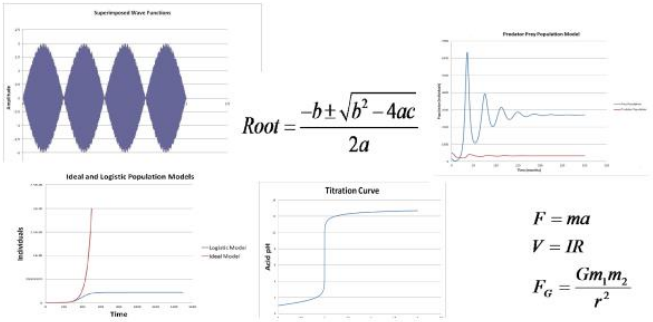
Spreadsheet Lab Manual LLC

Educating students, training and equipping teachers with spreadsheet modeling since 2009



STEM Data Applications for High School

Physics
Chemistry
Biology
Math
Design

Students code *then* investigate and interpret a spreadsheet model: Learn by testing variables using inquiry to observe quantitative phenomena, guided by curiosity & interaction with living graphs

www.SpreadsheetLabManual.com

Subject	Module Title	Content Area(s)
Bio 401	"Genetics Simulation"	Genetics, Hardy Weinberg, Population Traits
Bio 402*	"**Modeling Population Growth 1**"	Ideal Growth, Competitive/Carrying Capacity
Bio 403	"Modeling Population Growth 2"	Ecology: Predator Prey Population Simulation
Chem 301	"Determining the Limiting Reagent"	Stoichiometry, % Excess, LR
Chem 302*	"**Titration Simulation**"	Strong Acids/Bases, pH
Chem 303	"4 Gas Laws"	Ideal Gas Laws, Quantitative Reasoning
Chem 304	"Graham's Law"	Diffusion, Effusion, Kinetic Theory
Chem 305*	"**Newton's Law of Cooling 1**"	(Object only) Heat Mechanics/Transfer
Chem 306	"Newton's Law of Cooling 2"	(Object + System) Heat Mechanics/Transfer
Math 501	"Quadratic Formula"	*Algebra 1*, Finding Roots, Graphing Parabolas
Math 502	"Investments & Amortizations"	*Applied Math:* Interest Rates, Debts and Stocks
Math 503	"Casino Simulation"	*Prob/Stat* & Logical Functions, Simulations
Math 504.$_{1\text{-}4}$	"Graphing and *Algebra 2* Functions"	Parabola$_{0.1}$ Cubic$_{0.2}$ Hyperbola$_{0.3}$ Exponential$_{0.4}$
Math 505	"Designing the Optimum Can"	Use *Geometry* for packaging cost analysis.
Math 506	"The Monty Hall Problem"	*Prob/Stat*, Simulating Game Show Outcomes
Phys 201	"Vector Solver"	Vectors, Components & Addition
Phys 202*	"**Terminal Velocity**"	Kinematics, Newton's Laws, Forces
Phys 203*	"**Comparing Trajectories**"	2D Kinematics, Newton's Laws, Forces
Phys 204	"Helium Balloons"	Buoyancy, Density, Kinematics*, Newton's Laws*
Phys 205*	"**Rocket Science 1** and 2"	Impulse, Newton's Laws, Kinematics Graphs
Phys 206	"Gravitation"	Universal Gravitation, General Gravitational PE
Phys 207	"Angular Motion in Cars"	Angular Motion, Newton's Laws, Energy, Power
Phys 208	"The Superposition Principle"	Wave Superposition, Beats
Phys 209	"Electrostatics (Coulomb's Law 2D)"	Electrostatics Force, Field, PE, Potential
Phys 210	"Electrostatics (Coulomb's Law 3D)"	Electrostatics, Point Charges & Continuous
Phys 211	"Current Electricity"	Circuits, Power Equation, Ohm's Law

***Training Videos Live**

Training Instructional Materials:

- "9 Quick Activities" Training Module
- "Spreadsheet Modeling: A Comprehensive How-To"
- "Keyboard Command and Corner-Cutting"
- "Teacher Tips" and "Graphing Instructions"

Does your school use Sheets or Excel? (both available)

WHY SPREADSHEETS?

Fluency multiplies worker productivity. Spreadsheets have been standardized for decades. **Today's job decisions are dictated by conclusions drawn from data. Data fluency is a need.** Coding and navigating a numerical spreadsheet, enhances and upgrades fluency, delivers a new content capability, readily differentiates and breaks down a language barrier with the universal language of math. Increasing applications increases student fluency.

