Vernier

the CALIPER

SPRING 2015 | VOL 32 NO.1

A PUBLICATION FOR USERS OF VERNIER PRODUCTS

in this issue

NEW Graphical Analysis™ App for Chrome™

Free App Enables Direct-USB Sensor Data Collection with Chromebooks™

Many schools are adopting Chromebooks for their low cost and ease of management. Vernier is committed to supporting data collection on this new platform. To that end, we have released a Go! Link- and Go!Temp-compatible version of Graphical Analysis for Chrome.

Connect any of over 30 different sensors directly to your Chromebook using a Go! Link interface. It is easy: Plug in the Go! Link interface to the Chromebook's USB port, connect the sensor to the Go! Link, and start Graphical Analysis. Click collect and you're taking data. You can also use a Go!Temp temperature sensor.

In the coming months, enhancements to Graphical Analysis will allow you to
- Connect a USB motion detector, Go! Motion, to your Chromebook USB port and graph position, velocity, and acceleration. (May 2015)
- Perform expanded analysis and use additional data-collection modes.
- Connect additional USB interfaces, such as a LabQuest Mini, for direct USB data collection.

Our goal is to let your students perform the experiments found in the books *Physics with Vernier*, *Chemistry with Vernier*, and *Biology with Vernier* using a Chromebook and a directly connected Vernier interface.

In addition to the expanding USB options, you can also link multiple Chromebooks to a single LabQuest 2 to wirelessly collect and stream data to each student's Chromebook. In this case, you can use any sensor compatible with a LabQuest 2. *(continued on page 13)*

NEW Go Wireless® Link

Expands Wireless Capabilities to Over 30 Vernier Sensors

GW-LINK, $99

Go Wireless® Link, our latest addition to the Go Wireless family of sensors, allows students to collect data from one of over 30 Vernier sensors using Graphical Analysis app on a compatible iPad®, iPhone®, or iPod touch®. Go Wireless Link will work with more devices later in the year. Initial sensor support includes CO_2 Gas Sensor, Hand Dynamometer, pH Sensor, Conductivity Probe, Current Probe, and Differential Voltage Probe, and more. Let this inexpensive, powerful interface transform data logging in your classroom. Available May 2015.

PHYSICS

Repeatable Rope Twisting

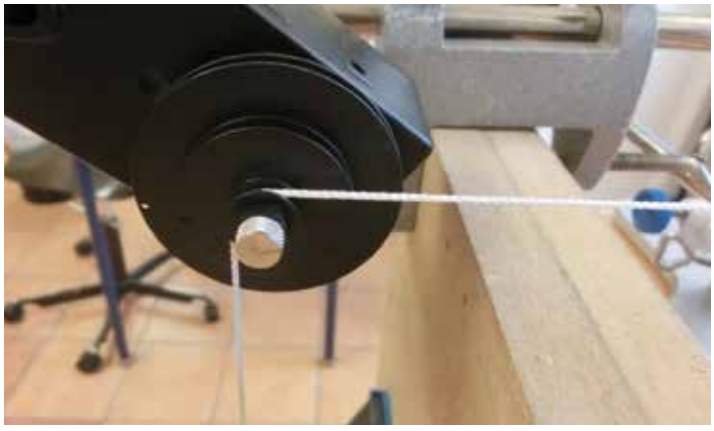
Investigating Loops and Coils with Vernier Sensors

New Zealand electrical engineer, Patrick Herd, used Vernier sensors to help Swedish teens prepare for the International Young Physicists' Tournament last year. One of the problems the students were investigating dealt with the loops and coils that develop while twisting rope. Patrick and physicist Felicia Ullstad designed and built a rig to help the team study the twisting of the rope under tension. The study included how much the rope shortened with each extra loop formed and the speed changes that accompanied the loop formation.

A twisting rope

An electric drill controlled by a knife switch was used to twist the rope. A magnet was attached to the drill chuck and a Vernier Magnetic Field Sensor detected and counted the turns of the drill.

Several design iterations were involved with measuring the linear contraction of the rope. First, a Motion Detector was tried and abandoned due to noisy results. Next, Patrick rigged a homemade photogate and pulley using a Light Sensor and a light in a tube, but the resolution for this measurement was not fine enough. Finally, a Rotary Motion Sensor was used in place of the pulley, giving smooth, high-resolution data.



Rotary Motion Sensor in position to measure change in length of rope

A Dual-Range Force Sensor measured the tension in the rope. Trials were conducted with the rope held to a constant length and with the force sensor hanging from the rope with an attached mass to control the allowed tension.

While Team Sweden did not take top honors in the tournament, they certainly learned a lot and had some fun! After five rounds of competition, Team Sweden came in 11th place out of a field of 28 countries.

For more information about the International Young Physicists' Tournament, go to www.iypt.org/Home

For Patrick's original blog post about this experiment, with many more photos, go to www.pnuke.co.nz/search/label/IYPT

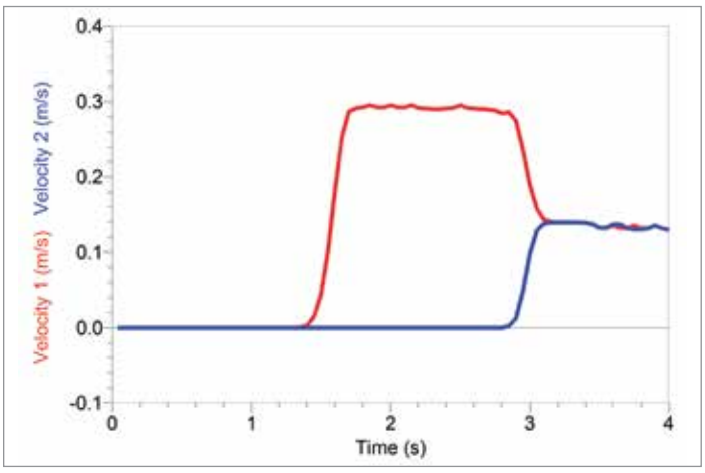
Lab Instructions Written for Motion Encoder System

Last year we introduced the Motion Encoder System (VDS-EC, $424), and many instructors are now using them with their physics classes. Now, the five experiments from *Physics with Vernier* (PWV, $48) that use the Vernier Dynamics System have been updated for use with the Motion Encoder System. These experiments include

- **Experiment 2,** Back and Forth Motion
- **Experiment 3**, Cart on a Ramp
- **Experiment 4,** Determining *g* on an Incline
- **Experiment 18,** Momentum, Energy, and Collisions
- **Experiment 19,** Impulse and Momentum

If you already own a copy of *Physics with Vernier* and would like the updated files for the student pages for the five experiments, email us at physics@vernier.com

More information on the Vernier Motion Encoder System can be found at www.vernier.com/vds-ec



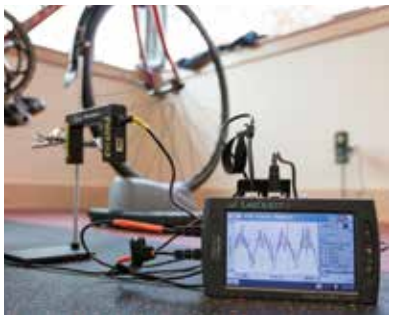
Motion Encoder data for an inelastic collision of two carts

PHYSICS

Investigating Weight Distribution on a Bicycle

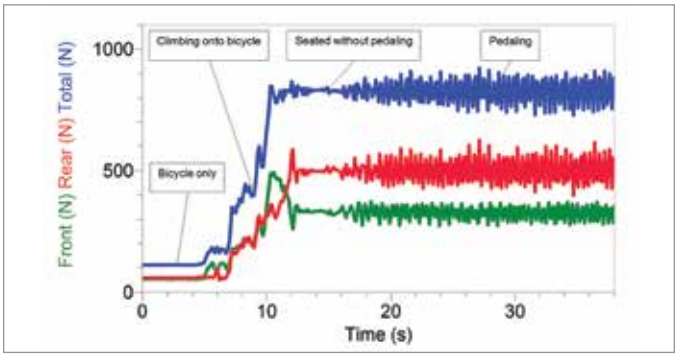
A bicycle is practically a rolling physics lab. From the forces you exert on the pedals to your energy output while climbing a steep road, there are hundreds of avenues for physics exploration. One investigation that works well in high school and college physics courses is investigating weight distribution of a rider on a bicycle.

Have you ever seen a cyclist get low and forward while diving into a turn? Or have you seen a mountain biker shift her weight backward when descending a steep pitch? How the rider is positioned on the bicycle is the dominant factor in determining the center of mass of the bicycle-rider system. (By comparison, a motorcycle typically weighs much more than its rider, thus the rider's actions have a much smaller influence on the location of the center of mass.) By moving forward, a rider can place more weight over the front wheel, creating the extra friction and traction between it and the road that makes high-speed cornering possible. Likewise, a rider who moves her weight backwards when descending a steep incline keeps her center of mass between the wheels, making it much harder to "endo" (go "end over" the handlebars).



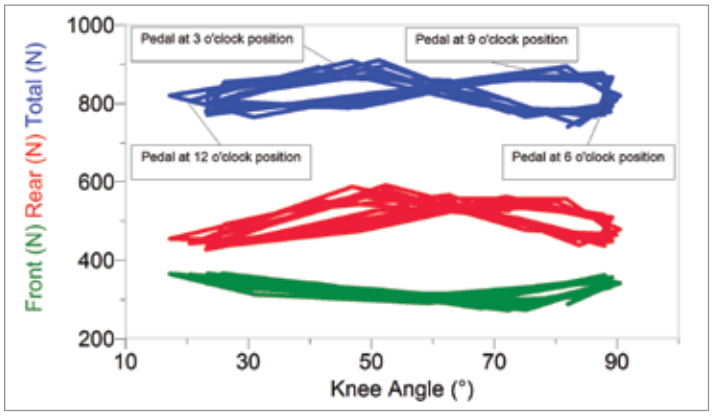
Don't have a goniometer? A photogate can measure cadence and a motion detector pedal position.

