



Problem Solving and Critical Thinking Through Project-Based Learning

An all-in-one STEM guide for getting starting with ExploraVision
For educators teaching grades 7-12 in the U.S. and Canada



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What is ExploraVision?



TOSHIBA



Through Toshiba's shared mission and partnership with NSTA, the Toshiba/NSTA ExploraVision competition has made a vital contribution to the educational community for over 30 years.

It is a **FREE critical-thinking** and **collaborative** program and all students receive recognition for participating in the competition.

Why ExploraVision?



Why **Bill Nye the Science Guy** loves ExploraVision and his advice for students.

Why ExploraVision?



The impact **ExploraVision** made and the **applicable skills** the **alumni** have learned from ExploraVision.

How you can incorporate in your classroom?



How does she engage her high school students in ExploraVision? Learn from a multi-awards winning coach, Mrs. Cynthia Smyser, who uses our program to encourage her students to enrich them

How you can incorporate in your classroom?



How do he engage his students in ExploraVision? Mr. Huy Pham who uses the program to encourage his students in the immigrant community to build critical-thinking, communication, and collaboration skills, and unleash their creativity.

How can you incorporate in your classroom?



How does Ms. Laura Laun, a 7-9 teacher, engages her students and keep winning in ExploraVision? Learn from the coach uses the program and her advise,



Introducing Toshiba/NSTA ExploraVision

- ExploraVision is a STEM competition for K-12 students in the US and Canada
- It challenges students to **think creatively** yet **collaboratively** about current scientific research and technology and its limitations
- Teams of 2-4 research an existing technology and **envision what that technology might look like 10 or more years in the future**
- Teams then identify what scientific “breakthroughs” are required for their idea to become a reality and **describe the consequences** that technology may have on society
- Teams then **write an online research paper and create sample web pages** to describe their invention
- Finalists then **develop a prototype** and **build a website** and **online live presentation to the judges** of their invention
- ExploraVision is more than a science fair or a competition—it lets you **dream big** and **solve a problem you care about** using science!





Brainstorming: Solve Problems by Asking Questions

- How can we safely and easily bring light to people who need it?
- How can we keep our clothing dry and stain-free?
- How can we keep our soldiers safe from bullets?
- How can we allow people to connect and find information easily?



Brainstorming: Inventors Who Solved Problems

Early 1900's: Ichisuke Fujioka developed an economical, durable, mass-market light bulb.



Ichisuke Fujioka, Co-founder, Toshiba



Matsuda Lamp

1956: Patsy Sherman invented Scotchgard, a water and stain repellent.



Patsy Sherman, Chemist & Inventor, 3M



Scotchgard

1965: Stephanie Kwolek invented Kevlar, a strong, synthetic fiber used in body armor.



Stephanie Kwolek, Chemist, DuPont



Kevlar

2007: Steve Jobs developed Apple's first widely-adopted smartphone.



Steve Jobs, former CEO, Apple



iPhone Gen. 1

Brainstorming: Generating ExploraVision Ideas

- Need help brainstorming?
Encourage students to solve global challenges in the 17 areas addressed by the UN SDGs.
- Past ExploraVision winners developed solutions to reduce food waste, eradicate disease, improve energy efficiency and more.



[Learn more about UN SDGs](#)

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Brainstorming: Generating ExploraVision Ideas

Step One: Thought Starters

- Does your family or community face any environmental or health issues?
- Do any current technological devices or scientific solutions address these issues?
- Are there any current events or problems that make you worried for your future? (Examples: pollution, climate change, disease, natural disasters)
- What technology do people currently use and how could it be improved?

Think about which of these areas you are interested in investigating further.





Brainstorming: Generating ExploraVision Ideas

Step Two: Generating Investigative Questions About Problem Area

1) What questions do you have about the problem area?



2) Refine your questions:

How can we...?

Is there an alternative to...?

How much does...?

Could we create...?

What if...?

Is it possible...?



3) Rank your questions in order of interest:

1.

2.

3.

Brainstorming: Generating ExploraVision Ideas

Step Three: Categorizing Your Questions into Subject Areas

Do your investigative questions fall into any of these categories?

- Climate change
- Sustainable energy
- Food shortage/population growth
- Space
- Healthcare
- Mental health & social sciences
- Robotics
- Artificial Intelligence
- Infrastructure/civil engineering (building bridges, etc.)



Can you expand or modify your questions based on these areas of concern?

Research: Understanding Your Topic

- How is your area of concern impacting local or global communities?
- What improvements could be made in this area?
- What inventions already exist in this area?
- What recent improvements have there been in this area?
- What key problems are there in this area?
- What's the history and future of the area
- Check [past winning coaches' suggestions](#) on picking up your topic.
- Check last year's [students' motivations](#) for a project.



Past ExploraVision Winners, Grades 7-12

Using mycelium to create eco-friendly fabrics



"The textiles industry is known to be the second largest contributor to pollution."

Fungi Fabrics uses mycelium to create the fabric. The substrate should have a smooth texture so the fungi does not intertwine with the substrate. The substrate must have enough sugars for the fabric to grow evenly throughout the product. When the fabric needs to be disposed of it can be thrown in soils or water without a problem and break down toxic waste and bacteria which will clean our land and benefit the environment.

