The Tech Interactive

Next Generation Science Standards Engineering Progression Summarized

	K-2	3-5	6-8	9-12
Vocab / Concept Introduced	• Design Problem = *situation that people want to change or create* • Quantitative Data • (*Desired Features*)	• Design Problem = *a given need or want* • Criteria = *desired feature / criteria for success* • Constraints = *available materials / resources (time/cost)* • Prototype • Fair Test • Controlled Variables • Qualitative Data • Failure Points	• Constraints *(+human/environmental impact)* • Trade-off • Optimal / Optimize • Iterate • Independent variable • Dependent variables • Correlation • Causation • Precision • Accuracy • Error Analysis • Mean, Median, Mode • Validity	• Criteria *(+societal needs/wants)* • Constraints *(+satisfy societal requirements)* • Risk Mitigation • Reliability • Slope • Intercept • Correlation • Coefficient • Linear and nonlinear functions • Trigonometric functions • Exponentials • Logarithms

Skills Summarized *Define the Problem*	• Simple problem *(situation that people want to change or create)*
	• Teacher given problem / students understand by:
	  ○ Asking questions
	  ○ Making observations
		• Simple problem with:
		  ○ Several criteria
		  ○ Constraints on materials, time or cost
		• Students research and define the problem
			• Simple problem with:
			  ○ Constraints expand to include scientific knowledge
			• Students define the problem and jointly agree upon design criteria
				• Major, complex global or local challenge
				• Students:
				  ○ Break down the problem into smaller problems
				  ○ Ask questions to clarify and refine the problem
				  ○ Specify qualitative and quantitative criteria / constraints
				  ○ Break down criteria into simpler criterion / approach systematically
				  ○ Prioritize criteria over other criteria (make trade-offs)

Imagine / Create/ Iterate	• Simple sketch or model • 1-2 solutions	• Build prototypes • Multiple solutions • Identify failure points for aspects of design that can be improved	• Develop complex models where inputs and outputs can be tested • Multiple solutions • Combine best features of different designs into a new design • Optimize performance by prioritizing criteria and making trade-offs	• Complex models including computational simulations / models • Prioritize criteria and trade-offs to evaluate impact of designs

Test / Reflect (Analyze)	• Teacher-led investigations
	• Compare 2 solutions by:
	  ○ Making observations
	  ○ Making measurements
	  ○ Making comparisons based on data / observations
	  ○ Comparing performance strengths and weaknesses
	• Students determine if solution performs as intended / meets the goal by:
	  ○ Collecting, recording and sharing observations
	  ○ Describing patterns and relationships
		• Student teams plan / conduct evaluations
		• Compare 2 solutions by:
		  ○ Including a fair test with controlled variables and multiple trials
		  ○ Collecting quantitative and qualitative data
		  ○ Testing under likely conditions
		• Students assess test data to refine their design by:
		  ○ Representing data in tables / graphically to reveal patterns using digital tools where possible
		  ○ Comparing / contrasting data by different groups
		• Assess solutions individually based on how well each meets the criteria and constraints
			• Students plan and conduct investigations individually and with a team
			• Compare multiple solutions by:
			  ○ Using systematic evaluation processes
			  ○ Including fair tests with multiple variables
			  ○ Identifying independent / dependent variables, controls, tools, measurements and amount of data needed
			  ○ Testing inputs and outputs
			  ○ Testing under a range of conditions
			• Students define an optimal operational range to meet the criteria by:
			  ○ Using graphical displays of large data sets to identify temporal and spatial relationships
			  ○ Using statistics and probability (mean, median, mode, error analysis) to analyze data
			  ○ Consider limitations of data analysis
			  ○ Seek to improve precision and accuracy of data
			• Identify characteristics of each design that performed best on different tests for different criteria
				• Students plan and conduct investigations individually and with a team
				• Evaluate a complex conceptual, mathematical, physical and empirical models by:
				  ○ Including fair tests that consider confounding variables and ensure variables are controlled
				  ○ In a safe and ethical manner
				  ○ Using computer simulations
				• Students identify characteristics of a design to optimize it relative to the criteria by:
				  ○ Conducting detailed statistical analysis (function fits to data, slope, intercept, correlation coefficient for linear fits)
				  ○ Using tools, technologies or models
				  ○ Comparing data sets for consistency
				  ○ Using models to generate / analyze data
				• Identify failure points and evaluate how well solutions meet societal constraints

Share Your Solution	• Students make a claim about the effectiveness of a solution supported with evidence by:
	  ○ Comparing ideas
	  ○ Assessing whether the solution performs as intended
		• Students make a claim about the merit of a solution supported with evidence by:
		  ○ Comparing solutions based on how well they meet criteria and constraints
		  ○ Citing relevant evidence about how it meets the criteria / constraints.
		  ○ Critiquing peer solutions by citing evidence.
			• Students make an oral or written argument that supports or refutes the performance of a solution based on evidence by:
			  ○ Evaluating solutions to determine whether they meet criteria / constraints.
			  ○ Analyzing / interpreting data for similarities and differences
			  ○ Constructing a convincing argument that supports or refutes solutions
				• Students make and defend a claim or critique based on evidence about the effectiveness of a design solution by basing claims and critiques on:
				  ○ Scientific knowledge
				  ○ Student-generated evidence
				  ○ Prioritized criteria
				  ○ Trade-off decisions
				  ○ Logical arguments regarding relevant societal / environmental / ethical factors.

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