TeacherGeek®

The Science of TeacherGeek

White Paper

TeacherGeek Inc. 2013 R1.

Introduction: Why TeacherGeek?

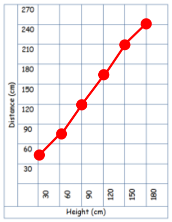
- TeacherGeek engages the hands and minds of students and teachers alike with a broad range of exciting and inspiring STEM education activities and concepts.
- TeacherGeek is a high level solution to increasing STEM skills that is built on sound research, is evidence-based, and represents best practices in education.
- TeacherGeek is true science and engineering that responds to the needs of students, teachers, parents, and schools, fosters creativity and innovation, and prepares students for work and careers.
- TeacherGeek is trans-disciplinary, offering explicit links to Math and ELA standards and instruction.

A student testing his *Hill Climb Vehicle* created with TeacherGeek components.

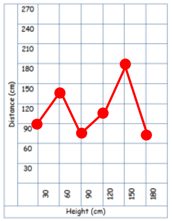
True Science & Engineering

- Students create unique solutions through scientific and engineering methods that are process-, performance-, and goal-driven.
  - Various design solutions from the same set of TeacherGeek components:

- Data-driven design
  - Science and engineering projects may fail to provide usable and consistent data if the materials perform unreliably. Without reliable data to drive the science and engineering processes, projects are reduced to craft activities.
  - TeacherGeek components allow for designs which test accurately and consistently, so engineering can be driven by scientific research and method.



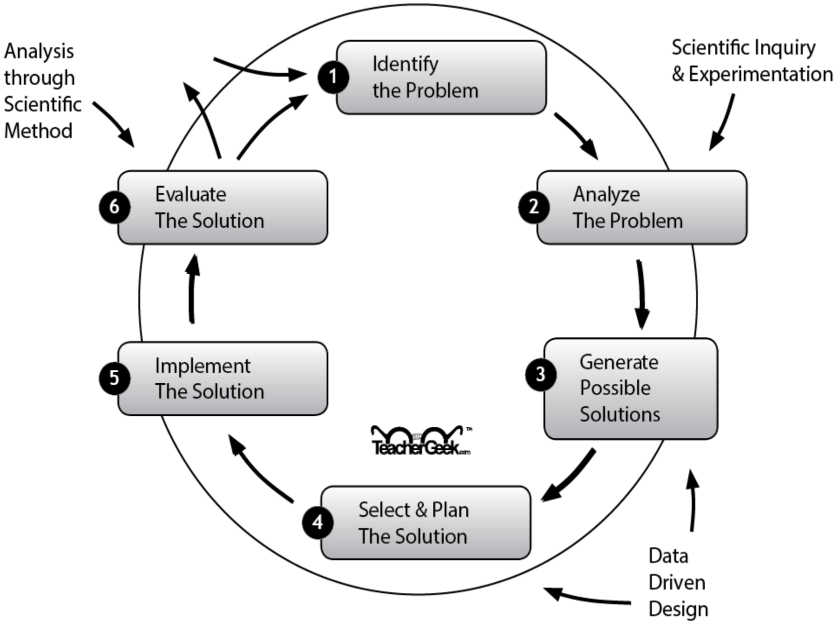
Linear data from a TeacherGeek ramp rolling vehicle



Noisy, confusing data from a craft built ramp rolling vehicle

Facilitates Critical Thinking

- Students develop critical thinking and problem-solving skills.
  - TeacherGeek offers a problem-based approach to learning that focuses on the experience and requires students to apply the engineering process of investigating, proposing, creating, and evaluating solutions. As a result, students learn how to ask scientific questions, gather information, and analyze it to solve problems (Strobel et al., 2013).
  - When students investigate subject matter through hands-on activities and problem-based learning, they learn content as well as critical thinking strategies and self-directed learning skills (Hmelo-Silver, 2004).