To study weight distribution quantitatively, we mounted a road bike in a stationary trainer perched atop two Force Plates (FP-BTA, $245). One Force Plate was for the front wheel and the other was for the rear. In the graph, you can see that without a rider, the weight was distributed fairly evenly between the two wheels. With a rider aboard, the center of mass moves rearward, with nearly 60% of the total load on the rear wheel. Once our rider started pedaling, the front and rear wheel loads oscillated by about 10%, although on average the total load was just about the same as it was while seated without pedaling.



Bicycle wheel loads

The wheel load oscillations were about a quarter of a rotation out of phase with each other. This forward-and-backward loading and unloading of the bicycle is a result of the movement of the rider's legs. By attaching a Goniometer (GNM-BTA, $159) to the rider's right knee, we could gauge the position of the drive-side pedal and plot wheel load versus pedal position.

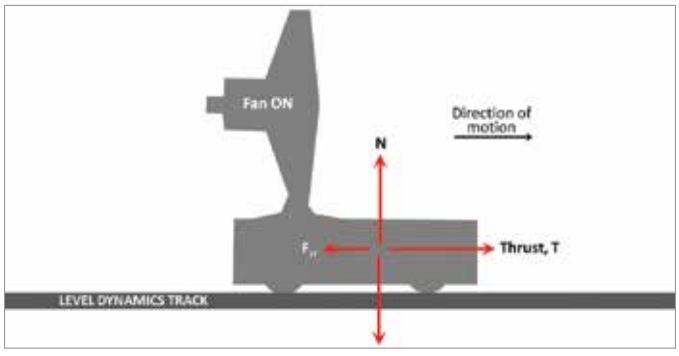


Wheel load and drive-side pedal position

Have you ever used a Vernier sensor on a bike ride or done your own bicycle physics investigation? If so, we'd love to hear about it! Send us photos, write ups, and experiment files to physics@vernier.com, and your experiment may be in the next *Caliper*.

Investigating Thrust and Rolling Resistance with the Motion Encoder System and the Fan Cart

Richard Born (Northern Illinois University) has developed a great lab using two of our newer products, the Encoder Fan Cart (CART-FEC, $199) and the Motion Encoder System (VDS-EC, $424). In this investigation, he has students measure the forces on the cart (fan thrust and drag) and the mass of the cart/fan system and predict the acceleration. You can download the investigation, along with sample data, at www.vernier.com/r151



Free-body diagram—Encoder Fan Cart speeding up under the influence of the thrust from fan

PHYSICS

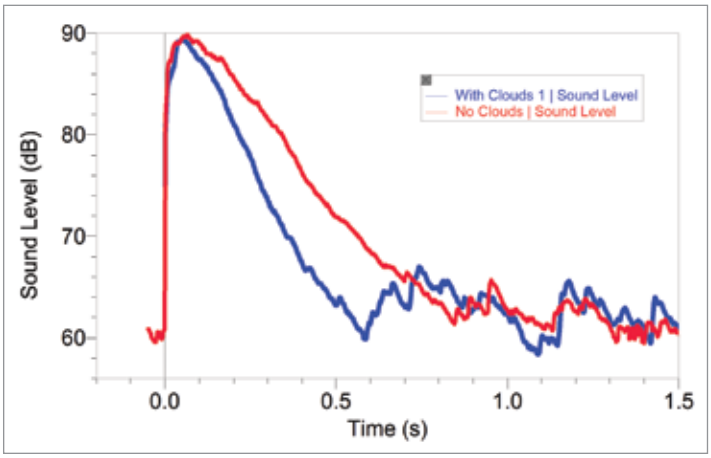
Measuring Reverberation with the Sound Level Meter

Sound Cloud Installation Makes All the Difference in the Vernier Classroom

We built a classroom in an addition to the Vernier office last summer. In early workshops there, we noticed that it was sometimes difficult for people to hear. The problem was that the walls, floor, and ceiling were all very reflective—the room had a long reverberation time. One quick way to estimate reverberation time is to use our Sound Level Meter (SLM-BTA, $165) to measure how quickly the decibel sound level drops when a loud sound is made. To test this, we set up the sensor on a LabQuest 2 using triggering. We started data collection, then clapped our hands. We noticed that the sound level dropped off much more slowly in our classroom than it did in other rooms.

Classroom before and after the addition of acoustic clouds

We added acoustic clouds to our classroom to fix the situation, and it has improved greatly. Data collected before and after the cloud installation show a shorter reverberation time.



For more information on measuring reverberation times with our Sound Level Meter, see www.vernier.com/r152

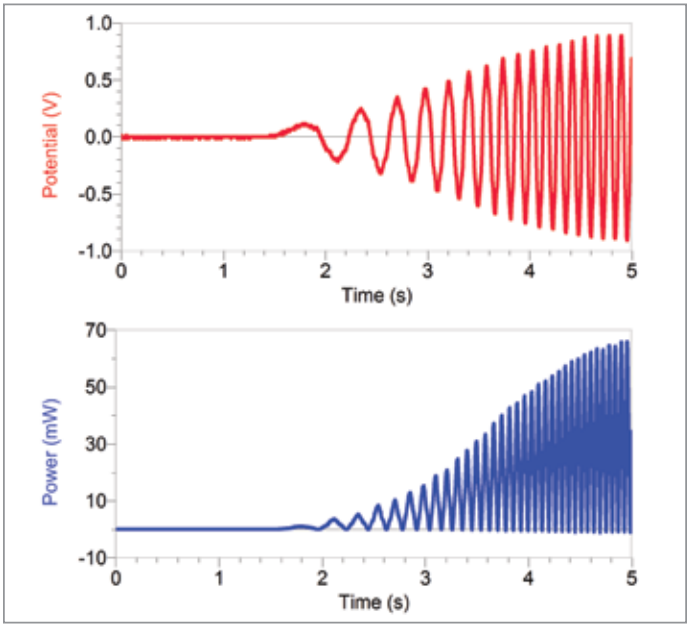
simpleGEN: A Better Generator

KW-SGEN, $35

The new KidWind simpleGEN is an easy-to-build electric generator that can be powered by hand or by the wind. Experienced KidWind customers may recall that the simpleGEN housing used to consist of a rectangular cross-section of PVC fence post. The new housing allows the generator to be mounted on a turbine tower, and additional holes for hex shafts allow for experimentation with the KidWind Gear Set with Spool (KW-GEAR, $9).

Students wrap enameled copper wire around the housing and sand the enamel off the wire ends to make an electrical connection. Turning the shaft spins a set of magnets inside the housing, and the interaction between the moving magnets and the electrons within the copper wire induces an alternating current and voltage in the wire.

For a quick measurement of the AC voltage, connect the wire ends to the Bridge Rectifier included on the KidWind Power Output Board (KW-POBD, $39) and connect the Bridge Rectifier to the Visual Voltmeter. The more potential difference induced, the more LEDs will glow.



Voltage and power produced by a simpleGEN powered by wind, starting from rest

Use the Vernier Energy Sensor (VES-BTA, $69) to measure the power produced by generators with differing numbers of wire coils, experiment with different wind turbine blade designs, and compare power generated by different gear ratios. Instructions can be found at www.vernier.com/kw-sgen

PHYSICS & ENGINEERING

Vernier in the Physics Journals

Kinesthetic Activities for the Classroom

Elliot Mylott; Justin Dunlap; Lester Lampert; and Ralf Widenhorn; Portland State University, OR.
***The Physics Teacher*, December 2014, Vol 52, 525**
This group from Portland State University uses our Force Plate and a video camera to do a number of interesting physics demonstrations involving human body motions. These were the heart of the 2013 AAPT Summer Meeting Demonstration Show. Dave Vernier was involved in one of the demonstrations, and his photo is in this article.

Experimentally Building a Qualitative Understanding of Newton's Second Law

Joshua Gates; The Tatnall School, Wilmington, DE
***The Physics Teacher*, December 2014, Vol 52, 542**
This series of experiments use our force probes, Atwood machines, and related apparatus to help students gain a better understanding of the connection between net forces and acceleration.

Bicycle Freewheeling with Air Drag as a Physics Experiment

Paul Janssen; Ewald Janssens; KU Leuven, Belgium
***The Physics Teacher*, January 2015, Vol 53, 25**
This article describes an experiment studying the motion of a bicycle rolling down a gentle hill. The data are compared with equations of motion involving both frictional drag and air resistance. They use Vernier software for comparing displacement and velocity with the models.

NEW KidWind Power Output Board

KW-POBD, $39

A new version of the KidWind Power Output Board is available for use with your KidWind wind and solar kits. The Power Output Board's Visual Voltmeter is an easy tool for measuring the output voltage, up to 5 V, of renewable energy devices. For power generation experiments, the board includes 10 Ω, 30 Ω, 51 Ω, and 100 Ω load resistors and a 1 F capacitor with an indicator LED. The new board gains a Bridge Rectifier to convert AC voltage outputs into DC for measurement with the Visual Voltmeter, allowing you to also use it with the KidWind simpleGEN (KW-SGEN, $35). The new version of the KidWind Power Output Board is now shipping in the KidWind Advanced Wind Kit (KW-AWX, $139) and is available separately.

www.vernier.com/kw-pobd

Engineering Tests with the Vernier Structures and Materials Tester

Years ago, Dave Vernier loved to run bridge building competitions while teaching physics in Hillsboro, Oregon. The students became more engaged with these hands-on activities, and competition often brought out their best efforts. The only part of the process that Dave did not relish was testing all of the bridges his students made. Borrowing weights from the PE teacher to hang off the bridges, pouring sand into a bucket to suspend under the bridges, and rigging up a scissor jack to apply a load to the structures all worked but required a lot of work and were time-consuming! Dave attributes this activity to his initial exploration of electronic sensors and the beginnings of Vernier Software & Technology.

