ASET Science & Engineering Practices (SEP) Tool: Using Mathematics and Computational Thinking

Name or ID:

Lesson/Unit Title: **Intended grade:**

SEP 5	**Using Mathematics and Computational Thinking:** In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of predictions.

Components of SEP **In this lesson/unit plan, it is clear that *students* have a structured opportunity to:**	**Mark with "x" if present in lesson**	**What teacher actions were taken to facilitate this component for students?**	**What are the students doing?**
1) Identify mathematical and/or computational representation(s) that can be used to interpret and make sense of phenomena or assess solutions to design problems	☐		
2) Apply mathematical and/or computational representation(s) of the phenomenon to identify relationships in the data and/or simulations	☐		
3) Use analysis of the mathematical and/or computational representation(s) as evidence to explain phenomena or assess solutions to design problems	☐		

Notes on Context/Special Considerations (part of school year, differentiation, student developmental considerations, etc.):

 Project Next Gen ASET was supported by a grant to the California State University East Bay by the National Science Foundation Discovery Research K12, Award No. DRL-1418440. PI: michele.korb@csueastbay.edu or contact corinne.lardy@csus.edu, michelle.sinapuelas@csueastbay.edu

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ASET Grade Band Criteria *(Grade Bands: 6-8, 9-12)*

<table>
<tr><th colspan="3">Science & Engineering Practices</th></tr>
<tr><td colspan="3">SEP 5: Using Mathematics and Computational Thinking: Mathematical and computational thinking in 6-8 builds on K-5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. In 9-12 they build on K-8 experiences and progress to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</td></tr>
<tr><td colspan="3">By the end of the grade band <u>students</u> will have had a structured opportunity to develop an understanding of each of these. Individual lessons or units should include opportunities for <u>students</u> to practice one or more of the following components ……</td></tr>
<tr><th></th><th>6-8 Grade Band</th><th>9-12 Grade Band</th></tr>
<tr><td>1) Identify mathematical and/or computational representation(s) that can be used to interpret and make sense of phenomena or assess solutions to design problems</td><td>Students will investigate a phenomenon and generate/apply mathematical representations to make sense of phenomenon or to test and compare proposed solutions to an engineering design problem.
To do this students will:
a. decide when to use qualitative vs. quantitative data
b. identify and select mathematical concepts and/or processes (such as ratio, rate, percent, basic operations, and simple algebra) that represent the phenomena or design problems
c. create or utilize a series of ordered steps (algorithms) to solve a problem or represent a phenomenon.
d. identify the relevant components/characteristics from given mathematical and/or computational representations of phenomena</td><td>Students will investigate a phenomenon and generate/apply mathematical representations to make sense of phenomenon or to test and compare proposed solutions to an engineering design problem.
To do this students will:
a. decide when to use qualitative vs. quantitative data
b. identify and select mathematical concepts and/or processes (such as ratio, rate, percent, basic operations, and algebra) that represent the phenomena or design problems
c. <u>apply techniques of algebra and functions to represent and solve scientific and engineering problems</u>.
d. identify the relevant components/characteristics from given mathematical and/or computational representations of phenomena
e. <u>apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.)</u></td></tr>
</table>

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2) Apply mathematical and/or computational representation(s) of the phenomenon to identify relationships in the data and/or simulations	Students will model phenomena or solutions to engineering design problem using mathematical concepts and/or processes. To do this students will: a. apply mathematical concepts and/or processes (as identified in 1.b or given by the instructor) to model scientific and engineering questions and/ or problems. b. use digital tools (e.g., computers) to analyze very large data sets for patterns and trends and transform data between various tabular and graphical forms c. use digital tools and/or mathematical concepts and arguments to represent phenomenon and relationships among data and/or underlying mechanism(s), or to compare solutions to an engineering design problem These include identifying relationships within data and/or simulations or correlations with physical observations	Students will model phenomena or solutions to engineering design problem using mathematical concepts and/or processes. To do this students will: a. apply mathematical concepts and/or processes (as identified in 1.b or given by the instructor) to model scientific and engineering questions and/ or problems. b. use digital tools (e.g., computers) to analyze very large data sets for patterns and trends and transform data between various tabular and graphical forms c. **create and/or revise a computational model or simulation** to represent phenomenon, designed device, process, or, system and relationships among data and/or underlying mechanism(s), or to compare solutions to an engineering design problem **d. use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world** These include identifying relationships within data and/or simulations or correlations with physical observations
3) Use analysis of the mathematical and/or computational representation(s) as evidence to explain phenomena or assess solutions to design problems	Students will: a. use mathematical representations to describe and/or support scientific conclusions and design solutions. b. identify relationships or explanations for phenomena that they will support The analysis of data includes consideration of: • Patterns in data • Predicting the effect of change in parameters or inform changes in an initial testing phase Synthesis of analysis with related scientific information	Students will: a. use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations b. identify relationships or explanations for phenomena that they will support The analysis of data includes consideration of: • Patterns in data • Predicting the effect of change in parameters or inform changes in an initial testing phase Synthesis of analysis with related scientific information

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