

Roadmap to Your Science & Engineering Journey 2022- 2023

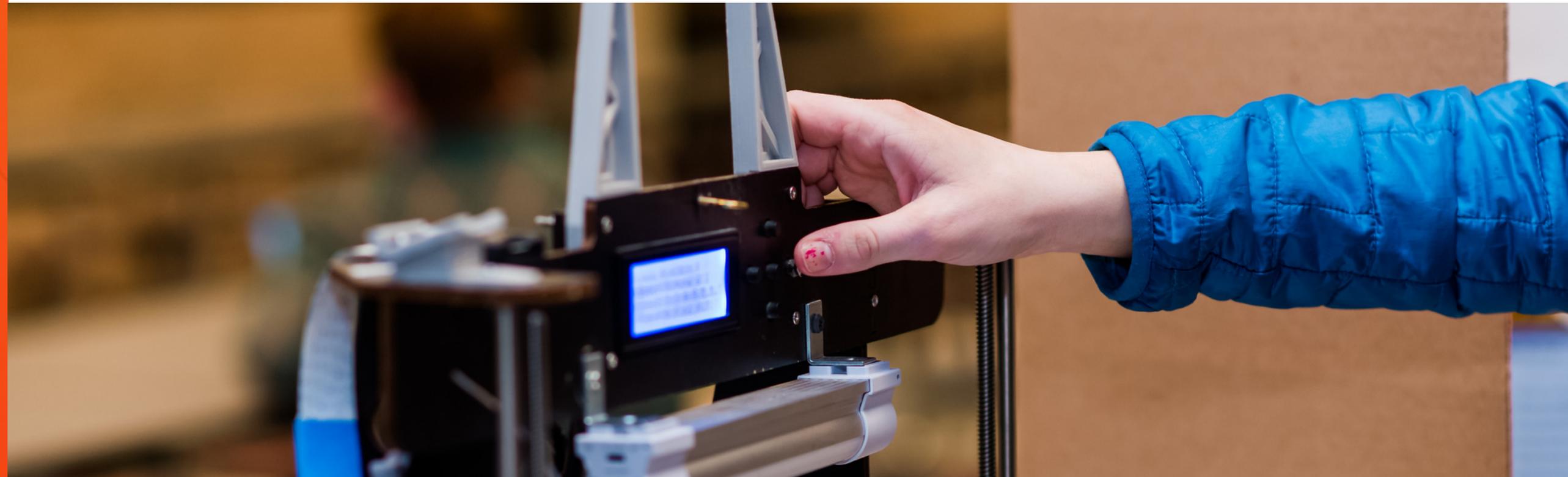
Students are naturally curious about the world around them: *Does the time of day affect your memory? How do different materials interfere with WiFi signals? Can lichen be used to detect air pollution? Could I program voice controls to make video games more accessible?*

Science & Engineering Fairs provide a unique journey for each student to explore personally meaningful questions, paving the way to academic growth and personal self-discovery.

Massachusetts Science + Engineering Fair, Inc. (MSEF) is on a mission to develop future thought leaders through experiences in science and engineering practices that empower students and educators to learn in and beyond the classroom. Each year, thousands of middle and high school students develop independent research questions, plan investigations, collect data, and share their stories with fellow students, teachers, and communities. MSEF is here to support students and teachers from the first step of their journey.

Let's OBSERVE, PLAN, EXPLORE, & EXPLAIN how to get Science Fair Ready!

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Making the Case: Why Science Fair?

“Modern STEM education promotes not only skills such as critical thinking, problem solving, higher-order thinking, design, and inference, but also behavioral competencies such as perseverance, adaptability, cooperation, organization, and responsibility (1).”

Science Fair and Mass STE Practices:

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Focusing on using **phenomena and real-world problems** in science and engineering lessons shifts from “learning about” to “figuring out” helps students apply existing STEMS skills in novel scenarios, identify knowledge or skills still needed to answer their questions, and find ways to reach solutions and fuel their curiosity. (2)

Each student’s journey builds a variety of practical skills – quantitative, analytical, and communication – giving them the tools to launch their STEM future. Projects are in

- physical sciences
- life sciences
- earth sciences
- mathematics
- computer science
- engineering

Students can pursue Science Fair projects as mandatory in-class assignments, part of an elective, through an after-school club, or as an independent project.

1.National Science and Technology Council Committee on STEM Education. 2018. Charting a course for success: America’s strategy for STEM education. Washington, DC: White House Office of Science and Technology Policy.g

2.National Academies of Sciences, Engineering, and Medicine 2019. Science and Engineering for Grades 6-12: Investigation and Design at the Center. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25216>.

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I. OBSERVE - Choosing a Project

The **Observe** phase engages students in brainstorming, idea sharing, and discussion with peers and community members can help students identify topics and questions that inspire, excite, and fascinate them. When picking a research topic, students should try to find something that has not been done before (or uses a different approach). Creativity is an essential component of this process—even a simple project idea can offer a rewarding growth experience to the imaginative student.

Engagement as Predictor of Achievement: “Students’ engagement in their own learning is a strong predictor of their achievement, and teachers often report that it is a challenge to engage students in learning when they are not face-to-face in a classroom. However, by centering students’ experience on figuring something out that they are genuinely curious about, science and engineering learning can become the most engaging part of a student’s day, even in remote learning environments.” (4)

"The most valuable aspect ... was to see if I enjoyed a different type of science than the one taught at school. I am taking Biology this year and although I have a good grade, I do not enjoy it and would not spend my free time learning it. I learned that I like forensics and psychology specifically and could see myself pursuing it for a future career."

-MSEF 2022 Student

Focus on Social Emotional Learning

By shifting the focus of science education to subject matter identified by students as relevant to their interests, cultures, and experiences, we can nurture students’ curiosity and build connections in their community. (2)

Students can more easily apply concepts and practices from their classroom STEM curriculum if they are able to explore a phenomena or problem they observed in their home, neighborhood, or community.(3)

2.NSTA Position Statement: Science Education for Middle Level Students, 2016<https://www.nsta.org/nstas-official-positions/science-education-middle-level-students>

3. National Academies of Sciences, Engineering, and Medicine 2020. Teaching K-12 Science and Engineering During a Crisis. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25909>

4.National Academies of Sciences, Engineering, and Medicine 2019. Science and Engineering for Grades 6-12: Investigation and Design at the Center. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25216>.

II. PLAN - Research & Design

The **Plan** phase introduces students to science and engineering methods, how to form hypotheses or a statement of purpose, and the types of qualitative and quantitative observations they need to collect for their research. By planning a project to determine a testable question or problem to solve, students will activate their language arts skills as they rephrase their research question in a way that is focused, measurable, relevant, and achievable.

Focus on Social Emotional Learning

Educators have reported their students struggling with independent thinking. We believe that participating in a science and engineering fair is an opportunity to support student growth in independent thought, build confidence in their ability to make decisions, and strengthen their organizational skills.

"In any remote or nontraditional learning environment, students will be required to be more independent in their learning. They need to learn how to set goals, monitor their progress toward those goals, and follow through on accomplishing them." (5) The Science Fair process provides an opportunity to practice these skills.

Working collaboratively with peers also fosters SEL skills between students towards a common goal.

Opportunity and Access to Materials and Resources

Although some projects make use of specialized laboratories or equipment, it is by no means an expectation. Student investigations can take place in the classroom or remotely without advanced equipment, driven by their desire to explore phenomena in their homes and communities. By planning what types of data are needed and how they can collect it, students will learn that they can solve problems in the world around them, beyond the walls of a traditional laboratory.(6)

The crucial piece of science fairs is the actual research process. It takes on a much different meaning when you are initiating the project from start to finish. The experience of devising an experiment, evaluating results and coming up with a conclusion is not something that all students get.

-MSEF 2022 Student

5.National Academies of Sciences, Engineering, and Medicine. 2020. Teaching K-12 Science and Engineering During a Crisis. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25909.4>.

6.National Academies of Sciences, Engineering, and Medicine 2019. Science and Engineering for Grades 6-12: Investigation and Design at the Center. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25216..>

III. EXPLORE - Experimentation & Investigation

During the **Explore** phase, students will follow the plan they developed to conduct their experiments or build their prototypes, collect and record data in their project notebooks, and repeat the process with different conditions or variables. For many students, this will be their first time exploring a topic through independent research. Research shows that opportunities for deeper engagement promote stronger conceptual understanding of STEM concepts than memorization-intensive methods.(5) Active participation in an independent investigation of their own design creates personally-meaningful and unforgettable learning experiences for all students.

I learned that mistakes teach you just as much as successes, and shouldn't be treated as letdowns, but rather as lessons. This applied to both my project and life, and has been really valuable in how I handle mistakes.
-MSEF 2022 Student

Reflecting & Revising:

No matter how much planning we do, accidents can happen and mistakes can be made—even for professional engineers and scientists!

Preparing students how to learn from unexpected outcomes on their research journey can build resilience and help identify ways to improve their research in the future—this is all part of the story of what they learned during their project. By reframing “failures” or “mistakes” as opportunities to reevaluate and make new observations, educators can foster a collaborative classroom community where students are encouraged to share any challenges encountered during their project, gaining the support and feedback from their peers in the process.

Focus on Social Emotional Learning

Science is an active process, and we know that students learn by doing. However, the ability to implement hands-on lessons during remote learning was a challenge that educators met with creativity and perseverance. Science Fair projects evolved to feature new techniques and technologies using coding, machine learning, data analysis or environmental investigations.

Students engaging in their own investigations are able explore the phenomena that fascinate them or solve problems that will make their community a better place. (5)

IV. EXPLAIN - Communication & Presentation

The Science & Engineering fair provides a pathway for students to evaluate their evidence, interpret patterns in their data, and communicate their independent research journey with their peers, families, and community. The **Explain** phase is the heart of the inquiry process, as students truly give life to their projects when they share their story with others. They will learn how to represent their results through graphs and diagrams, written reports, and poster presentations that summarize the key pieces of their discoveries.

Focus on Social Emotional Learning

The need for science literacy extends beyond K-12 classrooms, as all individuals should be able to make sense of data and critically evaluate evidence. (6)

Providing students with experiences that improve critical thinking and communication skills benefits their connectivity to others and their sense of empowerment in challenging times.

Showcasing Student Accomplishments

During the fair, students have an opportunity to showcase all their hard work and creativity through oral presentations and responding to questions from the judges, students, and members of their community. Although science and engineering fairs still involve an element of competition, this experience celebrates each student's learning journey. This can be a powerful experience, as receiving meaningful feedback from their peers and professionals in STEM fields can bolster a student's science literacy skills while building connections that were challenging to attain during the transition to virtual learning.(6)

After competing at our school's fair, the regional fair, and the state fair, I found that the feedback from the judges were very helpful and it was crucial to my understanding of the scientific process.

-MSEF 2022 Student

Our Science Fair Ready framework for middle and high school educators provides guidance for successful implementation of science and engineering projects driven by student interest and initiative. This free resource library and related professional development opportunities will help your classroom navigate the process and policies for participating in a fair at the school, regional, and state level.

Learn more about how to help your students become Science Fair Ready at scifair.com