A creative idea—one that is both novel and useful—is at the root of any successful invention. As we consider innovative thinking in classrooms, technology has taken on a significant role both in how ideas are developed and displayed. However, getting to the root of what’s required for students to invent requires building their foundational 21st century skills, creative thinking and problem-solving. The skills do not depend on technology, but students’ ability to be meaningful technology users does depend on these skills.

For example, 3D printing technology allows for the creation of a physical object from a three-dimensional digital model. Recently, these printers have gained popularity in learning centers and makerspaces as a cost-effective way to bring students’ inventions to life. However, simply observing the process of 3D printing does not leverage the full learning potential of such projects. Instead, students can engage in higher-level thinking when they are challenged to work through developing their own 3D models that translate ideas from digital to print.

Every year, students who participate in the Archimedes School for Creative Thinking’s summer camp are challenged to invent their own product that can be brought to life with 3D printing technology. The camp’s programming combines MindAntix’s How to Be an Inventor learning modules with 3D printing instruction from Archimedes. Over the course of a week, students gain new thinking strategies to help them build an innovator’s mindset and learn the basic application of 3D printing by participating in a variety of hands-on learning experiences.
Combining Hands-on Activities with Minds-on Learning

Students work through a variety of minds-on learning modules and hands-on assignments that teach creativity while exploring the camp’s specific area of study. Using the How to be an Inventor teacher guides, instructors provide 10 detailed and sequential lesson plans that support development of higher order thinking skills, including the following, each of which are a key element of an innovator’s mindset:

- **A modified approach to mind mapping** - a brainstorming technique that teaches students come up with different ideas—helps students avoid creative blocks by exploring new areas to generate ideas
- **Associative thinking** - tasks students to combine unrelated objects to create a new solution
- **Spatial reasoning** - is the ability to think about objects in three dimensions and to draw conclusions using limited information
- **Reverse thinking** - involves developing an assumption about a particular problem and then using this to look for opposite ideas that go against the initial assumption in a meaningful way
- **Critical thinking** - involves analyzing the information surrounding a situation to make an informed decision
- **Narrative reasoning** - uses storyboarding techniques to illustrate how a new invention will be used in real-world settings

Each lesson averages 45 minutes of instruction and teaches students the basics of creative thinking, helps them develop a thorough understanding of the camp’s educational theme, and challenges them to combine their new skills and knowledge to develop their own 3D printed prototype. In the end, they aren’t just thinking like an inventor — they truly have become one.

Students Demonstrate New Skills at the Inventors Showcase

The highlight arrives when students present their 3D printed product at the inventors showcase. During the event, students demonstrate how their product is a viable application of the camp’s learning theme.

For example, students recently explored thermochromism, a study of smart materials that leverages a change in color to showcase a significant change in temperature. Using a variety of creative thinking techniques, students come up with several ideas that could use thermochromic paint in meaningful ways. Product-based inventions showcased different applications of thermochromism in real-world settings.

**STUDENT INVENTIONS**

- **Electronics produce heat when overused.** Students developed accessories that change color to identify a significant rise in the device’s temperature and caution users to take a break.
- **An increase in body temperature can signal an infection or illness.** Students created color changing band-aids that help detect infected cuts and soft headbands that signal fever spikes.
- **Temperature is an important component of food safety.** Students created a flexible band to go around baking dishes that helps keep track of cooling and changes color to signal when it is safe.