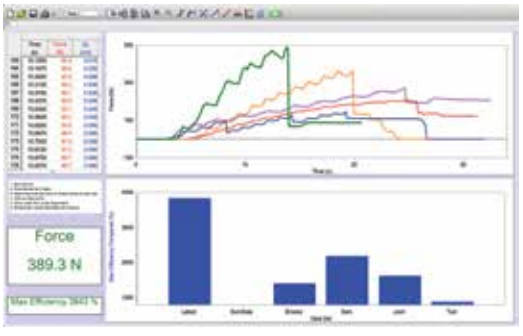
VSMT, $999

Fast forward 40 years, and these early seeds of the company became the basis for a new product. It turns out teachers like Dave are still looking for a device that will quickly and accurately test a structure to failure while collecting valuable data. The answer is the Vernier Structures and Materials Tester (VSMT).

The VSMT has a load cell rated to 1000 N (225 lbs) and a displacement sensor capable of measuring deflection to a tenth of a millimeter. It is ideal for exploring the strength of materials and engineered structures.

The VSMT ships with a well-outfitted Tackle Kit to allow for a variety of methods to connect structures to the test platform. Logger *Pro* experiment files make testing prototypes and conducting classroom competitions easy and convenient. One file even measures beam deflection.

A local Oregon high school with an excellent bridge building program has been putting the VSMT through its paces. One student noted that it is much easier to see exactly what element of his bridge failed. The force applied to the structure can be removed as soon as failure occurs and the rest of the structure often remains intact. Combining the data from the test with video allowed the student to pinpoint the failure and repair his structure for further testing!



Side-by-side comparison of bridge efficiency in a competition

ENGINEERING

Vernier and LEGO® MINDSTORMS® Education EV3

Teaching and Learning NGSS Engineering Practices

EV3 projects using Vernier sensors

Tate Rector, an Engineering instructor at Beebe Public Schools in Arkansas, is teaching his 8th grade students about robotics using Vernier sensors as part of an Introduction to Engineering class he started this year.

Through grants and support from his administration, he was able to purchase eleven LEGO® MINDSTORMS® Education EV3 kits, as well as a set of Vernier sensors including temperature, pH, force, and light. During the first few weeks of the course, students learned the basics of building and programming robots. Next, they spent a week or two learning how to use and program the Vernier sensors. At this point, the students learned about engineering principles and the NGSS Engineering Practices. Then they were presented with a challenge to define an everyday problem and then design, test, evaluate, and present a solution that uses Vernier sensors and EV3 robots.

Some of the problems the students came up with included biting into scalding hot food fresh from the microwave, forgetting to feed the fish, forgetting to check the pH of an aquarium, making a good pitcher of tea, determining if your coffee is too hot, and cleaning the litter box.

Tate observed that his students quickly learned how to use and program the robots. He discovered that incorporating Vernier sensors made the robots more than just toys. He suggests that while every kid loves playing with robots, they can be seen as just toys if they aren't presented to the students in the appropriate light. By incorporating Vernier sensors, the robots become a technology that has a purpose in the real world.

For more information, including our free, online curriculum guide *Vernier Mars Challenge with LEGO® MINDSTORMS® Education EV3* that introduces students to the physical concepts of electricity and magnetism through exciting, hands-on robotics activities, go to www.vernier.com/mars-ev3

Arduino and Vernier Sensors

BT-ARD, $25

We recently updated the Arduino™ section of our website. It has instructional material to lead students through a short course on Arduino terminology, an introduction to how sensors work, and sample projects. We have also posted sample code to read from over 80 Vernier sensors, which can be connected via the Vernier Arduino Interface Shield. This includes code to auto-ID any Vernier BTA (analog) sensor. We also have several sample projects that students will find interesting, including a laser pointer aimed with a servo motor, alarm systems based on motion detection, and a system to keep a pendulum swinging indefinitely. For more information, see www.vernier.com/arduino

A New Face in Our Engineering Education Department

The newest addition to our Tech Support/R&D Department is Josh Ence. Josh has nine years of experience teaching physics and engineering in Fairfax County, Virginia. He challenged his students to a water rocket competition each year, and Josh mentored a *FIRST*® Robotics Competition team for most of his teaching career. Josh earned his B.S. in physics from Brigham Young University and a Master's degree in Science Education from Virginia Tech.

As an avid cyclist, Josh commutes to work daily by bicycle and enjoys exploring the sights that Oregon has to offer with his family.

Josh Ence heading out to launch water rockets with his kids

ENGINEERING & MATH

Vernier Engineering Contest Winners

Vernier Software & Technology sponsors a contest for educators who creatively use Vernier sensors to introduce engineering concepts or engineering practices. The prizes for the winners include $1,000 in cash, $3,000 in Vernier technology, and $1,500 toward expenses to attend either the NSTA STEM conference or the ASEE conference. This $5,500 award is presented to one college instructor, one high school teacher, and one middle school teacher.

CONGRATULATIONS TO THE 2015 WINNERS!

Gioya De Souza-Fennelly, an instructor at Teachers College, Columbia University, New York, NY, teaches STEM/Physical Science Curriculum and Methods to pre-service science teachers. She had her students design and conduct an original middle school/high school hands-on, physical science activity that uses engineering practices, as set forth by the Next Generation Science Standards (NGSS). One activity challenged students to design a solar oven.

Ross Gunderson, a Science, Math and Engineering teacher at Delaware County Christian School, Newtown Square, PA, culminated his Materials Engineering course with a challenge to create a light bulb from an ordinary staple. This challenge focused on NGSS standard HS-PS3-3, in which students design, build, and refine a device that works within given constraints to convert one energy form into another.

Tate Rector, an Engineering and Project Lead The Way teacher at Beebe Public Schools, Beebe, AR, challenged his 8th grade engineering students to present a solution (using Vernier sensors with LEGO® MINDSTORMS® Education EV3) to an everyday problem in order to make connections with the engineering practices identified in NGSS. (See the article on page 6 for details.)

Honorable mention goes out to the following teachers

Steve Cogger at Reading Memorial High School, Reading, MA, for his demonstration of designing musical instruments using Vernier sensors with Arduino to link engineering, science, and art.

Jennifer Hutchinson at Colonia Middle School, Colonia, NJ, who had her students follow NGSS practices to design solutions for transportation safety issues.

John Tompkins at St. Thomas Aquinas High School, Overland Park, KS, for his "Sustainability" lab that focused on an Air-Air heat exchanger with a focus specifically on NGSS HS-PS3-3.

For details about the contest and to see videos of the winning entries, visit www.vernier.com/grants/engineering

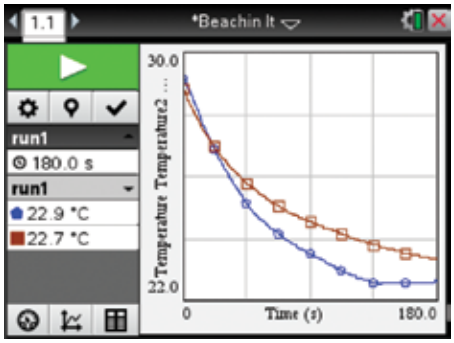
Interested in submitting an application of your own?

Applications are due January 15, 2016.
www.vernier.com/grants/engineering

Beachin' It

by Sarasota County Middle School staff

There's a beach somewhere out there and Sarasota County School District middle-school students can be found on it! Middle school science teachers Dorothy Rieger and Amy Proch-Moore have developed an experience that lets students apply concepts learned in the classroom to their observations and measurements in the field. The experience involves analyzing the properties of beach materials in terms of light reflection and heat retention.



"The TI-Nspire handheld shows the data all in one place."

Students use TI-Nspire CX Handhelds, TI-Nspire Lab Cradles, and Vernier temperature and light sensors to collect data at each of the five Sarasota beaches. "The freedom to take the equipment into the field gives students a chance to connect the classroom content to the real world," said Rieger. "It facilitates the collection of quantitative data about the amount of light reflected, which would not be possible without the use of the data-collection technology."

Students, Cameryn and Olivia, said that using temperature and light sensors, aside from being fun, helped them learn. "We were able to collect data quickly and get precise numbers, which would be much harder to do with a thermometer and a mirror," Cameryn said. "The TI-Nspire handheld shows the data all in one place, and it's easy to identify exactly what the temperature and lux (light intensity) are with the equipment," added Olivia.

But what if classes can't take a trip to the beach? Sheree Barlow, another district science teacher, brought the beach to her students to conduct a similar experiment involving heating and cooling sand and water.

Barlow's students found that sand and water cool and heat at different rates. "It's great because the probes allow students to collect data in a fraction of the time it took to collect it in the past," explained Barlow. They connected this to their real life experience where the sand gets so hot in the afternoon that it burns people's feet, that is, except for the sand on Sarasota's Siesta Beach. "We were able to use the probes to analyze the specific powdery white properties of the quartz sand at Siesta Beach and its high albedo (reflective power) compared to the sand at other local beaches," Barlow said. "We also made predictions of how the black sand beaches in Hawaii and Tahiti would compare to lighter brown sand beaches here in Florida with regard to their surface temperatures on a hot afternoon."

