Science and Engineering Practices Progression

Science utilizes observation and experimentation along with existing scientific knowledge, mathematics, and engineering technologies to answer questions about the natural world. Engineering employs existing scientific knowledge, mathematics, and technology to create, design, and develop new devices, objects, or technology to meet the needs of society. By utilizing both scientific and engineering practices in the science classroom, students develop a deeper understanding and competence with techniques at the heart of each discipline.

The categories of scientific and engineering practices appear across all grade levels and content areas. Those categories are: asking questions and defining problems; planning and carrying out investigations; interpreting, analyzing, and evaluating data; constructing and critiquing conclusions and explanations; developing and using models; and obtaining, evaluating, and communicating information. These science and engineering practices are embedded in instruction to support the development and application of science content. The expectations within each of these categories build as students progress in their academic work. Once an expectation has been introduced at a grade level, they are expected to continue with this expectation through future grade levels. This continued exposure to each expectation and the vertical progression of the categories will provide students with the practices they will need to be scientifically literate graduates.

A specific scientific and engineering practice may include a word or phrase that is *italicized* or **bolded**. The grade level where that word or phrase occurs is also *italicized* or **bolded** in the chart.

Scientific and Engineering Practices:		K	G1	G2	G3	G4	G5	G6	LS	PS	HS
	uestions and defining problems										
	ask testable questions based on observations and predict reasonable outcomes	Х					X				
-	based on patterns										
	ask questions and make predictions based on observations		Х								
	ask questions that can be investigated and predict reasonable outcomes			Х	X						
	ask questions about what would happen if a variable is changed				X						
SU	identify scientific and non-scientific questions					Х					
lestio	ask questions to determine relationships between independent and dependent variables							X			
Asking questions	ask questions and develop hypotheses to determine relationships between independent and dependent variables								Х		
ski	ask questions that require empirical evidence to answer									Х	
Ask	ask questions that arise from careful observation of phenomena <i>and/or organisms</i> , examination of models and theories, or unexpected results, and/or to seek additional information										X (B)
	determine which questions can be investigated within the scope of the school laboratory or field to determine relationships between independent and dependent variables										Х
	make predictions based on observations and prior experiences	Х		X							
50 00	develop hypotheses as cause-and-effect relations					Х	Х				
oping heses	develop hypotheses and identify independent and dependent variables							Х			
velop pothe	develop hypotheses indicating relationships between independent and dependent variables									Х	
De	generate hypotheses based on research and scientific principles										Х
[make hypotheses that specify what happens to a dependent variable when an independent variable is manipulated										Х
	identify a problem based on need	Х									
DefiningDefiningbroblemsproblemside <t< td=""><td>identify a simple problem that can be solved through the development of a new tool or improved object</td><td></td><td>Х</td><td>Х</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	identify a simple problem that can be solved through the development of a new tool or improved object		Х	Х							
	define a simple design problem that can be solved through the development of				Х	Х	Х				
	an object, tool, process, or system										
D D	offer simple solutions to design problems							Х	Х	Х	
	define design problems that involve the development of a process or system										C, ES, PH
	with interacting components, criteria and constraints										гΠ

Scientif	ic and Engineering Practices:	K	G1	G2	G3	G4	G5	G6	LS	PS	HS
Planning	and carrying out investigations										
	make observations to collect data	Х									
50	identify characteristics and properties of objects by observation	Х	X								
Planning and conducting investigations	with guidance, <i>plan and</i> conduct investigations to produce data		Х	X							
lict	with guidance, plan and conduct investigations				Х						
ing and condu investigations	identify variables when planning an investigation					Х					
cor tio	collaboratively plan and conduct investigations to produce data					Х	X				
iga	identify independent variable, dependent variables, and constants						Х				
an est	determine data that should be collected to answer a testable question						Х				
nvn	independently and collaboratively plan and conduct observational and							Х	Х	Х	
in i	experimental investigations; identify variables, constants, and controls where										
lar	appropriate, including the safe use of chemicals and equipment										
-	individually and collaboratively plan and conduct observational and										Х
	experimental investigations										
	determine appropriate sample size and techniques										В
	record information from investigation	Х									
	measure relative length and weight of common objects	Х									
	use tools to measure relative length, weight, volume, and temperature of		Х								
	common objects										
	use appropriate tools to measure length, weight, and temperature of common			Х							
a	objects using U.S. Customary units										
dat	measure time intervals using proper tools			Х							
50	measure elapsed time				Х	Х					
Recording data	use appropriate methods and/or tools for collecting data				Х						
10L	estimate length, mass, volume, and temperature				Х						
kec	measure length, mass, volume, and temperature in metric and U.S. Customary				Х						
H	units using proper tools										
	take metric measurements using appropriate tools and technologies including the					Х	Х	Х	X	Х	
	use of microscopes										
	evaluate the accuracy of various methods for collecting data							Х	Х	Х	
	select and use appropriate tools and technology to collect, record, analyze, and										Х
	evaluate data										

