ASET Science & Engineering Practice (SEP) Tool: Designing Solutions

Name or ID:
Lesson/Unit Title: Intended Grade:

Directions for use

Indicate if a component is present using Y (yes) or N (no) and then, if it is present, fill in the right 2 columns.
A single lesson will most likely not address each of the components below.
The numbering of these components is not meant to indicate they should be used in sequence, they are simply for reference.

SEP 6	**Constructing Explanations and Designing Solutions:** The end-products of science are **explanations** of natural phenomena and the end-products of engineering are solutions to design problems. **a. Constructing Explanations:** The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power than previous theories. **b. Designing Solutions:** The goal of engineering design is to find a solution to problems that is based on scientific knowledge and models of the material world. During the design process models or prototypes are systematically tested, and iteratively revised based on performance. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

SEP 6b. Designing Solutions

Components of SEP **In this lesson/unit plan, it is clear that students have a structured opportunity to:**	Present? **Y/N**	**What teacher actions were taken to facilitate this component for students?**	**What are the students doing? What sensemaking or intellectual work are students doing?**
1) **Describe criteria** and **constraints** of a design problem, including quantification when appropriate			
2) **Apply scientific knowledge** to **generate** a design plan that includes consideration for the criteria and constraints			
3) Build, t**est,** and evaluate the design of an object, tool, process, or system			
4) **Refine and/or optimize** the design solution based on performance during testing and consideration of the criteria and constraints			

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ASET Grade Band Criteria (Grade Band: 6-8)

Science & Engineering Practices	
SEP 6b: Designing Solutions: Designing solutions in 6–8 builds on K– 5 experiences and progresses to include designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.	
By the end of the grade band **students** will have had a structured opportunity to develop an understanding of each of these. Individual lessons or units should include opportunities for **students** to practice one or more of the following components ……	
1) **Describe criteria** and **constraints** of a design problem, including quantification when appropriate	Students **identify and describe**: a. **Criteria and constraints** for specific sub-problems within a larger complex problem b. **How all criteria and constraints** will be taken into account when designing the solution c. **The rationale for which criteria** should be given highest priority if tradeoffs must be made
2) **Apply scientific knowledge** to **generate** a design plan that includes consideration for the criteria and constraints	Students **apply scientific ideas or principles** to design and/or construct a solution (object tool, process, or system) that solves a problem. As part of this solution, students: a. Break down a complex problem into a set of two or more **sub-problems** b. Propose two or more **solutions** for at least one of the sub-problems c. Describe/label the **components** of the solution d. Describe the **scientific rationale** for each solution (how it solves the problem), including choice of materials and structure of the device where appropriate e. Describe how solutions to **sub-problems are interconnected** to solve all or part of the larger problem
3) **Build, test, and evaluate** the design of an object, tool, process, or system	Students test a solution to determine **how well it solves** the defined problem. Students systematically **evaluate the solution(s)** to a complex real-world problem, including: a. Analysis (quantitative where appropriate) of the **strengths and weaknesses** of the solution with respect to each criterion and constraint b. An **evidence-based decision** of which solution is optimum, based on prioritized criteria, analyses of the strengths and weaknesses (costs and benefits) of each solution, and barriers to be overcome c. **Critiquing competing design solutions** based on set criteria and constraints
4) **Refine and/or optimize** the design solution based on performance during testing and consideration of the criteria and constraints	**Consideration of other factors** to implementing each solution, such as cultural, economic, or other sources of resistance to potential solutions a. **Refine a solution** based on the results from testing and evaluation b. **Improve the design** relative to criteria and constraints c. Optimize performance of a design by **prioritizing criteria**, making tradeoffs, testing, revising, and retesting

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