CHEMISTRY

Choosing a Temperature Probe for Chemistry Classrooms

Vernier offers several temperature probes for a variety of applications. Deciding which probe is best for you often depends on the types of experiments in your curriculum:

The Stainless Steel Temperature Probe (TMP-BTA, $29) is the most popular choice for chemistry classrooms. This probe has a range of –40°C to 135°C and can be used for all temperature experiments in *Chemistry with Vernier* (CWV, $48), *Advanced Chemistry with Vernier* (CHEM-A, $48), *Investigating Chemistry through Inquiry* (CHEM-I, $48), and *Vernier Chemistry Investigations for Use with AP* Chemistry* (APCHEM, $48).

The latest addition to our temperature probe family is the Vernier Go Wireless® Temp (GW-TEMP, $75). Its durability, temperature range (–40°C to 125°C), and wireless capability make it perfect for a variety of uses. Students can view live readings, capture data in real time, and examine results. Go Wireless Temp works with iOS, Android, and LabQuest 2. See www.vernier.com/gw-temp for current compatibility details.

Do you need to monitor temperatures above 135°C? The Wide-Range Temperature Probe (WRT-BTA, $79) has a range of –20°C to 330°C and is designed to match the diameter of a typical glass thermometer. It can be used to monitor temperature for distillation experiments such as "Experiment 3: Determination of a Boiling Point: Simple and Fractional Distillation" in *Organic Chemistry with Vernier* (CHEM-O, $48).

The Thermocouple (TCA-BTA, $69) is a simple and rugged sensor designed to measure temperature in the range of –200°C to 1400°C. The wide range results in a lower resolution than other temperature sensors but it can be used to measure flame temperatures as high as 1400°C or liquid nitrogen temperatures at –196°C. One application for this sensor is to compare the temperatures of different flames (candles *vs.* Bunsen burner).

Sensor	Range	Accuracy
Stainless Steel Temperature Probe	–40°C to 135°C	±0.2°C at 0°C ±0.5°C at 100°C
Go Wireless® Temp	–40°C to 125°C	±0.5°C
Wide-Range Temperature Probe	–20°C to 330°C	±0.1°C at 0°C
Thermocouple	–200°C to 1400°C	±5°C at –200°C to 0°C ±2.2°C at 0°C to 900°C ±15°C at 900°C to 1400°C

Looking for additional information or other options? The Temperature Sensors webpage offers a detailed comparison chart that includes tech specs about all of our temperature sensors, interface compatibility information, and prices. See www.vernier.com/products/sensors/temperature-sensors

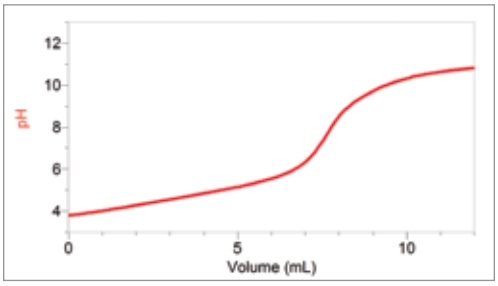
For a different look at our product options, watch our "Which Temperature Sensor is Right for Me?" Tech Tips video at www.vernier.com/v130

NEW *Vernier Chemistry Investigations for Use with AP* Chemistry*

The College Board's AP Chemistry Curriculum Framework has undergone significant changes, shifting the course from a more traditional, content-based model to one that is intended to support an inquiry-based model of instruction. According to the AP chemistry course overview, six labs should use an inquiry-based model of instruction.

APCHEM, $48

Our newest lab book, *Vernier Chemistry Investigations for Use with AP* Chemistry*, is organized into 16 student-directed investigations using probeware that are aligned with the labs in the AP chemistry lab manual published by the College Board. Included in the lab manual are teacher resources, such as sample data, graphs, and helpful tips for investigations that foster scientific inquiry, critical thinking, and reasoning. Investigations can be customized for your own classroom and teaching style using the included CD with student instructions in Microsoft® Word® format.



Acid-base titration of apple juice using 0.1 M NaOH

A few examples of the investigations in *Vernier Chemistry Investigations for Use with AP* Chemistry* include

- Exploring the relationship between Percent Transmittance and Absorbance using the SpectroVis Plus Spectrophotometer (SVIS-PL, $469) in "Investigation 1: Investigating Food Dyes in Sports Beverages"
- Using a pH Sensor (PH-BTA, $79) to investigate acid-base titrations in "Investigation 4: The Acidity of Juice and Soft Drinks"
- Looking into the relationship between enthalpy and temperature using a Stainless Steel Temperature Probe (TMP-BTA, $29) in "Investigation 12: Investigating Commercial Hand Warmers"

If you would like to preview *Vernier Chemistry Investigations for Use with AP* Chemistry*, evaluation PDF copies of all the student pages of the investigations are available at www.vernier.com/apchem

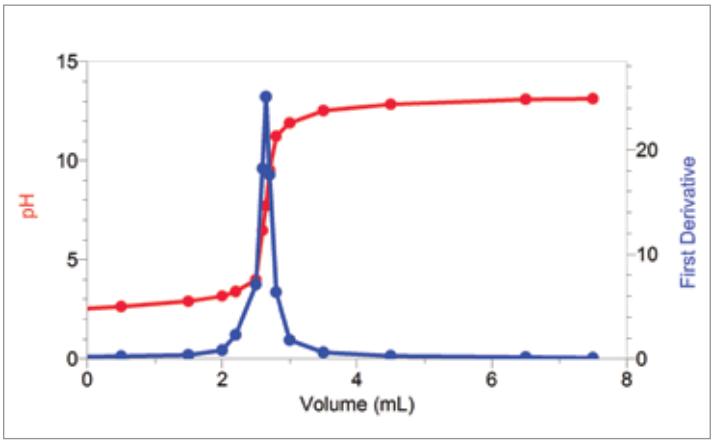
* AP and Advanced Placement Program are registered trademarks of the College Entrance Examination Board, which was not involved in the production of and does not endorse this product.

CHEMISTRY

NEW Glass-Body pH Electrode

GPH-BNC, $85

Our new Glass-Body pH Electrode, coupled with either our Go Wireless® Electrode Amplifier or Vernier Electrode Amplifier, allows you to measure the pH of non-aqueous solutions and solutions that contain organic solvents, strong acids, or strong bases. The entire shaft of the pH electrode is made of glass, allowing you to perform experiments such as titrations of strong acids (e.g., aliphatic amines), titrations of weak bases (e.g., aromatic amines), monitoring the pH of protein denaturation with the addition of ethanol, and many others.



Non-aqueous titration of acetic acid

Helpful Tips for Using the Voltage Probe in Electrochemistry Experiments

VP-BTA, $12

In electrochemistry, a voltaic cell is a specially prepared system in which an oxidation-reduction reaction occurs spontaneously. This spontaneous reaction produces an electrical potential that can be easily measured using a Voltage Probe. Taking advantage of this fact, students are able to quickly establish the reduction potentials of five unknown metals relative to an arbitrarily chosen metal in "Experiment 28–Establishing a Table of Reduction Potentials: Micro-Voltaic Cells" from *Chemistry with Vernier* (CWV, $48).

When using a Voltage Probe to measure the half-cell potential, you must zero the probe using a specific process before starting the experiment:

1. Connect the Voltage Probe to the data-collection interface and start the data-collection program.
2. Clip the red and black leads of the Voltage Probe together. The meter reading will drop to a value below ~0.1 V, which is expected behavior.
3. Choose Zero from the Experiment menu (Logger *Pro*) or from the Sensors menu (LabQuest App). After the probe is zeroed, the meter reading will be approximately 0.00 V. You are now ready to measure potential.

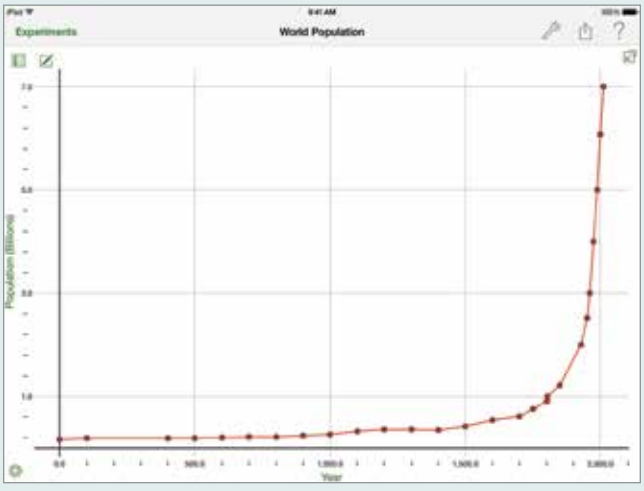
Additional tips:

- If you exit Logger *Pro* 3 or LabQuest App and restart the program, you will need to zero the Voltage Probe again.
- Zero the probe only when the red and black leads are connected together.

For troubleshooting information, visit www.vernier.com/til/1425

25 YEARS AGO IN *THE CALIPER*

In 1990, we published a graph that was created in the Apple II version of Graphical Analysis, showing the world population as a function of year from 0 to 1990. We thought it would be appropriate to update the graph and show how it looks on Graphical Analysis for iOS with a couple more data points added. In 1990, the world population was just over 5 billion, and we mentioned in the article that world population was predicted to reach 6.1 billion by 2000. That prediction was very close. World population reached 7 billion in 2011.