The Next Generation Science Standards (NGSS) have prioritized and emphasized model building as SLM has since 2009. Here'

SLM PD provides multiple benefits simultaneously: deliver skills to students, multidisciplinary content, efficient access to training and instructional materials for teachers. Upgrading literacy to fluency empowers teachers and enhances the students' experience. *Literacy:* read and input numbers or text on a spreadsheet *Fluency:* mathematically command the modern microprocessor to solve problems, display solutions, analyze data and interactively learn with dynamic models using experimentation and inquiry, spending less time and getting greater accuracy on **all future data tasks!** ***Got fluency?***

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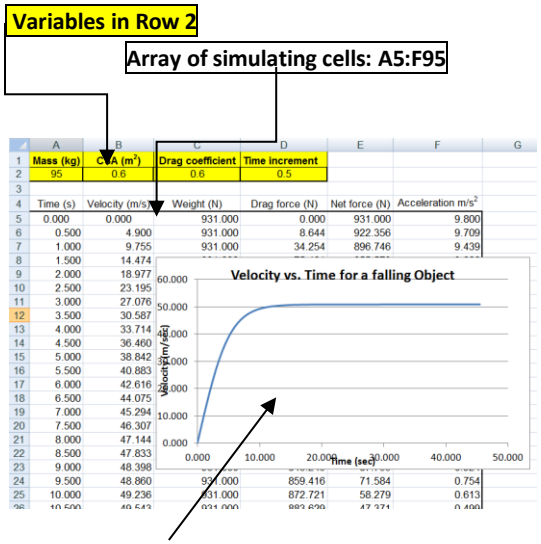
What is a "SLM Module"?

Starting from a blank spreadsheet, students follow a procedure to build a specific mathematical model using formulas from established science and math curriculum content. A wide variety of phenomena can be studied quantitatively with the spreadsheet's calculating power. Like in the example (student view) below, a student will study and learn from the model after first programming it. By experimenting on the variables in row 2 which are referenced in the calculating cells below, students can directly link the Math to the Science while growing their skills sets on spreadsheets for all future applications.

Below: Screenshot of "Terminal Velocity" (available to be downloaded in its entirety from) www.SpreadsheetLabManual.com/freesample.htm



Velocity vs. Time Graph: Students alter the variables in row 2 and observe the immediate response in the graph. They learn by experimenting on each variable scientifically and quantitatively model everyday objects of all shapes and sizes falling through air.

No calculus needed! How?

Continually changing (non-ideal) motion variables or functions are broken up into many very small increments that can be treated as uniform/constant ones. (Liken it to modeling a curved line with 1000 connected straight line segments)

SLM Modules Have 6 Teacher Files:

Pedagogy is sequenced in NGSS aligned Lesson Plan.XLS File$_1$: Reserve student computers; Print; Present; Proctor.

1. Present the Introductory .PPT file$_3$ to the students.
2. Students follow the printed Activity Handout .DOC file$_2$ to program the spreadsheet model from blank spreadsheet, as the teacher proctors. Teachers have a completed, fully working spreadsheet model .XLS file$_5$ on their USB (provide students with a time saving blank template .XLS file$_4$ with columns labeled, graphs made, but they still program it)
3. With a printout of the Answer Key .DOC file$_6$ Teachers actively support students as they work (the key has detailed description of any/all necessary spreadsheet manipulations needed to solve the 'Development Questions' that assess the design and model building objectives so they reflect on the programming and the 'Analysis Questions' that guide student inquiry and assess the content specific objectives).

HOW DOES THIS HELP SCHOOLS SATISFY NGSS?

NGSS established 8 Science and Engineering Practices (SEPs) including *quantitative reasoning*, *modeling* and *data analysis and interpretation* that students are required to employ in learning disciplinary core ideas (DCIs). Spreadsheets elegantly demonstrate cross cutting concepts (CCCs) like *scale*, *proportion and quantity*, *cause and effect*, *patterns*, better than other methods because that is what people use! SLM is curriculum aligned multidisciplinary experiences that are highly engaging for students. Spreadsheet models represent and visualize meaningful phenomena. Instant feedback (is craved by students and essential to curiosity driven, inquiry based learning) enables time efficient design of experiments, testing of variables. By engaging students with **all 8 SEPs** through writing and investigating spreadsheet models, this pedagogy gives life to math, enhances STEM learning, and optimizes valuable instructional time.

Since 2009 The Spreadsheet Lab Manual was working to incorporate spreadsheets into the high school STEM experience well before NGSS was adopted. NSF SBIR Phase 1 Funding Award (Summer 2019):