The engineering process

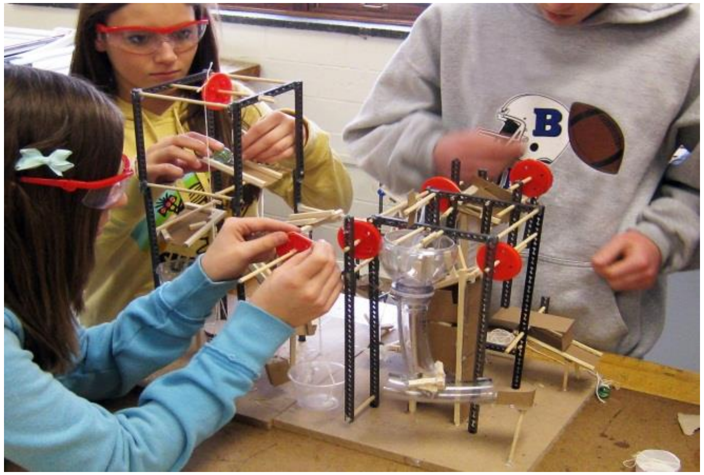
Promotes Student Engagement

- Students are focused and on-task.
  - Teachers using TeacherGeek report engaged students who are excited to learn. Educators who use hands-on learning also report increases in student engagement, knowledge retention, and learner independence (Haury & Rillero, 1994; Schoerning & Hand, 2013).
  - Engaged students are better able to comprehend complex ideas, master difficult skills, and increase their achievement. Positive student engagement is related to higher achievement and lower drop-out rates (Fredricks et al., 2011).

High school students engaged in a TeacherGeek *Hydraulic Arm* activity.

Encourages Teamwork

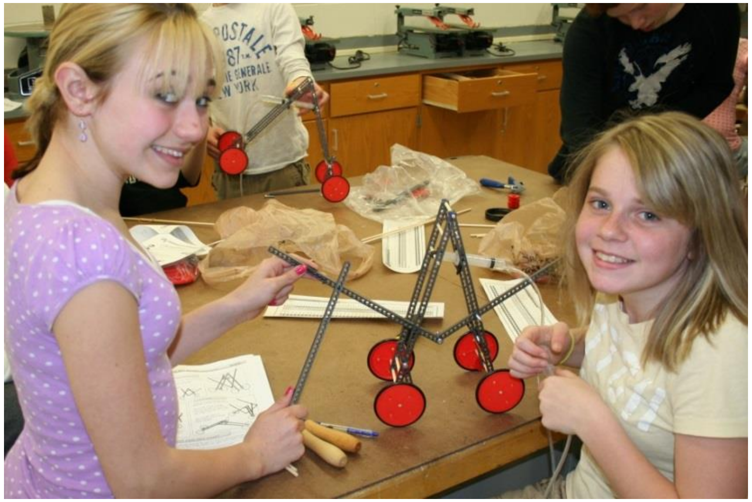
- Students work together to solve problems.
  - Through TeacherGeek, students learn to work productively with other team members who may have different socioeconomic backgrounds, different learning styles, and different cultures. As a result, learning is enriched and students are better prepared to take their place in the business world.
  - Businesses complain that our education system fails to teach students the 21st-century skills needed for the work world, such as problem-solving, communication, and the ability to work well in teams (Casner-Lotto and Barrington, 2006).
  - Entrepreneurship and learning through design criticism is facilitated through collaboration and teamwork (West & Hannafin, 2011).



Elementary students collaborating to create a TeacherGeek *Crazy Contraption*.

Builds Communication & Language Skills

- Students talk about what they are doing.
  - Students increase their ability to use multiple modes of verbal and non-verbal communication with TeacherGeek STEM activities that use real engineering materials and concepts.
  - Student language skills increase as they learn and use new vocabulary to describe and communicate the problem, the processes they use to solve the problem, and to justify their solutions (Lara-Alecio et al., 2012).
  - Hands-on, collaborative activities allow students to discuss, debate, verbalize, and explain processes and concepts while working together (Bass et al., 2011).



Students explaining how their *Hydraulic Pet* works.

Empowers Students

- Students can showcase their abilities.
  - TeacherGeek empowers students because the activities meet students where they are. Students interact with the lessons in a way that builds on their unique level of prior knowledge, past experiences, and current abilities. Such hands-on activities inspire students to meet and exceed high standards for learning and participation, while engaging multiple senses and abilities.
  - Students who are economically or academically disadvantaged can gain significantly from activity-based programs, thereby closing achievement gaps (Bredderman, 1983; Jackson & Ash, 2012; Minner et al., 2010).

Students working on TeacherGeek activities in an after school program.

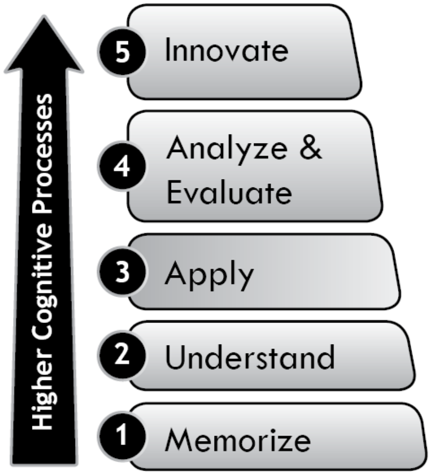
Enhances Spatial Ability

- Students can develop spatial ability
  - Over 50 years of research indicates that spatial ability plays an important role in STEM (Wai et al., 2009).
  - Spatial ability can be developed through training which can lead to higher grade point averages in courses such as chemistry, physics and mathematics (Fredricks et al., 2011; Small & Morton, 1983).
  - Spatial ability is neglected in school curricula and not addressed in traditional standardized assessments, resulting in an under-indentified, under-served population who has the potential to bolster the current scientific and technical workforce (Benbow, 2012; Wai et al., 2009).
  - Students who go on to obtain advanced degrees in STEM appear to have higher developed spatial ability than verbal ability (Robertson et al., 2010).

Students engineering an electrical system for a TeacherGeek *Bug*.

Cultivates Creativity & Innovation

- Students become creative and innovative
  - TeacherGeek activities take students through a process which grows their understanding and abilities to the levels at which they can apply, analyze, evaluate, and innovate new solutions.
  - TeacherGeek infuses creativity into math and science domains, thereby fostering student interest and debunking the perception that math and science are not creative (Charyton, Jagacinski, & Merrill, 2008; Kaufman & Baer, 2004).
  - Considerable evidence suggests that employee creativity can make a substantial contribution to an organization's growth and competitiveness (Baer & Oldham, 2006).
  - Employee creativity and corporate innovation are critical if companies are to reach their goals and become profitable (Scott, 1995).



Steps to innovation

Designed for Optimal Learning: Grading the Systems

	Simple Construction	Robust Mechanisms	Take-Home Affordability	Integrates with Other Materials	Design & Engineering Process Compatible	Scientific Method Compatible	Gender Equitable	No Machinery Required (can be used in any classroom)	Challenge Ready
Beam & Hub[1]	B	C	C	C	A	B	A	A	B
Bricks[1]	A	C	C	C	A	B	A	A	A
TeacherGeek	A	A	A	A	A	A	A	A	A
Craft [2]	B	C	A	A	C	C	A	A	A
Wood Shop [3]	B	B	A	B	B	B	C	D	A

Simple Construction: Students focus on design and engineering without feeling limited by the construction system.

Robust Mechanisms: Sturdy, fully functioning mechanisms can be created that reproduce actual, real-world applications.

Take Home Affordability: Students can take their projects home for further experimentation and to share with their family.

Integrates with Other Materials: Students can incorporate other materials and components ,which promotes innovation.

Design & Engineering Process Compatible: Students can redesign and evolve projects through engineering processes.

Scientific Method Compatible: Projects provide reliable, precise, and usable outcomes that facilitate testing and analysis.

Gender Equitable: The system appeals equally to males and females.

No Machinery Required: The system can be used in a standard classroom without machinery.

Challenge Ready: The system is conducive for classroom competitions.