CHEMISTRY

A Chemistry Department's Epic Transformation

LabQuest 2 and LabQuest Viewer Established in North Park University's New Science Laboratories

The Nancy and G. Timothy Johnson Center for Science and Community Life

North Park University, located in Chicago, Illinois, recently added a three-story 101,000-square-foot science building, named The Nancy and G. Timothy Johnson Center for Science and Community Life. The new building fully integrates LabQuest 2 and the Connected Science System into its laboratories.

"When I came to North Park [University] in 2007, the department had inadequate facilities. Despite strong teaching, the department was small with only two faculty and averaging about one major per year," says Jonathan Rienstra-Kiracofe, Professor of Chemistry. "My goal was to transform the department into the chemistry department that North Park and its students desired. We've come a long way in 7 years. Vernier LabQuests have been an important part of our transformation."

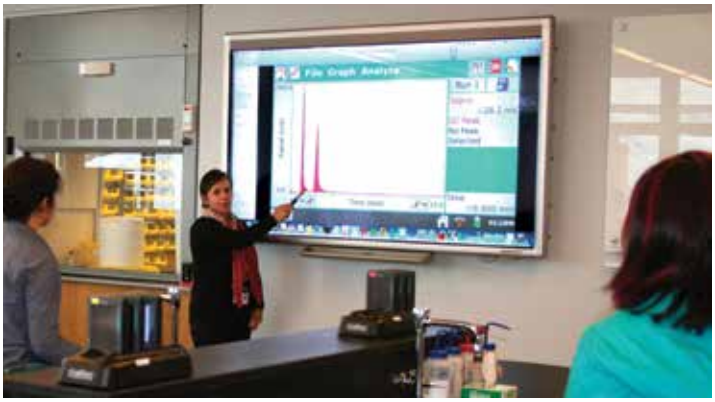
When the original LabQuest was released, North Park University purchased the interface for use in its chemistry courses. "It was an immediate hit with the students," Dr. Rienstra-Kiracofe adds.

In 2011, Dr. Rienstra-Kiracofe worked with a Vernier specialist, Matt Anthes-Washburn, to display the screens of the original LabQuest interfaces onto a computer with USB adapters and LanSchool Software, which were then displayed on a high-definition television.

"In principle the smart lab worked, allowing me to display the screen of any of 12 LabQuests being used in the lab. Pedagogically, this enhanced my teaching, allowing me to teach from an enlarged display of a LabQuest screen and to show students how to perform a task on the LabQuest or to select a particularly good (or bad) graph from a student user and display that for the class to see," Dr. Rienstra-Kiracofe explained. "With the release of LabQuest 2 and the LabQuest Viewer program, we knew we could implement a much more robust and interactive smart lab system."

For the past two years, IT staff Steve Clark, Jeff Lundblad, and David Frisk worked diligently with science faculty members to implement the wireless technology by configuring Wi-Fi access and planning the AV technology that enables the entire system to work.

The school specifically designed their labs to take advantage of the LabQuest 2 and the Connected Science System. Laboratories for general, organic, and advanced chemistry courses are equipped with LabQuest 2 and a variety of probes and sensors, including the Mini GC and the Polarimeter. Each lab features an interactive Sharp HDTV that allows a student or instructor to control LabQuest Viewer directly from the large screen.



Dr. Isabel Larraza uses LabQuest Viewer during a gas chromatography experiment.

"The Vernier system was an awesome system to experience," says Andrea Diugan, a first-year chemistry major at North Park University. "Having the LabQuests and connected HDTV display has definitely aided in our learning because it not only gave us the opportunity to share our results with other students and our professor, but also provided a way to learn how to analyze our results quickly and accurately."

Students can use iPad® tablets, provided in the laboratory by cart, to share data from the LabQuest 2 and analyze their results. Wireless printing has also been added to these laboratories, allowing students to print directly from their LabQuest 2. In addition, two biology laboratories are equipped with LabQuest 2, iPad tablets, and touch-capable high definition televisions.

"The whole system is truly beautiful and a joy to teach with," says Dr. Rienstra-Kiracofe. "Most anyone I have demonstrated the system to has been blown away with the technology, but most importantly, I can now teach much more efficiently and effectively."

Interested in submitting a success story of your own?

We welcome your ideas and stories on how you're using Vernier technology. Send your ideas to **innovativeuses@vernier.com**

CHEMISTRY & BIOLOGY

Vernier in the Chemistry Journals

Integrating Biology into the General Chemistry Laboratory: Fluorometric Analysis of Chlorophyll *a*

Meredith C. Wesolowski; *J. Chem. Educ.* 2014, 91, 1224–1227.
This article describes a laboratory experiment introducing the fluorometry of chlorophyll *a* using the fluorescence capabilities of SpectroVis Plus. Students isolated chlorophyll *a* from the photosynthetic bacterium spirulina to generate a fluorometric standard curve with which fluorescence intensities of chlorophyll *a* solutions from plant leaf extract were compared.

Summer Enrichment Programs to Foster Interest in STEM Education for Students with Blindness or Low Vision

Cary A. Supalo; April A. Hill; and Carleigh G. Larrick; *J. Chem. Educ.* 2014, 91, 1257–1260.
This article describes hands-on activities featured over a two-day, summer enrichment program providing blind or low vision (BLV) students with successful exposure to science activities. The workshop was one of the first times the Sci-Voice Talking LabQuest had been used by an entire class of BLV students from a number of different age groups. We developed the original LabQuest, and then Independence Science, an access technology firm founded by Dr. Supalo, developed the text-to-speech software interface that is used on LabQuest.

Undergraduate Analytical Chemistry Experiment: The Determination of Formation Constants for Acetate and Mono- and Dichloroacetate Salts of Primary, Secondary, and Tertiary Methyl- and Ethylamines

Ronald P. D'Amelia; Stephanie Chiang; Stephanie Pollut; and William F. Nirode; *J. Chem. Educ.* 2014, 91, 1070–1072.
This experiment was designed to develop an understanding of the principles of acid-base equilibria for an undergraduate quantitative analysis chemistry laboratory. The procedure involves using a pH Sensor, Drop Counter, LabQuest, and Logger *Pro* 3 software to collect and analyze titration data. The learning objectives include determining the K_a of the selected acid, the pK_b from the titration curve, the pH at the end point from the titration curve, examining the titration curves and contrasting these with strong acid–weak base and weak acid-strong base titrations, calculating the salt formation constants (K_{sf}) for the reaction of an amine and a carboxylic acid, and understanding the effect of additional chloro substituents on the strength of the acid.

Laboratory Experiment Investigating the Impact of Ocean Acidification on Calcareous Organisms

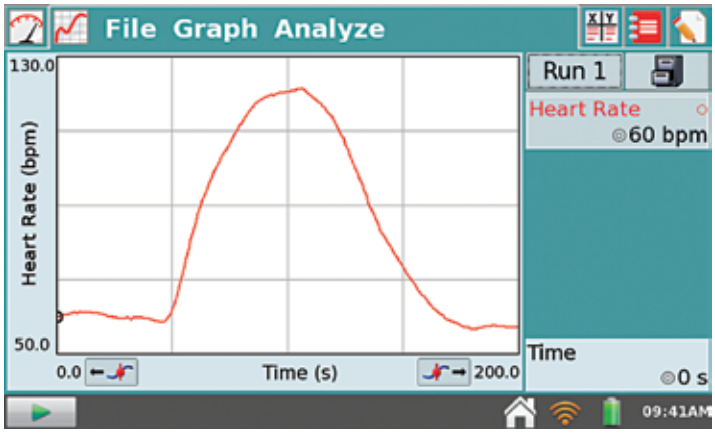
Alokya P. Perera and A. M. R. P. Bopegedera; *J. Chem. Educ.* 2014, 91, 1951–1953.
This article presents an experiment to help students grasp the impact of ocean acidification on calcareous organisms. Ocean water was mimicked with acidic buffer solutions of varying pH and calcite pieces were used to represent calcareous organisms. Students monitored the pH using various pH meters, including Vernier pH Sensors, and then class data were pooled to generate a graph of mass loss of the calcite as a function of the pH of the buffer solutions.

NEW Go Wireless® Heart Rate

GW-HR, $89

We have expanded our line of wireless sensors with the new Go Wireless Heart Rate. This affordable sensor consists of a pair of wireless hand grips that can be used to measure human heart rate with a mobile device. It is ideal for continuously monitoring heart rate before, during, and after exercise. Go Wireless Heart Rate works with iOS, Android, and LabQuest 2. See www.vernier.com/gw-hr for current compatibility details.

Go Wireless Heart Rate is perfect for biology and physiology experiments that study the heart, heart rate, or exercise. It is simple and easy to use as it displays live heart rate readouts before you begin data collection. The hand grips are easy to clean and share between students and do not require special electrodes. The sensor is powered by a small, replaceable battery and turns itself off when not in use, allowing the device to be used for over 200 hours. Data collected with Go Wireless Heart Rate and LabQuest 2 during the "Heart Rate and Exercise" activity are shown below. The data show a period of resting heart rate, followed by an increase of heart rate due to moderate exercise, and then the recovery of the heart rate.



Heart rate increase and recovery with moderate exercise

For a hands-free option for measuring heart rate, you can purchase a Go Wireless Exercise Heart Rate (GW-EHR, $79) that uses a chest strap instead of hand grips. If you already have a Go Wireless Heart Rate, the Exercise Heart Rate Strap (HR-STRAP, $21) can be purchased separately. Simply detach the transmitter module from the hand grips and attach it to the chest strap. This provides an easy option for monitoring heart rate during running, cycling, and other physical activities that are best studied hands free.

