CONNECTICUT STEM FOUNDATION, INC.

CURRICULUM FOR A HIGH SCHOOL STEM RESEARCH PROGRAM

DRAFT 1: YEAR 1 and ADVANCED

ENDURING UNDERSTANDINGS
(Adapted from NGSS Science and Engineering Practices)

Scientists conduct research to collect data with the objective of furthering knowledge in a particular science area. Engineers put scientific knowledge to practical use. Both use the eight identified Science and Engineering practices to achieve their objectives.

1. ***Asking questions and defining problems*** **are initial steps that scientists and engineers must undertake.**
   - **In order to understand how natural and designed worlds work, scientists must ask and refine questions that can be empirically tested.**
   - **In order to clarify problems, determine criteria for successful solutions and identify constraints to solve problems about the designed world, engineers must ask questions**
   - **In order to clarify ideas, both scientists and engineers must ask questions.**

2. **Both scientists and engineers** ***develop and use models*** **as a means of representing ideas and explanations.**
   - **Diagrams, drawings, physical replicas, mathematical representations, analogies and computer simulations are some examples of modeling tools that scientists and engineers use to aid their understanding.**
   - **Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas.**
   - **Models are used to build and revise scientific explanations and proposed engineered systems. Revisions to models and designs are achieved by use of measurements and observations.**

3. **Scientists and engineers have different objectives for** ***planning and carrying out investigations.***
   - **Scientists use investigations to test hypotheses and models they have created to represent how the world works or to describe a scientific phenomenon.**
   - **Engineers use investigations to fix a malfunctioning technological system or to improve its performance. Additionally they use investigations to compare different solutions to a technological problem and to test effectiveness, efficiency and durability of their designs under different conditions.**
   - **Both scientific and engineering investigations are systematic, require selection of the most pertinent data to evaluate the outcome and must identify and take into account variables and parameters that may affect the outcome of the investigation.**

4. **Proper *analysis and interpretation of data* is necessary for scientists to draw accurate conclusions and for engineers to make informed decisions regarding the optimal engineering design.**
   - **Both scientists and engineers use tabulation, graphing, visualization and statistical analysis to organize and interpret the raw data collected.**
   - **Scientists evaluate experimental data look for relevant features and patterns, to identify sources of error in the investigation and to determine the degree of certainty in the results.**
   - **Engineers use data to assess the degree of performance of the design and to compare the effectiveness of various designs.**

5. **Both scientists and engineers *use mathematics and computational thinking* to predict the behavior of systems and to test the validity of these predictions.**
   - **Scientists and engineers use mathematics and computational thinking to represent physical variables and the relationships among these variables.**
   - **Scientists and engineers use mathematics and computational thinking to construct simulations and solve equations. Additionally these tools are used to recognize, express and apply quantitative relationships.**
   - **Despite the differences in how mathematics and computational thinking are used by scientists and engineers, there is an interdependence: Engineers apply the mathematical forms of scientific theories and scientists use information technologies developed by engineers. Thus both scientists and engineers are able to successfully carry out investigations and analyses and build complex systems that might not be possible without this synergy.**

6. **Scientists *construct explanations* for the causes of phenomena, whereas engineers *design solutions* to solve problems.**
   - **Scientists develop theories to explain observed phenomena. A scientist will test a theory and make adjustment to the theory, based on the outcome of the experiment. This process continues until testing the theory yields the same outcome multiple times and explains the phenomenon better than previous theories. At this point the theory is accepted.**
   - **Engineers use scientific knowledge and accepted scientific models to design solutions to problems. Engineers develop and test multiple solutions and select the optimum solution based on various considerations or criteria, such as function, feasibility, cost, safety, aesthetics, and legal restrictions.**

7. **Scientists *engage in argument from evidence* in order to reach agreements and arrive at the best explanation. Engineers *engage in argument from evidence* in order to determine the best solution to a design problem.**
   - **Evidence-based arguments are used by both scientists and engineers when listening to, comparing and evaluating competing ideas and methods.**

- **Evidence-based arguments are used by both scientists and engineers when they investigate phenomena, test a design solution, resolve questions about measurements, build data models and evaluate claims.**

8. **Being able to *obtain* information from various media sources, accurately *evaluate* the content and *communicate* information, evidence and ideas clearly and persuasively are fundamental skills for both scientists and engineers.**
   - **Both scientists and engineers must be skilled in reading various sources of scientific and technological information.**
   - **Both scientists and engineers must be able to critically evaluate ideas contained in information sources, spot errors and methodological flaws, distinguish observations from inferences, arguments from explanations and claims from evidence.**
   - **Both scientists and engineers must be effective communicators of information, evidence and ideas. They must be skilled in selecting the appropriate communication tools, including tables, diagrams, graphs models, interactive displays and equations. They must be fluent in communicating orally, in writing and through extended discussions.**