[1] Common toy construction systems that may include beams and hubs or interlocking bricks.
[2] Craft: Projects created with common house and school supplies (e.g., paper, screws, glue, tape, pipe cleaners).
[3] Wood Shop: Projects created using wood and metal processing tools; tools generally only available in workshops.

NGSS Physical Science Standards Met Through TeacherGeek

- PS2 Motion and stability: Forces and interactions—How can one explain and predict interactions between objects and within systems of objects?
  - A: Forces and Motion
  - B: Types of Interactions
  - C: Stability and Instability in Physical Systems
- PS3 Energy—How is energy transferred and conserved?
  - A: Definitions of Energy
  - B: Conservation of Energy and Energy Transfer
  - C: Relationship Between Energy and Forces
  - D: Energy in Chemical Processes and Everyday Life
- PS4 Waves and their applications in technologies for information transfer—How are waves used to transfer energy and information?
  - B: Electromagnetic Radiation
  - C: Information Technologies and Instrumentation

NGSS Engineering Standards Met Through TeacherGeek

- Engineering Practices
  - S1. Ask Questions & Define Problems
  - S2. Develop and Use Models
  - S3. Plan & Carry Out investigations
  - S4. Analyze & Interpret Data
  - S5. Use Mathematics & Computational Thinking
  - S6: Constructing Explanation and Designing Solutions
  - S7: Obtaining & Communicating Information
- Engineering Connections
  - Interdependence of science, engineering, and technology
  - Influence of Science Engineering and Technology on Society and the Natural World
- Engineering DCI's
  - ETS1A: Defining and Delimiting an Engineering Problem
  - ETS1B: Developing Possible Solutions
  - ETS1C: Optimizing the Design Solution
  - ETS2A: Independence of Science, Engineering, and Technology
  - ETS2B: Influence of Engineering, Technology and Science on Society

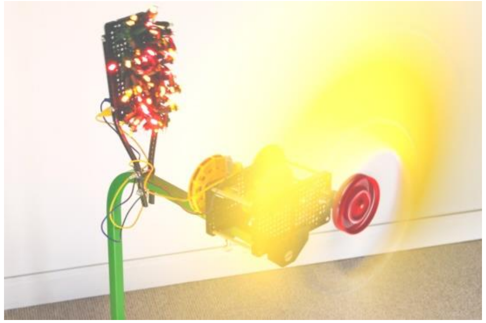
Common Core Practices Met Through TeacherGeek

- Math
  - MP1. Make sense of problems and persevere in solving them
  - MP2. Reason abstractly and quantitatively
  - MP3. Construct viable arguments and critique the reasoning of others
  - MP4. Model with mathematics
  - MP5. Use appropriate tools strategically
  - MP6. Attend to precision
  - MP7. Look for and make use of structure
- ELA
  - EP1. Demonstrate independence
  - EP2. Build strong content knowledge
  - EP3. Respond to the varying demands of audience, task, purpose, and discipline
  - EP4. Comprehend as well as critique
  - EP5. Value evidence
  - EP6. Use technology and digital media strategically and capably
  - EP7. Understand other perspectives and cultures

Next Steps: Why TeacherGeek is your choice for STEM Education

- Do you want an efficient, effective, and **exceptionally affordable** way to teach STEM?
- Would your students benefit from hands on STEM materials with lesson plans and activities?
- Are you looking for an integrated STEM curriculum that addresses ELA and math?
- Could your students benefit from a STEM product line that teaches critical thinking, teamwork, and communication skills?
- Would you like for your students to be able to take their STEM project home to share with their parents, family, and friends?

A student creating an *Alternator* from TeacherGeek components.



A student-designed TeacherGeek *Wind Turbine* using an *Alternator* to power over 100 lights.

Next Steps: Obtaining TeacherGeek

- Learn more, place an order:
  - TeacherGeek
    - Web: teachergeek.com –Browse products, investigate activities, peruse documents, watch videos, place an order
    - Phone: 888-433-5345
    - Fax: 585-286-1873
    - Email: sales@teachergeek.com
  - Ward's Science
    - Web: Wardsci.com/teachergeek
    - Phone: 800-962-2660
    - Email: wardsc@vwr.com

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