For more information and free sample activities including "Heart Rate and Exercise," visit www.vernier.com/gw-hr

BIOLOGY & ENVIRONMENTAL SCIENCE

NEW USB Digital Microscope

BD-EDU-100, $119

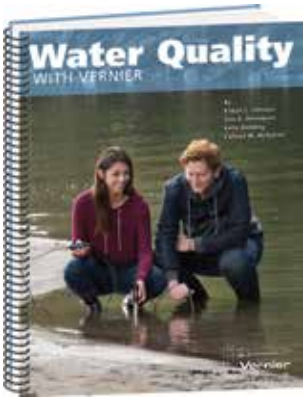
The Vernier Biology Department has been on a continuous quest to uncover new, exciting, and affordable tools for biology teachers. Our newest offering is the USB Digital Microscope that works on Chromebooks and with Logger *Pro* software on a computer. This 5 MP digital microscope connects to a computer or Chromebook via USB, giving you a live image that is very similar to what you would see with a traditional dissection microscope. It features a 10–300X lens with manual focus and an adjustable LED light source. In addition to capturing still images, you are able to record short videos and time lapse sequences.

Lichen image captured with the USB Digital Microscope

Included with the USB Digital Microscope is an adjustable stand that, in conjunction with the manual focus, allows you to change the plane of view you are looking at on the screen. With a fast response time and high resolution, you can get very clear images that are easy to display, save, and place directly into lab reports. This new tool offers a world of possibilities for you and your students to explore.

For more information, visit www.vernier.com/bd-edu-100

Water Quality with Vernier Lab Book Update

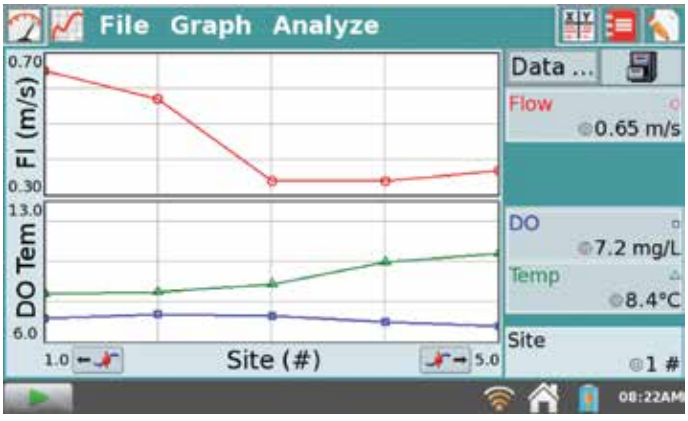


WQV, $48

After many years, we are happy to announce the second edition of *Water Quality with Vernier*. This updated version has many improvements that we think instructors will appreciate. This is our first book with instructions for using LabQuest with Data Matrix mode—a mode designed especially for field work. While many of the tests are familiar, they have been updated to incorporate new sensors, such as the Vernier Optical DO Probe, that have been developed since the first edition of the book.

Water Quality with Vernier still incorporates the nine tests used to calculate the Water Quality Index, along with nine additional tests, giving a full picture of the health of the water being tested. Some tests have been improved to make them easier, while others have been updated with current research techniques in mind.

Other changes include
- Two new tests: "Physical Profile of a Lake" and "PAR Attenuation"
- Enhanced Instructor Information sections, including updated data-collection tips and time estimates for all tests
- Revised data-collection sheets



Dissolved oxygen, temperature, and flow at a stream site

If you already own a copy of *Water Quality with Vernier* and would like the updated files of the student pages, email us at support@vernier.com. We will send you a link to download the updated student files. If you'd rather have a printed copy that includes the updated student and teacher pages, appendices, and a CD, a new copy can be purchased for $48 (WQV).

SOFTWARE

NEW Graphical Analysis App for Chrome

(continued from cover)

Students can use Graphical Analysis to collect data, and then analyze the data using statistics and curve fits. All work is automatically synced to the student's Google Drive storage, so that work can be accessed by the student on other Chromebooks or on a computer running the Chrome browser. Students can easily finish their work at home or in the library. Export graphs and data to Google Docs and Sheets, or to Plotly. Compiling experimental work into report form is easy.

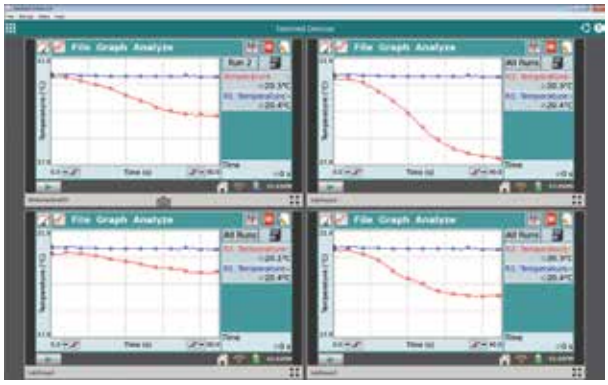
To learn more about Graphical Analysis, visit www.vernier.com/ga-chrome

Graphical Analysis is available in the Chrome Web Store. It runs on Chromebooks and within the Chrome browser on Mac and Windows computers.

For an updated list of supported sensors, visit www.vernier.com/til/2871

NEW Introducing LabQuest Viewer 2.0

We are excited to announce the release of a major update to our LabQuest Viewer computer software and iPad® app. LabQuest Viewer is an application that displays and controls the screen of a LabQuest. When used in conjunction with a projector, this application can be used to demonstrate the functions of LabQuest and to enhance group presentations of your students' lab work.



Comparing results from four different lab groups investigating temperature changes as Alka-Seltzer® dissolves in water.

LabQuest Viewer 2.0 introduces My Lab—a view that displays live images of all LabQuests in your lab. You can use My Lab to monitor your students' progress, letting you know who is on task and who might need help. You can easily add, arrange, and remove LabQuests from My Lab and your settings persist every time you launch the software, making it easy to get started each lab period.

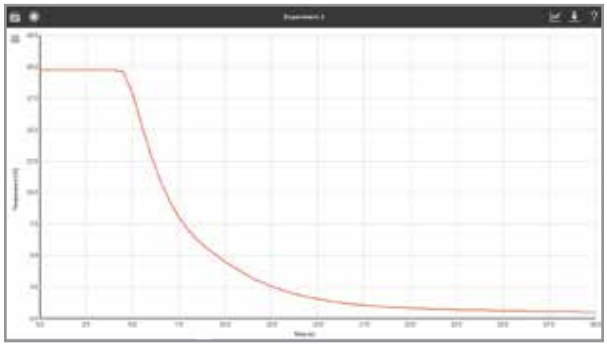
LabQuest Viewer 2.0 has enhanced presentation features that make group discussions more fluid. After selecting one of your LabQuests for full-screen presentation, you can easily flip through all devices without returning to My Lab. Also with version 2.0, you can view and control up to four LabQuests simultaneously for side-by-side comparison of experimental results.

If you already own LabQuest Viewer, the update to version 2.0 is free. The computer software, for either Windows or OS X, (order code LQ-VIEW, $79) includes a site license for your school or college department. The iPad app, available for purchase on the App Store ($4.99), is not part of the computer software site license.

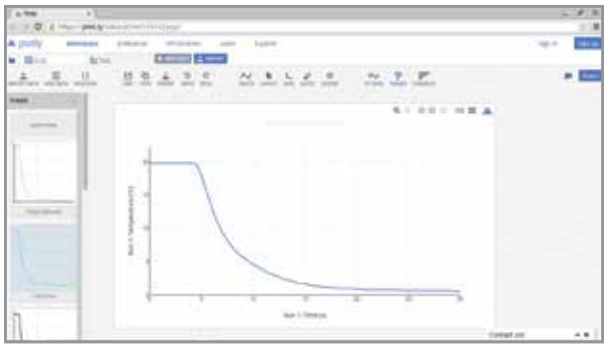
To learn more about LabQuest Viewer 2.0, visit www.vernier.com/lq-view

NEW Plotly and Graphical Analysis for Chrome

We are big fans of Plotly at Vernier! Plot.ly (that's the URL, although it doesn't look like it) is a web-based graphing tool that complements Vernier tools. Collecting data from Vernier sensors and then analyzing it in Plotly is sometimes just the right thing to do. For example, our Graphical Analysis for Chrome application is a lean, streamlined data-collection program for Chromebook. You can collect data and do basic curve fits and statistics, which is enough for most experiments. But if you want more, it is now easy to export your data to Plotly, and from there you can apply further transforms, calculations, or custom graph styles that you need.



Graphical Analysis with some simple temperature data



The graph in Plotly

SOFTWARE UPDATES

We regularly release software updates to support new sensors, as well as to add new features. Keeping up to date with software releases is one way to keep things running smoothly in your classroom or lab. Have you updated your Vernier applications recently?

Logger *Pro* 3.9

Logger *Pro* 3.9 was released in January 2015. This update is free to all users of any previous version of Logger *Pro* 3 and is available at www.vernier.com/lpupdates

The new version adds support for the Vernier Structures & Materials Tester and fixes several issues with OS X 10.10.

We have again updated support for the Connected Science System. Logger *Pro* can share sensor data with Graphical Analysis for iPad, iPod touch, and iPhone and with the Vernier Data Share web app in any device running a modern browser. This new version of Data Share supports use with Graphical Analysis for Chrome, in addition to Android and iOS.

We recommend that all users of Logger *Pro* update to this release. With an account on the Vernier website and a purchase history of Logger *Pro*, you can download its full installer at any time—you don't have to wait for a CD or download link.

LabQuest 2.5

LabQuest 2.5 for LabQuest 2, with support for the Go Wireless® sensors on supported LabQuest 2 hardware, was released in February 2015. The new version adds support for the Vernier Structures & Materials Tester, Go Wireless Heart Rate, and Go Wireless pH.