Planning	and carrying out investigations (con't)	K	G1	G2	G3	G4	G5	G6	LS	PS	HS
lg ing ss	use tools and/or materials to design and/or build a device that solves a specific problem				X	X	Х	X			
Applying engineering practices	apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process, or system									Х	
ıd Suə V	plan and conduct investigations or test design solutions in a safe and ethical manner including considerations of environmental, social, and personal effects										Х
Scientif	ic and Engineering Practices:	K	G1	G2	G3	G4	G5	G6	LS	PS	HS
Interpret	ing, analyzing, and evaluating data										
	organize and represent data	Х									
	classify and/or sequence objects based on a single physical characteristic or property	Х									
d ata	describe patterns and relationships	Х	X								
and 5 dat	use and share pictures, drawings, and/or writings of observations		Х								
Recording and representing data	organize and represent various forms of data using tables, picture graphs, and object graphs		Х								
cor ese	classify and arrange objects based on a single physical characteristic or property		Х								
Re	organize and represent data in pictographs and/or bar graphs			Х	X						
r(organize and represent data in bar graphs and line graphs					Х					
	organize simple data sets to reveal patterns that suggest relationships						X	Х			ļ
	record and present data in an organized format that communicates relationships and quantities in appropriate mathematical or algebraic forms										C, PH

Interpr	eting, analyzing, and evaluating data (con't)	K	G1	G2	G3	G4	G5	G6	LS	PS	HS
	read and interpret data in object graphs, picture graphs, and tables	Х									
	read and interpret data displayed in tables, picture graphs, and object graphs,		Х								
	using the vocabulary more, less, fewer, greater than, less than, and equal to										
	read and interpret data represented in pictographs and bar graphs			Х							
	read, interpret, and analyze data represented in pictographs and bar graph				Х						
	interpret and analyze data represented in bar graphs and line graphs					Х					
	compare two different representations of the same data (e.g., a set of data displayed on a chart and a graph)					Х					
	represent and analyze data using tables and graphs						Х				
ata	construct, analyze, and interpret graphical displays of data							Х			
ng da	compare and contrast data collected by different groups and discuss similarities and differences in their findings						X	Х			
alyzi	consider limitations of data analysis and/or seek to improve precision and accuracy of data								X		
an	identify, interpret, and evaluate patterns in data								Х		
nd	construct, analyze, and interpret graphical displays of data								Х		В
ing a	compare and contrast data collected by different groups and discuss similarities and differences in their findings								X		
Interpreting and analyzing data	construct and interpret data tables showing independent and dependent variables, repeated trials, and means									X	B, ES
Inte	construct, analyze, and interpret graphical displays of data, <i>including scatterplots</i> and line plots, and consider limitations of data analysis									X	B, ES
	apply mathematical concepts and processes to scientific questions									Х	ES
	solve problems using mathematical manipulations including the International System of Units (SI), scientific notation, derived units, significant digits, and dimensional analysis										C
	analyze data using tools, technologies, and/or models (<i>e.g., computational, mathematical, statistical</i>) to make valid and reliable scientific claims or										B, <i>C</i> , ES.
	determine an optimal design solution										PH
	analyze data graphically and use graphs to make predictions										C, PH
	differentiate between accuracy and precision of measurements										C
	consider limitations of data analysis when analyzing and interpreting data										C, PH

