STEAM subjects—science, technology, engineering, art, and mathematics—are essential for fostering students’ 21st-century skills. STEAM promotes critical-thinking skills, including analysis, assessment, categorization, classification, interpretation, justification, and prediction, and are enhanced through the integration of subjects.

At the elementary level, teachers have inherently integrated STEAM, compared to their secondary-level counterparts. However, with this approach comes an even greater need for attention to safety, given the many hazards that could arise through teaching these subjects.

STEAM and Safety

Under the legal concept of “duty of care,” teachers are required to perform hazard analyses and risk assessments prior to performing any STEAM demonstration or investigation. The following process is a suggested approach for addressing safety issues prior to performing a demonstration or conducting an activity.

First, a safety analysis should identify the hazards associated with the demonstration or investigation. Then, the assessment should determine the level of risk. Finally, teachers should take action to minimize safety risks through the use of appropriate personal protective equipment (PPE; e.g., gloves, safety goggles, aprons) and other safety equipment. Teachers should also be trained in safety procedures (e.g., how to use a fire extinguisher) and school emergency procedures.

Step 1: Analysis

Teachers must be aware of potential hazards in any STEAM activity. Investigations involving biologicals (e.g., food, plants, unsterilized owl pellets), chemicals (e.g., vinegar, alcohol, clay, paints), or physicals (e.g., metersticks, sharp objects) can be hazardous. Teachers can use their own experiences, those of colleagues, or research to conduct an initial safety analysis. Examine any relevant Safety Data Sheets (SDSs), warning labels, instructions, or precautions that come with chemicals and science kits. Teachers can also consult the school nurse’s list of student medical issues to avoid triggering allergic reactions in the classroom.

Step 2: Assessment

Following the analysis, teachers should assess the risks of the STEAM activity being addressed by:

- reviewing any chemicals involved in the proposed activity and determining the amounts that will be used. Chemicals’ SDSs sometimes limit the amount of a chemical that can safely be stored; alcohols, for example, are highly flammable and large amounts of them should not be stored in one place. Take note of whether the activity is to be done once or if the chemicals will be handled repeatedly. Also review the safety risks involved in using any physical or biological hazards identified during the initial safety analysis, such as sharp objects, hand tools, glass, projectiles, unsterilized owl pellets, or food.

- researching any additional safety information and assessing the types of risk involved. Again, consult current SDSs for each chemical needed for the proposed activity. Also make note of any required PPE, the flammability or toxicity of any substances used, correct disposal procedures, safety labels, and appropriate materials storage. These safety measures apply to stains, paints, markers, glue, food coloring, vinegar, and alcohol. Additionally, find al-
ternatives to physical hazards, such as plastic in lieu of glassware and metal blades; materials can also be precut so students do not have to handle sharps. Also assess the level of risk for cross-contamination from biological materials such as unsterlized owl pellets.

• determining the potential routes of exposure for each chemical or biological. For example, some liq-uid substances can be absorbed through the skin, and some activi-ties can create dusts or aerosols that might be inhaled. Also determine whether the activity involves a sig-nificant risk of inadvertent ingestion or injection of chemicals or biologicals.

• selecting appropriate procedures to minimize exposure. Use basic, prudent practices for handling chemicals, including safe storage, appropriate ventilation, using PPE that is appropriate for the material, and properly disposing of hazardous waste.

• preparing for contingencies. Note the signs and symptoms of exposure to the chemicals to be used in the proposed investigation. Have appropriate measures in place in the event of exposure or accidental release of any of the chemicals. SDSs can be good sources for this information.

**Step 3: Action**

Once the assessment is complete, a decision must be made regarding whether the activity’s supplies can safely be used. Appropriate engineering controls (e.g., ventilation, eyewash stations, protected electrical receptacles), school-required safety measures, and PPE must be available. If teachers have these tools in place or can adopt safe alternatives, they can implement the activity. If there are hazards that cannot be addressed or eliminated, the investigation should not take place.

Investigations involving sharps, such as wires, blades, scissors, and glass, can result in students scratching or puncturing their eyes. PPE such as sanitized safety glasses or googles must be used in these cases. For primary grades, the teacher or adult volunteers can work with the sharps instead to prevent student injuries. In the case of food being handled and used in the general elementary classroom, a risk of cross-contamination exists, so food should not be eaten in areas where hazardous chemicals or biologicals have been used. Paint markers and glue present additional chemical hazards. Review of SDSs is critical to determine the potential for respiratory irritation, use of appropriate ventilation, and need for PPE (goggles and gloves). For owl-pellet investigations, use commercial sources that provide sterilized pellets.

**Conclusion**

Elementary teachers must model, post, and enforce all necessary safety procedures prior to having students do a STEAM investigation. Remember AAA (Analysis, Assessment, Action) ensure that safety has been addressed prior to implementing any STEAM activity.

Ken Roy is director of environmental health and safety for Glastonbury Public Schools in Glastonbury, Connecticut, and NSTA’s chief science safety compliance consultant. If you have questions or an issue dealing with safety that a future column might help address, send an e-mail to royk@glastonburyus.org. Follow Ken Roy on Twitter @drroysafersci for more safety information.

**Internet Resources**

- Safety in Elementary School Science

- STEAM Portal: STEAM Resources for Any Classroom
  - [http://educationcloset.com/steam/steam-resources-for-any-classroom](http://educationcloset.com/steam/steam-resources-for-any-classroom)

- STEM to STEAM: Art in K–12 Is Key to Building a Strong Economy
  - [www.edutopia.org/blog/stem-to-steam-strengthens-economy-john-maeda](http://www.edutopia.org/blog/stem-to-steam-strengthens-economy-john-maeda)

**Safety in the News**

Several months ago, seven elementary school students in California’s Orange County suffered minor burns during a botched science experiment. The students were participating in a YMCA after-school program at Wagon Wheel Elementary School in Coto de Caza. Students were melting a bar of soap in a microwave under the supervision of a teacher. Because they were excited about the investigation, students touched the liquefied soap before it cooled, resulting in first- and second-degree burns. This safety incident could have been prevented through the AAA safety process. For additional information about the incident, visit [http://abc7.com/news/7-oc-kids-burned-during-science-experiment/565010](http://abc7.com/news/7-oc-kids-burned-during-science-experiment/565010).