We strongly recommend that all users of LabQuest 2 update to this release. This free update to LabQuest App is available at www.vernier.com/lq2updates

LabQuest 1.7.3

LabQuest 1.7.3 for the original LabQuest hardware was released in January 2015. The new version adds support for the Vernier Structures & Materials Tester.

For more information about this free update, see www.vernier.com/lqupdates

Logger Lite 1.8

Logger Lite 1.8 was released in February 2015. The new version adds support for the *Investigating Wind Energy* book, as well as OS X 10.10. The free update is available at www.vernier.com/llupdates

LabQuest Viewer 2.0

LabQuest Viewer version 2.0 for Windows and OS X was released in March 2015. This significant update adds the ability to display and control multiple LabQuest units simultaneously. The free update is available at www.vernier.com/support/updates/labquest-viewer

LabQuest Viewer for iPad app, version 2.0, was released in March 2015. This release adds significant new capabilities, including the display and control of multiple LabQuest units simultaneously. The app is available in the App Store.

Video Physics for iPad, iPhone, and iPod touch

The current version of Video Physics is 3.0.2, which was released in March 2015. This new version includes an object auto-tracking feature; it is also easier to mark points, to delete points, adjust the origin, and set the scale. As in earlier versions, we include the important ability to export video analysis data to Graphical Analysis for iOS. Once in Graphical Analysis, you can perform selections, add annotations, perform curve fits, and create high-resolution graphs.

Updates to Video Physics are always free and are available in the App Store.

Graphical Analysis for iPad, iPhone, and iPod touch

Graphical Analysis for iPad®, iPhone®, and iPod touch®, version 2.2, was released in February 2015. Graphical Analysis adds support for Go Wireless pH and Go Wireless Heart Rate. You can also rename experiments. Graphical Analysis is available for free in the App Store.

Graphical Analysis for Chrome

The second release of Graphical Analysis for Chrome™ was in March 2015. Graphical Analysis collects data from a directly connected USB Go!Temp sensor, a sensor connected via Go!Link, and from a LabQuest 2 connected by Wi-Fi. Graphical Analysis is available for free in the Chrome Web Store.

Graphical Analysis for Android

Graphical Analysis for Android, version 2.0, was released in January 2015. Similar in features to the iOS version, but crafted for Android, Graphical Analysis brings history, curve fits, and data collection to this popular platform. Go Wireless Temp sensors are supported on Android tablets with compatible hardware. Graphical Analysis is available for free in the Google Play store.

Apple Volume Purchase Program

Purchasing apps for iOS devices can be a challenge for schools. Did you know that your school or department can purchase vouchers to distribute apps, such as Vernier Video Physics, to multiple devices?

This is a way to distribute iOS apps to both school-owned and student devices. You can use purchase orders or a credit card, and school purchases are tax-exempt. You receive a 50% discount when purchasing 20 or more copies of Vernier Video Physics.

www.apple.com/itunes/education

AWARDS & GRANTS

Ecology/Environmental Science Teaching Award Winner Announced

Ella Bowling of Mason County Middle School, in Marysville, Kentucky, was the 2014 recipient of the NABT Ecology/Environmental Science Teaching Award. This award is sponsored by Vernier and was presented at the 2014 NABT Professional Development Conference in Cleveland. Ms. Bowling is a 7th grade science teacher, teaching Earth Science using an integrated approach. She engages student by having students work in the field, where they learn about the local environment and ecosystems. They search for invasive species, investigate water and soil quality, and even do macroinvertebrate surveys on local streams. As an educator, Ms. Bowling feels strongly that she needs to empower her students by having them use critical thinking skills and active problem solving in the field and classroom. By doing so she feels that this helps her students make informed decisions about living on this planet.

This award is given to a secondary school teacher who has successfully developed and demonstrated an innovative approach in the teaching of ecology/environmental science and has carried his/her commitment to the environment into the community. Vernier's sponsorship of this award includes $1,000 toward travel to the NABT Conference, and $500 of Vernier equipment. The recipient also receives a recognition plaque and one year of complimentary membership to NABT. The application deadline for the Ecology/Environmental Science Teaching Award is March 15 of each year. While it has just passed for 2015, start thinking about applying in 2016. Applications will be available after the NABT Conference in November. You can find more information about this award at www.nabt.org

Interested in submitting an application of your own?

Applications are due March 15, 2016.
www.vernier.com/grants/nabt

ULTIMATE PI DAY

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During the NSTA National Conference in Chicago, the Vernier team, including Christine and Dave Vernier, pictured here, celebrated Ultimate Pi Day by giving away Pi Day t-shirts to teachers who stopped by the booth.

VERNIER AWARDS

Vernier is proud to be recognized for its philanthropic commitment, steady growth, and as one of the Best 100 Companies to Work For in Oregon—15 times.

INTERNATIONAL AWARD FOR LABQUEST

BUSINESS JOURNAL CORPORATE PHILANTHROPY AWARD FOR 2013

FASTEST GROWING PRIVATE COMPANIES

PLACED 17TH OF 100 BEST GREEN COMPANIES IN OREGON

2013 HEALTHIEST EMPLOYERS 2ND PLACE

HALL OF FAME OREGON BUSINESS AWARD

VERNIER PHYSIOLOGY WINS AWARD

GESS EDUCATION AWARDS WINNER 2015

Vernier Physiology Receives "Best Product to Promote Health and Fitness in the Classroom" Award

The Dubai-based Global Educational Supplies and Solutions (GESS) Education Awards named the LabQuest 2 Physiology Packages the Best Product to Promote Health and Fitness in the Classroom. The GESS Education Award recognizes excellence in the educational industry and is presented to suppliers and distributers that supply educational establishments with high quality, safe products appropriate to everyday teaching and learning needs.

SCIENCE HUMOR

I'm reading a great book on anti-gravity.
I can't put it down.

How to count to 10 at Microsoft:
1, 2, 3, 95, 98, NT, 2000, XP, VISTA, 7, 8, 10.

AWARDS & GRANTS

Vernier/NSTA Technology Awards Winners 2015

Recipients Receive $5,500 in Cash and Technology

Co-sponsored by Vernier and NSTA, The Vernier/NSTA Technology Awards recognize educators for their innovative use of data-collection technology. Christine and David Vernier presented each of this year's winners with their awards at the NSTA conference in Chicago. Each winner receives $1,000 in cash, $3,000 in Vernier technology, and $1,500 towards expenses to attend the conference. Below are brief synopses of the 2015 award-winning entries.

ELEMENTARY SCHOOL

Amy Atkinson,
Hominy Valley Elementary School, Candler, NC

Amy Atkinson created a project that focuses on healthy lifestyle choices in diet, exercise, and relaxation, which culminates with a fourth-grade health and wellness fair. As part of the project, students work with local health professionals to explore different facets of healthy living and use Vernier sensors to measure and collect real-time heart rate, blood pressure, and respiration data.

MIDDLE SCHOOL

Susan Brown,
Northland Preparatory Academy, Flagstaff, AZ

To help students in grades 6–12 explore how climate change affects lichen growth and diversity, Susan Brown created a long-term research project in partnership with a local arboretum and Northern Arizona University. The project utilizes gardens along an elevation gradient, as well as an on-site one at the school. Students will use Vernier sensors to collect weather-related data from the gardens and then make their own observations and inferences about climate change and its effects.

Dennis Pevey, Jr.,
eSTEM Public Charter School, Little Rock, AR

Dennis Pevey, Jr. engages his students in science education by infusing STEM concepts into projects that focus on the environmental issues impacting central Arkansas. In one particular project, students will create biofiltration units for the school's parking garage to help prevent the leeching of chemicals into the Arkansas River. They will use Vernier Ion-Selective Electrodes and SpectroVis spectrophotometers to monitor and analyze water samples over a three-month period.

HIGH SCHOOL

Kristy Bibbey,
Poudre High School, Fort Collins, CO

During a project that introduces the physics of sound, Kristy Bibbey's physics students—as well as a local musician—bring in an instrument that they play and use a Vernier Microphone to record sounds of various wavelengths. The data is shown in real time on the classroom's whiteboard so that students can analyze data, recognize properties of a wavelength, and understand the inverse relationship between period and frequency.

Karlheinz Haas,
The Pine School, Hobe Sound, FL

To help make kinematics and dynamics more accessible and relatable to students, Karlheinz Haas adapted a series of commonly used physics labs to incorporate the use of the TI-Nspire CX handheld in combination with Vernier sensors and TI-Nspire's DataQuest software. These labs include a marble activity that teaches students about horizontal velocity and an investigation involving echoes that teaches students about the speed of sound.

Ann Shioji,
William C. Overfelt High School, San Jose, CA

In Ann Shioji's "Beauty and the Yeast" unit, students explore how chemicals affect their daily lives. At the beginning of the unit, students conduct preliminary research on the gestation period and respiration rates of yeast and then conduct a class investigation using a Vernier CO_2 Gas Sensor to determine the rate of respiration of glucose by *Saccharomyces* to monitor a closed population of yeast. Then, students are provided the opportunity to design their own inquiry-based experiments to test the effects of chemicals on living yeast cells.

COLLEGE

Lois Zook-Gerdau,
Muskingum University, New Concord, OH

Muskingum University partnered with the Muskingum Soil and Water Conservation District to assess the water quality in nearby Salt Creek Watershed. They used Vernier sensors and spectrometers, which were instrumental in helping students conduct a variety of analyses on these water samples. Through this partnership, students worked with local environmental professionals. The community won a grant for conservation efforts based on the water quality assessments.

Interested in submitting an application of your own? Applications are due November 30, 2015. **www.vernier.com/grants/nsta**

PROFESSIONAL DEVELOPMENT

Free Hands-On, Data-Collection Workshops

2015 Workshops	
AZ	Phoenix 4/13
CA	Pasadena 4/16 Riverside 4/15 San Francisco 4/28 Santa Clara 4/27
CT	Hartford 4/9, 4/11
DE	Wilmington 4/23
MD	Baltimore 4/28
NC	Charlotte 4/20 Greensboro 4/21 Raleigh/Durham 4/22
NJ	Newark 4/13 Princeton 4/14
NY	Long Island 5/5, 5/6 Westchester County 5/7
PA	Philadelphia 4/22
SC	Charleston 4/18
TN	Nashville 4/9
VA	Arlington 4/27 Richmond 4/25

Join us for a four-hour exploration of the latest and greatest in Vernier probeware and data-collection technology. You will conduct hands-on experiments using various sensors and Vernier interfaces.

These workshops are perfect for science educators interested in getting started with probeware and data collection, and for those who want to refresh their knowledge of Vernier equipment.

Attendees receive
- Four hours of free training
- Light lunch or dinner
- Workshop Training Manual download
- Discount on an equipment package

To register, go to www.vernier.com/free-workshops

Hands-On, One-Day Summer Institutes

2015 Summer Institutes	
CO	Denver 7/7
IL	Chicago 7/15
MA	Boston 7/31
MO	St. Louis 7/13
NY	New York 7/29
OH	Columbus 7/17
OK	Oklahoma City 6/26
OR	Beaverton 8/6
PA	Philadelphia 7/27
TX	Dallas 6/24, Houston 6/22
UT	Salt Lake City 7/10
WA	Seattle 8/8

Join us for a full-day exploration of Vernier's award-winning line of computer and handheld data-acquisition technology. You'll leave the workshop ready to excite your students' learning with data collection.

The cost of the institute is $99, which includes a lab book of your choice (a $48 value). Please see the website for Training Package pricing. The registration form can be found at www.vernier.com/summer-institutes

Free Hands-On Training at Conferences

Vernier will offer hands-on workshops at each of these conferences. For a complete list of our conference exhibits, check our website at www.vernier.com/conferences

Conference	Location	Dates
NSTA STEM Forum & Expo	Minneapolis, MN	5/20–5/23
International Society for Technology in Education	Philadelphia, PA	6/28–7/1
American Association of Physics Teachers	College Park, MD	7/25–7/29
NSTA Area Conference	Reno, NV	10/22–10/24
National Association of Biology Teachers	Providence, RI	11/11–11/14
NSTA Area Conference	Philadelphia, PA	11/12–11/14
Conference for the Advancement of Science Teaching	Fort Worth, TX	11/12–11/14
NSTA Area Conference	Kansas City, MO	12/3–12/5

Chautauqua Short Course

Promoting Active Learning in Introductory Physics Courses with Research-Based Curricula and Tools

This hands-on course is designed for those who teach introductory physics at universities, colleges, and high schools. Graduate credit will be available.

June 18–20, 2015
Vernier Software & Technology, Beaverton, OR

Instructors:
- Priscilla Laws (Dickinson College)
- David Sokoloff (University of Oregon)
- Ronald Thornton (Tufts University)

For more information and to register go to http://pages.uoregon.edu/sokoloff/CHAUT.htm or contact David Sokoloff, sokoloff@uoregon.edu, 541-221-6543

Video Training Library

Want to learn the basics or sharpen your skills at your convenience, right from your own computer? Our free online video library offers introductory and advanced videos featuring experiments and product demonstrations. To watch our latest videos, including tips for using the Vernier Structures & Materials Tester, visit **www.vernier.com/latest-videos**

PROFESSIONAL DEVELOPMENT

Two-Day, Subject-Specific Institutes

AP* CHEMISTRY

For beginner, intermediate, and advanced users
During this two-day, hands-on workshop, you will explore how to integrate probes, instruments, and software into your AP* Chemistry courses. A significant portion of the workshop will focus on inquiry-based methods of conducting experiments, featuring experiments from the new AP* Chemistry lab book from Vernier.

Examples of experiments and sensors that will be covered:
- Acid-Base Titration: Determining the K_a of a Weak Acid – pH Sensor
- Determining the Rate Law of a Chemical Reaction – SpectroVis Plus
- Identifying an Unknown Solid by Melting Temperature – Melt Station
- Analyzing a Mixture with a Gas Chromatograph – Mini GC Plus

July 6–7, 2015
Vernier Software & Technology, Beaverton, Oregon
The $199 registration fee includes lunch and a copy of the new lab book, *Vernier Chemistry Investigations for use with AP* Chemistry*, a $48 value.

ENVIRONMENTAL SCIENCE / AP* ENVIRONMENTAL SCIENCE

For beginner, intermediate, and advanced users
This two-day, hands-on workshop gives you the opportunity to explore how to integrate probeware into your environmental science course. Participants will conduct experiments that investigate ecology, field biology, and renewable energy. A variety of experiments that are correlated to the AP* Environmental Science framework will be offered. Specific emphasis will be placed on conducting inquiry investigations.

Experiments and sensors include
- Microclimates – PAR Sensor, Temperature Probe, UVB Sensor
- Primary Productivity – Optical DO Probe
- Water Quality Testing – Optical DO Probe, Conductivity Probe, pH Sensor
- Exploring Wind Turbines and Solar Panels – Energy Sensor, Variable Load

July 8–9, 2015
Vernier Software & Technology, Beaverton, Oregon
The $199 registration fee includes lunch and a copy of the Vernier lab book, *Investigating Environmental Science through Inquiry*, a $48 value.

BIOLOGY / AP* BIOLOGY

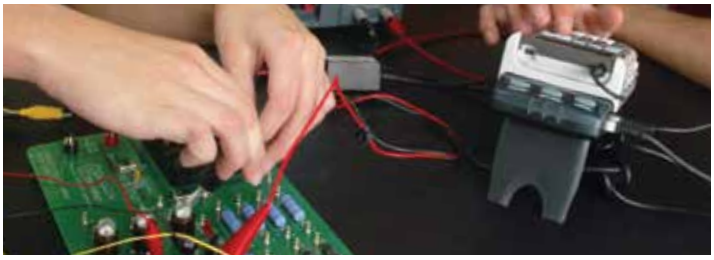
For beginner, intermediate, and advanced users
This two-day, hands-on workshop gives you the opportunity to explore how to integrate probeware into your biology courses. You will have the option to conduct experiments in human physiology, ecology, and cellular biology. A variety of experiments that are correlated to the AP* Biology framework will be offered. Specific emphasis will be placed on conducting inquiry-based laboratory investigations.

Experiments and sensors include
- Cell Respiration – CO_2 Gas Sensor
- Testing Catalase Activity – Gas Pressure Sensor
- Transpiration – Gas Pressure Sensor
- Analysis of Enzymes using Peroxidase – SpectroVis Plus Spectrophotometer
- The Visible Spectra of Plant Pigments – SpectroVis Plus Spectrophotometer
- Primary Productivity – Optical DO Probe
- Heart Rate – Hand-Grip Heart Rate Monitor

July 10–11, 2015
Vernier Software & Technology, Beaverton, Oregon
The $199 registration fee includes lunch and a copy of the Vernier lab book, *Investigating Biology through Inquiry*, a $48 value.

PROFESSIONAL DEVELOPMENT

PHYSICS



For beginner, intermediate, and advanced users
This two-day, hands-on physics workshop gives you the opportunity to explore data collection and video tools offered by Vernier. You will learn basic and advanced skills in Logger *Pro*, such as configuring graphs, performing custom curve fits, setting up calculated columns, and customizing data-collection modes. Video analysis using computers and tablets will be covered. A variety of Vernier interfaces and applications will be available, including LabQuest 2, LabQuest Mini, iOS, Android, and Chrome apps.

Topics include
- Dynamics and kinematics using the Motion Encoder Cart, Encoder Fan Cart, and the Vernier Dynamics System
- Optics and diffraction using the Optics Expansion Kit and the Diffraction Apparatus
- Circuits using the Vernier Circuit Board

July 14–15, 2015
Vernier Software & Technology, Beaverton, Oregon
The $199 registration fee includes lunch and a copy of *Physics with Vernier*, 3rd edition, a $48 value.

One-Day, Subject-Specific Institutes

ENGINEERING AND STEM WITH LOGGER *PRO*

For intermediate users
Explore several ways to use Logger *Pro* software and Vernier technology to introduce STEM and engineering during this one-day, hands-on workshop.

In the morning, you will learn how a Digital Control Unit (DCU) can be used to develop logic-based, sensor-control systems. Some exercises include
- Controlling inexpensive DC devices (motors, buzzers, LEDs, and others) with the DCU
- Creating an automated, sensor-controlled apparatus

In the afternoon, you will have a choice of two topics:
Option A – Using the Vernier Structures and Materials Tester
- You will learn how to conduct an engineering lesson moving from basic concepts of geometry and design, through testing of small components, and capping it off with a bridge- or truss-design contest.

Option B – Building and Calibrating Your Own Sensors
- You will build simple sensors and learn how to calibrate them for use with Logger *Pro*. Examples include temperature sensors, force sensors, and photogates.

Participants should have some experience with Logger *Pro* software and the use of sensors.

July 16, 2015
Vernier Software & Technology, Beaverton, Oregon
The $99 registration fee includes lunch and a Vernier Digital Control Unit, a $61 value.

VERNIER SENSORS WITH ARDUINO™

For intermediate users
The availability of inexpensive, easy-to-program microcontrollers, such as Arduino, make engineering projects easy and affordable. