arm with a hot glue gun. After that, we made a platform for our project to stand up by itself. We cut out large cardboard squares and placed an old battery in the center to allow the movement of the arm. When that was done, we took popsicle sticks, small cardboard pieces, toothpicks, and a syringe to limit where the arm can carry and drop the items.
We made the controls for the arm using multicolored water and syringes, which got attached to popsicle sticks, toothpicks, and cardboard. Of course, it wouldn't be able to stand by itself yet, so we made a platform and hot-glued the syringes to the platform. The syringes in the arm are empty, and we did that purposefully. We connected all four of the controls to the empty syringes on the arm so that when you push the popsicle sticks, the water will get pushed into the empty syringes, causing the arm to move.

Conclusions: Acting swiftly in the battle against climate change is crucial, and the hydraulic arm has shown that it is the top choice for environmentally conscious individuals. Not only does this machine boost impressive efficiency, but it also leaves a small environmental footprint. Additionally, it doesn't emit any greenhouse gases, making it a superb option for those who prioritize the health and sustainability of our planet.

Team: **Science Nerds (IMS5)**
Title: Effects of Greenhouse Gases
Participants: Karunya Gujja, Ruhitha Anand, Visesha Pasumarthi and Kshipra Lakkavajhala

Objectives: We all hear about the terrible effects of global warming due to the increase in greenhouse gases, but how do greenhouse gases really affect our planet? In this project we want to study how an increase in greenhouse gases affects the temperature in a closed environment.

Methods: From the research, we learned that greenhouse gases absorb and radiate the heat energy reflected from earth's surface; this happens because of the molecular structure of greenhouse gases.
For our experiment, we chose one of the greenhouse gases, Carbon Dioxide; we had two identical plastic containers, one was empty and the second one filled with carbon dioxide (CO_2). We exposed both containers to heat lamps and measured the changes in temperature using

thermometers. Our hypothesis was that an increase in the amount of CO2 will cause an increase in the temperature in the container.

Conclusions: The experimental results supported the hypothesis that an increase in carbon dioxide caused an increase in the temperature.

Team: **Sisters N' Science (IMS6)**
Title: Water Purification System
Participants: Kimberly De Leon, Madison Kwiatek and Susan Onyameh

Abstract not available
Title: We can build a water purification system out of everyday materials.

Middle School Projects (Grades 7-8)

Team: **Innovative Thinkers (MS1)**
Title: ChatGPT Hype or Real?
Participants: Ojas Shrivastava, Gaurav Naira and Anish Sinha

Objectives/Goals: ChatGPT has taken the internet by storm due to its human-like conversational abilities. From answering simple to complex questions, like telling jokes, writing a poem, or even writing songs in the styles of different singers, ChatGPT does almost everything, like a human speaking back to you. But can ChatGPT give answers accurately, ethically, and contextually? Can educational institutes, hospitals, governments, businesses, and others confidently adopt ChatGPT?

Method/ Materials: We will base our research using these categories:

- Bias / Ethics
- Hallucination
- Misinformation
- Fraud
- Spam/Phishing
- Lack of Explainability.
- Security

To conduct our research, first, we will collect the questions, organize them in the above categories, and analyze them with various techniques. We need an internet connection, an Open AI account, a Google account to analyze the data, and the device to access the ChatGPT interface.

Results: Innovative Thinkers will research these burning questions on ChatGPT, collect the answers, and compare them with other conversational AI techniques to create a point of view, using spreadsheets to help organize our questions and answers.

Team: STEMinists (MS2)
Title: The Human Heart
Participants: Mahati Vemula, Poorna Thogulava, and Saanvi Singh

Goals: This presentation is primarily to help raise awareness related to this vital organ, as it serves various purposes that many are unknowledgeable about. We hope to bring greater attention to heart diseases, as it is a leading cause of many casualties. Leverage this presentation as an opportunity to reinforce the message to participants on some quick, but essential lifestyle changes to protect yourself from a range of possible heart diseases.

Materials/ Method: The method that we used was to build an experimental pump mechanism with a syringe which would serve as a functional replica of the human heart. The heart's ventricle is depicted by the syringe, and the muscle that contracts and pumps blood from the heart, by the plunger. The blood vessels leaving the heart are modeled by connecting the syringe to tubing. The model is expanded with extra elements to show the various parts and functions of the heart, such as valves and chambers.

- Human torso body model
- Paper / Cardboard
- Colors
- Tube connectors / Syringes

Results: By making this model, we expanded the viewers' knowledge on the fundamental parts of the human heart. This replica diagram allowed us

to further gain insight into diseases that form in the heart.

Conclusions: The human heart is a vital part of the body as it is the primary source that keeps our body functioning and alive. Many maladies ought to occur to all of us, but knowing more about our body in general can help keep our body safe and open us up to newer forms of learning methods.

Team: Contributors to Science (C2S) (MS3)
Title: The Power of Wind
Participants: Anagha Meda and Pranav Oza

Objectives/Goals: Having clean, renewable energy has got a lot of people talking about wind power. Wind power is collected using wind turbines and converted to other energy forms. Our goal is to experiment which blade size produces more energy.

Methods/Materials: We used 1L and 500ml plastic bottles, marbles, drill, paper, straws, ruler, glue, tape, paper clip, string, fan and scissors. We cut the top and sides from the 1L plastic bottle and added marbles in it. On the 500ml bottle drill 2 holes (one in the cap and other in the bottom). We attach the 500ml bottle horizontally over the 1L bottle. To create the blade straw, we cut two 'x' cm by 'y' cm pieces of paper and taped it on each end of the straw. We carved the blades in opposite directions. To make the axle we folded a paperclip into a T shape. Tape this T-shaped paper clip to the middle of the blade straw. Fit a straw onto the bottom of the T-shaped paper clip. Tape this straw to the blade straw. To make the other half of the axle take a new straw and tape a paper clip at the end and tie a string with some weight attached to this paper clip. We connect the straw with the weight to the T shaped assembly through the 500ml bottle. When the fan(wind source) is turned on the blades in the axle turn around to pull the weight up. Repeat the above process for different blades.

Results: We concluded that longer blades are more efficient and produce more energy. This shows how wind energy can be converted to mechanical energy.

Conclusions: By doing this experiment we understood that the design of the blades play an important role in the amount of generated energy.

Team: Brainy-Badgers (MS4)
Title: Smart House
Participants: Nethra Gujja, Ayush Sharma and Subramanium Vignesh

Objectives/Goals: This study is aimed to find a way to make a system that is secure, can conserve resources, simplifies life, and increases comfort for the homeowner.

Methods/ Materials: The common materials used include Arduino Uno, servo motors, LED lights, LDR sensors, proximity sensors, and Smoke Detector. A model was constructed using foam board. To demonstrate the function of various smart features, we are using Arduino Uno as the brain of the project. Sensors like smoke detectors, light detectors, and infrared sensors detect the scenarios which provide input to UNO. Smart actions are then generated based on the input. When the smoke detectors detect any smoke, the UNO would turn on red lights to signal the danger. The light detectors are used to detect daylight. Based on its input UNO would turn on the lights. An automatic door opens based on the proximity sensor which would detect an incoming car.

Results: Energy consumption can be reduced exponentially when smart devices run your home.

Conclusion/Discussion: This work presents an overview of smart home projects. It showed the significance and limitations of smart home building blocks. In future it would be connected to various service providers to automate services. Smart Homes are the future as current trends indicate. We created a finished product that combines technical, engineering, computer programing, and demonstrates the practical results. Using the approaches described above, we can model relevant processes and implement similar technologies in real life. We learnt to develop a self-created system that provides

security, comfort, economy, and efficiency in managing our home.

Team: Math Cubers (MS5)
Title: Math in Rubik's cube
Participants: Nandan Kamalakannan and Nandita Kamalakannan

Objectives: The aim of this project is to analyze and understand the mathematical concepts involved around Rubik's cube.

Materials and Methods: We tried to explore the mathematical concepts behind Rubik's cube. A Rubik's Cube is essentially a permutation puzzle. We understood the mathematical formula involved in figuring out the number of permutations of the cube. We took 3*3 cube and 2*2 cube for our study. We figured out the formula that resulted in more than 43 quintillion combinations for the 3*3 cube and 3674160 combinations the 2*2 cube. We analyzed Rubik's Cube using group theory, a branch of mathematics. We executed mathematical properties such as Associative, Neutral, Inverse, commutative etc. We explored the algorithm involved in solving the Rubik's cube. There are many different algorithms that can be used to solve the cube. These algorithms are often based on group theory, permutation theory and can be quite complex. Finally, we were able to solve the Rubik's cube which we thought it's almost impossible.

Results: Rubik's cube is not just a toy or puzzle. There is indeed a lot of math involved in solving the Rubik's cube, including group theory, permutation theory, and algorithms.

Conclusion/Discussion: To conclude, the Rubik's cube is a fascinating puzzle that involves a lot of math, including group theory, permutation theory, and algorithms. By understanding these mathematical concepts, it is possible to solve this magical cube and appreciate the beauty of this 3D puzzle.

Team: Geo Engineering Minds (GEMs) (MS6)
Title: Geoengineering
Participants: Jay Pindipol, Ajay Sridharshan Arun Kumar and Davinder Singh

Objective: Geoengineering is a form of climate engineering or human climate intervention that seeks to alter long-term trends in Earth's climate. Geoengineering is a form of climate engineering or human climate intervention that seeks to alter long-term trends in Earth's climate.

Materials/ Methods: There are different methods of geo-engineering.

- Carbon dioxide removal (CDR)
- Solar Radiation Modification (SRM)
- Passive daytime radiative cooling
- Ocean geoengineering
- Iron fertilization
- Submarine forest

Current geoengineering technologies mostly focus on two categories: solar geoengineering and carbon capture.

1. Solar geoengineering: solar radiation management (SRM), this form of geoengineering seeks to block incoming solar radiation and send it back out to space. Doing so will theoretically reduce global temperatures. Solar geoengineering research has focused on marine cloud brightening (where clouds are sprayed with seawater), stratospheric aerosol injections (where added sulfate molecules in the stratosphere would reflect incoming light) and launching giant mirrors into orbit to reflect sunlight. Simpler methods with greater feasibility include painting roofs and streets light colors so as to reflect sunlight rather than absorb it.

2. Carbon capture: Carbon geoengineering seeks to remove carbon-based greenhouse gases from the atmosphere and stratosphere. It goes beyond simple emissions reduction and enters the realm of negative emissions. Some carbon capture methods are relatively simple, such as reforestation, afforestation (introducing trees to a region where they did not previously grow), and forest restoration to capture carbon in the form of biomass. Other carbon geoengineering methods

involve pulling carbon dioxide from ambient air and storing it in pressurized underground caverns. Still other carbon research programs have studied the prospect of iron fertilization, wherein iron is scattered across the ocean to stimulate the growth of carbon-absorbing phytoplankton.

Results: Geoengineering, in the form of both carbon dioxide removal (CDR) and solar radiation management (SRM), stands to offer many climate impacts.

- Actively reverse climate damage. Methods like emissions reduction and forest conservation serve as forms of mitigation, but they do not actively reverse damage done by human behavior. Proponents of geoengineering argue that the technology could offer a true reversal.
- Rapid results. Certain geoengineering methods, such as seeding the ocean with iron particles or pumping aerosol injections into the atmosphere, could lower average temperatures on the planet faster than could be achieved by changing human behaviors.
- Create jobs. Geoengineering research and geoengineering initiatives create jobs for scientists, engineers, and other workers.

Conclusion: Geoengineering is a new concept, and many initiatives only exist on theoretical or small-scale terms. This poses certain drawbacks.

- Geoengineering introduces unknown climate risks. Projects could alter Earth systems in unintended ways. Since the side effects of iron seeding or aerosol injections cannot be fully known unless put into practice, these initiatives present moral hazards to scientists.
- It may be ineffective. Geoengineering projects involve unproven technologies. Until these technologies are thoroughly proven to work without deleterious side effects, they must be regarded with skepticism.
- It may be financially unfeasible. Some forms of geoengineering, such as reforestation, are comparatively affordable and easy to implement. Others require enormous government investment and public will.

High School Projects (Grades 9-12)

Team: **Bio Bosses (HS1)**
Title: DNA Sequence analysis of Duckweed plant
Participants: Saloni Agshiker, Akshita Krishnakumar, Devashree Parambath, Sk Shadman Abdullah and Daniel Benimovich

Objective/Goal: Our research project focuses on the DNA sequence analysis of genes from the duckweed plant, Landoltia punctata, and how it compares to genes found in other species.

Methods/Materials: To isolate the DNA sequence, we performed a PCR and miniprep reaction using microfuges, dilution tubes, ddH2O, microcentrifuges, buffers, and pipettes. We then performed a restriction digest and agarose gel electrophoresis using buffer, enzyme, loading dye, agarose gel, and ethidium bromide to determine the quality and length of the sequence. We conducted literature searches and bioinformatic analysis on our sequence through the NCBI database and Protein Data Bank to determine its function, structure, protein interactions, localization, and if a human homolog exists.

Results: Succeeding agarose gel electrophoresis and PCR, the unknown sequence was determined to be coding for carbonic anhydrase, an enzyme which functions to minimize resistance to diffusion of CO2 from stomatal air spaces, where CO2 is initially absorbed, to stroma where carbon is fixed by enzyme RuBisCO.

Conclusions / Discussion: Based on literature research, carbonic anhydrase is classified into three major groups, specific to the type of organism: alpha, beta, and gamma carbonic anhydrase. Although each type may vary in its structure, the function is relatively similar among all types which indicates the biological importance of this molecule to all organisms. If this protein was absent in plants, excessive water loss and dehydration would occur to compensate for the lack of carbon dioxide diffusion through the stomata. In our next experiment, we would determine the other proteins that interact with carbonic anhydrase in Landoltia punctata through

protein co-purification and protein sequencing. This could provide further insight into the function of carbonic anhydrase.

Team: **JayPat (HS2)**
Title: Martian Madness
Participants: Amruta Jayaganesh and Nishi Patel

Objectives/Goals: This project aimed to determine whether Martian atmospheric conditions would allow habitation in direct comparison to atmospheric conditions on Earth.

Materials / Methods: Plant 1 (control) and Plant 2 (experimental) were labeled. Baking soda was dissolved in a bottle of vinegar to produce carbon dioxide (CO_2) and was harnessed using a balloon. Plant 2 was placed in a pot with rocks and soil and was placed underneath a glass jar as CO_2 was released inside, simulating low pressure. Plant 2 was surrounded with ice to simulate low temperatures and was kept on a windowsill to simulate low sunlight. Plant 1 was given the same soil and placed in direct sunlight to demonstrate the effect of an Earth atmosphere. The temperature in the pots were measured using a thermometer, and plant growth was recorded for seven days.

Results: Plant 2, placed in Martian atmosphere, had a stunted growth by a few centimeters, in comparison to Plant 1, placed in Earth atmosphere.

Conclusions/Discussion: Plant 2 had less growth and began to wilt since it was not fit for the environment. The results of this study imply that a Martian atmosphere has a significant impact on habitation. Low air pressure/temperature and high CO_2 levels are harmful to Martian life. In this case, a lack of oxygen and nitrogen impairs the plant's ability to photosynthesize, resulting in stunted growth. Water evaporates quickly because of the higher temperature within Plant 2, which is a probable cause of withering and dehydration.

Summary: This project attempts to analyze habitation in a Martian environment by using a simulatory experiment to analyze plant growth in low pressure and high CO_2 content conditions.

Team: **The Ionic Innovators (HS3)**
Title: Venoms in Cancer
Participants: Aanya Muniyappa, Meenaa Ram, and Anusha Vakkalagadda

Objectives/Goals: Many venoms have the ability to kill cancer cells in their own ways. Such animal venoms include: scorpion, spider, snake, bee venom, etc. We will be researching and modeling the effects of these venoms on cancer cells and will be exploring the chemical structures that allow this to occur. Our goal for this project is to find and compare the molecular structural components which are needed for anti-cancer activity.

Materials: Computer software and molecular structures

Methods: By using computer software, we will find patterns in the structures of the venom molecules in order to identify if a core structural component is responsible for its anti-cancer activities.

Results/Conclusions: Will be discussed at the Symposium

Team: **The Genetic Geniuses (HS4)**
Title: Analyzing the Effects of Genome Editing and Genetically Modified Organisms
Participants: Yashvi Patel and Sunidhi Mitikiri

Objective/Goal: We will be researching the process of genetic recombination and DNA.

Materials/Methods:

- 1⁄2 peeled ripe banana & 3 strawberries.
- Narrow glass cup
- 1⁄2 cup hot water
- 1 tsp salt
- 1⁄2 tsp dishwashing soap
- Rubbing alcohol
- Resealable plastic bag
- Coffee filter

Procedure: Perform twice with strawberries & bananas:

- Mush banana/strawberries in resealable bag.
- Fill the cup with hot water and salt.
- Pour saltwater into the bag and squeeze the mixture together.
- Add dishwashing soap into the bag and mix.
- Secure coffee filter around the clear glass and pour the mixture in.
- Slowly add cold alcohol along the side of the cup to create a layer of alcohol above the mixture.
- Wait for 8 minutes and observe bubbles and cloudy material moving around within the alcohol layer. They are the DNA segments clumping together.

Results: Our initial goal was to merge the DNA of a strawberry with the DNA of a banana to create a new hybrid fruit. After researching, we realized this is only possible in a controlled lab setting with specialized materials. We began studying how gene editing works and how it is possible to merge DNA to create a transgenic organism. Many fruits and vegetables that we eat (like apples & potatoes) have been genetically modified to increase nutrition, supply of food, and taste. The consumption of genetically modified fruits has been controversial for years and its safety continues to be studied.

Conclusion/Discussion: Genome editing has been explored in ways such as modifying the genetic DNA of the bacterium E-coli to prevent and treat human diseases, and even by selecting or altering genes associated with disease in the genetic makeup of a baby.

Team: **Algae RANGers (HS5)**
Title: The Biochemistry Behind Eutrophication Prevention
Participants: Rhea Palliath, Gabriella Seiden, Naachammai Ramu and Aruhi Vakkalagadda

Objective/Goals: Our goal is to address the global issue of eutrophication by removing harmful algae from bodies of water and repurposing it as a biofuel. As we have been working on this project since last year, this year we would like to place a special focus on researching the biochemistry behind turning algae into biofuel and we will try to develop it ourselves in our school's lab.

Methods/Materials: We will use our previously designed pathway that includes algae fermentation to test the process and to see if it can become a viable fuel source. We will collect harmful algae and attempt to convert it to a source of fuel by steaming it, using a hot plate, Bunsen burner, drying oven, or other forms of heat.

Results: Our goal this year is to focus on creating a biofuel by fermenting the algae under ideal conditions. We want to focus on the second step of our two-step solution which is repurposing the algae. We look forward to sharing our results at the symposium!

Discussion: Repurposing biofuel as fuel to power industrial machines and factories can benefit the environment in multiple ways. By removing harmful algae, we are helping marine organisms that compete for the same resources and we are improving oxygen availability. Moreover, by replacing other fuel sources like fossil fuels, we are reducing the amount of new carbon dioxide being introduced into our atmosphere which can help in the fight against climate change.

"The most beautiful experience we can have is the mysterious. It is the fundamental emotion that stands at the cradle of true art and true science."

"There are two ways to live: you can live as if nothing is a miracle; you can live as if everything is a miracle."

"Why does this magnificent applied science, which saves work and makes life easier, bring us so little happiness? The simple answer runs: Because we have not yet learned to make sensible use of it."

- Albert Einstein

Judges at a Glance

Barbara Wendell

Barbara Wendell has been teaching for 11years and with 4 years at North Brunswick. She started as an 8th grade Science teacher and is currently a 5th grade Science teacher. She received her first Bachelor's Degree in Biology, and went on to receive her Master's Degree in Education Leadership Management, Education Administration and Supervisory, and finally her second Bachelor's Degree in Environmental Science. She is currently on the Environmental Commission in East Brunswick. She is working with the local township Mayors to bring communities together to conserve native pollinators by providing them with a healthy habitat, rich in a variety of native plants.

Sachin Desai

Sachin Desai is NBTHS alum, Class of 2007. He went on to pursue a degree in Chemical Engineering and MBA from Rutgers University. During his professional career, Sachin has held roles with increasing responsibilities in Operations & Supply Chain at Catalent Pharma Solutions supporting the development and commercialization of pharmaceutical products. His current role is within Strategic Sourcing as the Associate Director, Analytical Testing Services, Cell Therapy at Bristol Myers Squibb

Frank Sweeney

Frank Sweeney is currently the Senior Process Safety Engineer at LyondellBasell's catalyst manufacturing facility in Edison, NJ. Throughout his career, Frank has worked in many aspects of engineering including research and development, business development, and manufacturing. A NBTHS alumnus, he holds a B.S. in Chemical and Biomolecular Engineering from Johns Hopkins University, where he is currently pursuing his Master's in Engineering Management.

Abhay Navale

Abhay Navale is Global Head of Digital Assets Technology at BNY Mellon. He has worked in Financial services technology across Fintech and Global banks. He has a passion for building great engineering products that solve business problems and delivering improved customer value.

Krystina Valdes

As a graduate of Northeastern University with a major in Chemistry, Ms. Valdes took her love of science to the classroom. She has been teaching middle school science for the last 15 years, 13 of which has been in the North Brunswick Township School District. Ms. Valdes has been the lead teacher for the district's noted Algebra-Based Physics program since 2017. During this time, she has developed various courses that have been taught in conjunction with the Physics course. These courses include the STEAM-Based Strategies class and the new Physics FUNdamentals course currently being taught at NBTMS. In March, Ms. Valdes was selected the 2023 STEM NJ Educator of the Year by the NJ STEM Pathways Network. Outside of science, Ms. Valdes is currently a member of the NBTMS Culturally Responsive Committee. She is also a teacher leader member of the Gifted and Talented Committee of the NJ Principals and Supervisors Association.

Dr. Lucille O'Reilly

Dr. Luci O'Reilly is currently a tenured faculty member of the North Brunswick Township High School Science Department, where she teaches chemistry at both the College-preparatory and the Advanced Placement levels. Dr. O'Reilly is also the team teacher for the North Brunswick Township High School's Waksman Student Scholars, a molecular biology and bioinformatics research group associated with Rutgers University, a volunteer for the North Jersey American Chemical Society's sponsored events to promote STEM to K-12 students and a participant on alumni panels to promote a K-12 education career track for graduate school science majors post-graduation. Dr. O'Reilly received her doctorate in Molecular Biology and Biochemistry from The University of Medicine & Dentistry of NJ's School of Biomedical Sciences (Piscataway, NJ), where her research focus was the interaction of retroviral particles with the host cell. Dr. O'Reilly is also an alumnus of Rutgers College (New Brunswick, NJ) and Montclair University

(Montclair, NJ). Prior to receiving her doctorate, Dr. O'Reilly worked in both academic and biotechnology/pharmaceutical laboratories and has taught at the college level.

Todd Lanphear

Todd Lanphear is currently a Lockheed Martin engineer. He attended Rutgers University, School of Engineering, where he majored in mechanical engineering and also completed the aerospace engineering course of studies. His first position was with General Dynamics, Electric Boat division as a nuclear engineer in Groton Connecticut, working on Ohio-class and Los Angeles-class nuclear fast attack submarines. Mr. Lanphear then returned home to New Jersey to join RCA. Although the company and division names have changed over the years to General Electric, Martin Marietta, and finally, Lockheed Martin, he has remained and rising to the position of Lead Engineer. He has had the opportunity to work on a variety of large scale projects for the defense, including AEGIS radar systems for naval ships.

Mr. Lanphear holds a Masters in Business Administration from Monmouth University and has completed advanced coursework in Electrical Engineering through Drexel University. He enjoys a variety of volunteer opportunities, including those related to science. For many years, he has been a volunteer daytime science and engineering presenter in the Riverside School District, near his offices. As his scientific interests have recently focused on ecology and climate change, he participates in a citizen science initiative for our watershed as a stream monitor. He has also been involved with supporting North Brunswick STEAM Tank teams as a subject matter expert.

Kabir Rekhi

Kabir Rekhi is part of senior management at RBC Capital Markets. He is the Global Head of Data Architecture division of RBC Capital Markets. He started his career in consulting with Ernst & Young and has worked in Information Technology for over two decades. He specializes in various trading products and trading analytics. He has Masters in Finance and Applied Math from Columbia University.

STEAMTank Team Ideas

STEAMTank Challenge, created and sponsored by NJSBA and the U.S. Army, encourages New Jersey's public school students in the areas of STEAM – Science, Technology, Engineering, the Arts, and Math. It's an open ended design challenge to maximize creativity.

This year again NBT Science Symposium Committee is supporting the teams participating in the STEAMTank Challenge from our school district by providing a venue to showcase their ideas in front of a Scientific Advisory Panel. The Panel will provide constructive feedback to the teams and help them prepare for the Finals.

Team Members: Denzel Zhou, Ian Maleck and Khiya Wildy
Team Name: Two Stones and a Feather
Abstract: This team has been designing a device to assist with security. Their device will help to break up incidences and keep those assisting with security safe at the same time.

Team Members: Adam Botello, Manveer Marok and Sriteja Malladi
Team Name: Team Spove
Abstract: The Spove is a cleaning invention that takes cleaning to a new level of convenience and efficiency. It also helps those with mobility issues to accomplish their cleaning tasks.

Team Members: Jaime Marin, Nana Yaw Tuah, Isaiah McArdle and Tyler O'Garro
Team Name: Quad Squad
Abstract: Quad Squad is developing high quality, earth friendly sports shoes.

STEAMTank Advisory Panel

Dr. Latha Nair
Dr. Venkata Nanduri
Vivek Sinha
Swetcha Ananthu
Jeannine Lanphear
Andrea Lamagra

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