Please note: As an eighth-grade teacher, I focused on standards for eighth grade and middle school; however, similar standards related to problem solving and engineering design exist across all grade levels in each of the standards documents.

The ITEEA Standards for Technological Literacy for Grades 6-8 that relate to problem solving and engineering design fall within the overall area of Design:

Standard 8 – Students will develop an understanding of the attributes of design.

- Design is a creative planning process that leads to useful products and systems.
- There is no perfect design.
- Requirements for a design are made of criteria and constraints.

Standard 9 – Students will develop an understanding of engineering design.

- Design involves a set of steps, which can be performed in different sequences and repeated as needed.
- Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.
- Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

Standard 10 – Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

- Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system.
- Invention is a process of turning ideas and imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it.
- Some technological problems are best solved through experimentation.

At every grade level in the Common Core State Standards for Mathematics, the first item on the list of Mathematical Practices is “Make sense of problems and persevere in solving them.” For example, this is one of the eighth-grade standards in Geometry 8.G:

> 9. Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

Within the Next Generation Science Standards, standards related to engineering design problems cross all grade levels. This is the middle school standard:

> MS-ETS1-1 Engineering Design – Students who demonstrate understanding can define the constraints of a design problem with sufficient precision to ensure a successful

> solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Within all three content areas (tech ed, math, and science), problem solving and design are given top priority as practices used in the application of all types of conceptual knowledge. It is apparent by comparing the three standards documents that problem solving and design are the overarching methods by which scientific phenomena are investigated and understood, technology is developed, and math is used for practical applications. According to the ITEEA, "[d]esign is regarded by many as the core problem-solving process of technological development" (p. 90), and students should learn that "[r]equirements for a design are made up of criteria and constraints" (p. 95). In the CCSSM, students are expected to "[m]ake sense of problems and persevere in solving them" (Mathematical Practices 1.). The NGSS state that students should be able to "define the constraints of a design problem with sufficient precision to ensure a successful solution…" (MS-ETS1-1.)

Problem solving and engineering design are common themes across each STEM content area; they are the means by which different learning outcomes are achieved. However, within each STEM discipline, the cognitive and procedural knowledge students are expected to learn is different. Still, these bodies of knowledge are reinforced and applied through solving problems and designing solutions. Mastery of a repertoire of problem-solving strategies and the ability to adroitly use the engineering design process in a variety of situations are, indeed, "unifying" skills. They are the procedural knowledge common to each STEM content area.

References

International Technology Education Association. (2007). *Standards for technological literacy: Content for the study of technology* (3rd ed.). Reston, VA: International Technology Education Association. Retrieved from https://www.iteea.org/Publications/STEMProducts/77454.aspx

National Governors Association for Best Practices, & Council of Chief of State School Officers. (2010). Common Core State Standards for Mathematics: Standards for Mathematical Practice. Retrieved from http://www.corestandards.org/Math/Practice/

NGSS Lead States. January 2013. *Next Generation Science Standards: For States, By States* (NGSS Public Release II, The Nature of Science in the Next Generation Standards). Washington, DC: The National Academies Press. Retrieved from http://www.nextgenscience.org/