Transporting perchlorate-reducing in mycelium to enable agriculture on Mars



My partner is passionate about botany and I'm fascinated by Space science and Mars.."

Agriculture on Mars is hindered by the presence of perchlorates in Martian regolith.. Perchlorate-reducing bacteria can effectively reduce perchlorates into chloride and oxygen. In order for such bacteria to be able to survive and transport itself through the arid Martian regolith, transporting Martian Mycrops, perchlorate reducing bacteria via fungal mycelium to Mars, we can efficiently reduce perchlorate concentration in Martian regolith and start safe agriculture on Mars.

Past ExploraVision Winners, Grades 7-9

A New Way to Prevent Coronary Heart Disease with Nanobots



"Me and my team mate are passionate about saving human lives." -- Aura Sukanpotharam

The CC Bot is a nanobot that can detect and eliminate heart disease before it takes a life. It's equipped with nanobiosensors, ultrasound, and artificial intelligence for early detection. To eliminate any problems within the arteries, it leverages macrophages to remove plaque. The nanorobot communicates using electromagnetic radio waves with a smart device such as a smartwatch which provides information through the display for the user.

Addresses a microplastics issue in the ocean with a ROV



"We wanted to address microplastics issue in the ocean after having learned about it." -- Amber Gutu

The A.L. 3000 is an autonomous ROV that filters microplastics from the ocean. The drone cruises beneath the surface and uses echolocation technology to detect microplastics, which are then passed through a fine filter to separate them from the seawater. The filter is subsequently exposed to plastic-digesting bacteria that degrade the collected microplastics.

Past ExploraVision Winners, Grades 7-9

A one-use cure for Hepatitis B Virus (HBV)



"It wasn't as fun as it was if I didn't work with my team mate." - [Akshar Ramkumar](#) (click & watch how they came up with the idea, how they worked and what he learned.)

This project is a novel one-use cure for HBV that contains a CRISPR-Cas9 cocktail specific to the genes for HBx (an important protein coded by the HBV genome) and NTCP (the receptor used by HBV to enter a patient's liver cell) using lipid nanoparticles targeted to the liver. Inhibiting HBx and NTCP with CRISPR-Cas9 will eliminate the virus from infected liver cells and cure patients with a single delivery.

Reducing road maintenance and preventing accidents significantly



"According to the U.S. Department of Transportation, each motorist spends \$290 on average on car repairs due to deteriorating roads each year, totaling \$410 billion per year."

Damaged road surfaces cause popped tires, broken axles, and loss of vehicle control, which lead to accidents. To address the continuous issues motorists experience as a result of damaged road systems, the team envisioned, "[NewFerro Roads](#)," which revolutionize road maintenance by using an advanced magnetic nanofluid, Phase-Mag Fluid (PMF), which allows the road to self-repair.

Past ExploraVision Winners, Grades 10-12

The Smart Way to Detect Strokes



"We have family member effected by a stroke, so we want to find a way to prevent it."

[iSpyStroke](#) is a sleeping mask designed to target wake-up strokes, a type of stroke that occurs while a person is sleeping. Consisting of electroencephalogram sensors that can detect any irregular brain wave activity, it can alert medical professionals and emergency contacts through the connected app if a wake-up stroke is detected. Vibrators and alarms attached to the device will also awake the wearer.

A Solution to Combat Bee Mortality from Insecticides



Western honeybees are vital pollinators in promoting biodiversity and securing crop production. However, since the early 1990s, a group of insecticides have contributed to the decline of honeybees due to its toxicity that disrupts bee's nervous systems. Our [solution](#) to combat bee mortality is a probiotic composed of neonicotinoid-degrading microbiome bacteria. Genetic engineering, CRISPR technology DNA cloning, and freeze-drying techniques will be utilized to develop a novel probiotic solution.

Past ExploraVision Winners, Grades 10-12

Genetically modify bacteria to tackle climate change



"I always wanted to go in bio or medicine, but this solidified for me." -- Valeria Millan (click & watch how they came up with the idea and what impact it made on her.)

This team engineered "M. Luteus" to fix the greenhouse gases methane and carbon dioxide. This method to reduce the amount of these gases in the atmosphere by genetically modifying the bacteria *Micrococcus luteus* strain ATCC 4698 is achieved by inserting carboxysomes and soluble methane monooxygenase (SMMO) operons into its genes.

Help restore nerve and tissue function after chemoradiation



"My mom went through a chemoradiation and it was very difficult to see her go through the treatments, so I wanted to research an idea to ease her pain."

This team designed the Cancer BAN-R: Blood and Nerve Regeneration. This device is a novel graphene patch which incorporates laser sensors, microneedles, nanotechnology, and growth hormones to provide noninvasive transdermal delivery of specialized therapeutics, helping to restore nerve and tissue function after chemoradiation.

Engineering Process for Problem Solving

The engineering process is often used by professional engineers to solve problems and it can be used to structure your team's ExploraVision efforts:

1. Identify the problem
2. Describe the problem in a "design brief," including the constraints and limitations
3. Gather information
4. Brainstorm for solutions
5. Select a solution
6. Develop an implementation strategy
7. Design a prototype
8. Test
9. (Rebuild it, if necessary)
10. Complete the project



Components Required to Complete a Project

- Abstract
- Description
 - Present Technology
 - History
 - Future Technology
 - Breakthroughs
 - Design Process
 - Consequences
- Bibliography
- Sample Web Pages

Research Paper
(Standard
ExploraVision
Program Format -
see left)





Key Components: Breakthroughs, Design Process, and Consequences

Breakthroughs: Research and describe the breakthroughs necessary to make your future technology a reality. Describe why this technology doesn't exist today. Choose one of your required breakthroughs and describe an investigation that would need to be carried out to test your project. If possible, include the kind of data or measurements that would be collected in this investigation.

Design Process: Describe three different features your team considered for the design of your technology. These features should be directly related to your current project, [not one submitted in previous years](#). Describe why your team rejected each feature in favor of the ones in the submitted technology. Explain why the features in your submitted project are better than the ones you rejected.

Consequences: Recognizing that all technologies have consequences, describe the potential positive and negative impact of this new technology on society

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Summary and Sources: Abstract and Bibliography

Abstract:

- An abstract should help the reader understand your project quickly and encourage them to read on
- In no more than 150 words, summarize your proposed future technology and other relevant information

Bibliography:

- Include all research sources in the bibliography. Please cite in MLA or APA
- Sources must be clearly labeled and include title, author, publisher, and copyright date (depending on citation format)

Communication: Website & Online Live Presentation

- Each team will learn how to best communicate the value of their project. Teams can either hand-draw or build actual websites that succinctly explain their project in 5 pages or fewer.
- Images, text and diagrams need to include descriptions of future ideas/technologies
- When possible, use data to backup your project's claims
- For regional winners, your team wishes to practice a online live presentation to the judges, create a video, consider using the website as a "storyboard" to layout the important themes



*Want to engage your students building a website? Consider these:
Wix.com, Squarespace, weebly.
Web.com, hibu*



Judge Expectations

- Each judge awards points for ideas that **haven't been invented, overall creativity, scientific accuracy, strong communication, and feasibility of the project's vision**
- Judges award higher scores to entries that are different from those that have previously won
- **Judging is divided into two phases:** regional and national judging. All eligible projects will be evaluated in the regional judging phase
- 24 regional winning teams will move on to national judging, where **8 teams become finalists**

Who are our judges?

ExploraVision judges are career scientists, innovators, engineers and industry professionals who recognize the value of STEM education. Past judges worked for NASA, UPenn and other forward-thinking organizations.

Due to their deep expertise, judges can assess the feasibility of submitted projects.

Resources

- [ExploraVision website](#) (more details on the entire program)
- Tap into [Skype a Scientist](#), which connects established scientists and K-12 students via video chat for 30-60 minute, Q&A sessions
- Collaborate with **school librarians** for research and **language arts teachers** for communicating the big idea
- Ask for **mentorship from parents or other adults** in the community who work in field(s) related to the project
- Useful websites for students: [NASA Climate Change](#), [Kids National Geographic](#), [Robotics for Kids](#), [Referral MD](#), [What's an Engineer?](#), [EIA for Kids](#), [DOE Sustainable Energy](#), [USPTO for Kids](#)
- Useful websites for teachers: [Robotics](#), [Science Friday](#), [NASA](#), [ASCE](#), [NGSS](#)



Resources

NSTA's Science Competition Director on ExploraVision:

- [What is ExploraVision](#)
- [How to Kick Off ExploraVision](#)
- [How to choose an ExploraVision topic](#)
- [How to Form ExploraVision Teams](#)
- [How to Keep Your Team Motivated](#)
- [How to Prepare for ExploraVision Project and Get Started](#)
- ExploraVision [FAQ](#) video



Resources

Past ExploraVision teachers have used this program as a tool to motivate students and bring schools together. Here are a few ideas to inspire you:

- Teachers at a magnet school in Nashville organized a **school-wide Shark Tank-style program** where teams presented their projects before a panel of four, including a non-science teacher, a parent, a community representative, and an expert in STEM
- A teacher in Atlanta hosted an **award ceremony** for upper grades with district leadership
- In Ottawa, a teacher celebrated the end of the year-long program with **cupcakes**





Resources & Collaboration Tools

Getting your students organized and ready for this **FREE** K-12 STEM competition can be done **easily** and **virtually** through the use of online tools such below.



Are you overwhelmed in this school year? Have questions or want to know tips on how to introduce to your classroom and how to get started virtual teams? Email to: **exploravision@nsta.org**

Resources & Social Media

Search #ExploraVision on Twitter, Facebook and Instagram to get insight of the program, how other teachers are using and motivating students

You will see cool photos and videos from our ExploraVision team as well as teachers chronicling their teams' projects over the school year.

Follow Toshiba on social media for program updates and inspiration!

Join out community!