Interpret	ting, analyzing, and evaluating data (con't)	K	G1	G2	G3	G4	G5	G6	LS	PS	HS
	analyze data from tests of an object or tool to determine if it works as intended				Х	Х					
50 5 0 50	use data to evaluate and refine design solutions to best meet criteria						Х	Х	Х	X	
plying neerin ictices	use data in building and revising models, supporting an explanation for phenomena, or testing solutions to problems										C, PH
Ap engi	evaluate the impact of new data on a working explanation and/or model of a proposed process or system										PH
Applying engineeringApplying constructing constructingApplying constructing constructingad ad b ad co co co co 	analyze data to optimize a design										C, PH
	ic and Engineering Practices:	K	G1	G2	G3	G4	G5	G6	LS	PS	HS
Construc	ting and critiquing conclusions and explanations										
	make simple conclusions based on data or observations	Х	Х	Х							
	recognize unusual or unexpected results		Х	Х							
	distinguish between opinion and evidence			Х							-
	use evidence (i.e., measurements, observations, patterns) to construct or support explanations <i>and to make inferences</i>				Х	X					
su	construct and/or support arguments with evidence, data, and/or a model						Х				
clusio	construct explanations that include qualitative or quantitative relationships between variables							Х	Х		
cone	construct scientific explanations based on valid and reliable evidence obtained from sources (including the students' own investigations)							Х	Х	Х	
ing	construct arguments supported by empirical evidence and scientific reasoning									Х	
uct	differentiate between a scientific hypothesis and theory and law								Х	X	Х
onstr	make quantitative and/or qualitative claims regarding the relationship between dependent and independent variables										В
Ŭ	make quantitative and/or qualitative claims based on data										ES, PH
	construct and revise explanations based on valid and reliable evidence obtained from a variety of sources including students' own investigations, models, theories, simulations, and peer review										X
	construct arguments or counterarguments based on data and evidence										Х
	generate and/or compare multiple solutions to a problem				Х						
	describe how scientific ideas apply to design solutions				X		Х				-
ying ering tices	generate and compare multiple solutions to problems based on how well they meet the criteria and constraints						X	X		Х	
Appl angine pract	apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and design solutions										X
Ŭ	compare and evaluate competing arguments or design solutions in light of currently accepted explanations and new scientific evidence										B, C, PH

Scientif	ic and Engineering Practices:	K	G1	G2	G3	G4	G5	G6	LS	PS	HS
Developi	ng and using models										
	distinguish between a model and an actual object	Х									
	use <i>physical</i> models to demonstrate simple phenomena and natural processes		X	Х							
	use models to demonstrate simple phenomena and natural processes				Х						
	develop a model (e.g., diagram or simple physical prototype) to illustrate a proposed object, tool, or process				X						
	develop and/or use models to explain natural phenomena					Х					
	identify (evaluate) limitations of models					Х	Х	X	X	X	
els	develop models using an analogy, example, or abstract representation to describe a scientific principle or design solution						X				
ode	use, develop, and revise models to predict and explain phenomena							Х			
B	use scale models to represent and estimate distance							Х			
rpret	construct, develop , and use models and simulations to illustrate, <i>predict</i> , and/or explain observable and unobservable phenomena, <i>life processes, or mechanisms</i>								X	X	
nte	evaluate the merits and limitations of models										Х
Develop and interpret models	develop, revise, and/or use models based on evidence to illustrate or predict relationships										B, C, ES
/elop	construct and interpret scales; diagrams; classification charts; graphs; tables; imagery; models; including geologic cross sections and topographic profiles										ES
Dev	read and interpret topographic and basic geologic maps and globes, including location by latitude and longitude										ES
	develop and/or use models (<i>including mathematical and computational</i>) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems										B, PH
	use models and simulations to visualize and explain the movement of particles, to represent chemical reactions, to formulate mathematical equations, and to interpret data sets										С
	identify and communicate components of a system orally, graphically, textually, and mathematically										PH

Scientifi	c and Engineering Practices:	K	G1	G2	G3	G4	G5	G6	LS	PS	HS
Obtaining	g, evaluating, and communicating information										
	read and comprehend reading-level appropriate texts and/or other reliable media				Х	Х	Х				
and ng ion	read scientific texts, including those adapted for classroom use, to obtain scientific and/or technical information							Х	X	Х	
Obtaining an evaluating information	gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication							Х	X	Х	
	gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and credibility of each source										X
)	compare, integrate, and evaluate sources of information presented in different media or formats to address a scientific question or solve a problem										Х
5	communicate comparative measures (e.g., heavier, lighter, longer, shorter, more, less, hotter, colder)	Х									
ing n	communicate observations using pictures, drawings, and/or speech	Х									
ommunicating information	communicate observations and data using simple graphs, <i>pictures</i> , drawings, numbers, speech and/or writing		X	X							
nu	communicate scientific information, design ideas, and/or solutions with others				Х	Х	Х				
Comn info	construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning							Х	X	Х	
·	communicate scientific and/or technical information about phenomena in multiple formats										Х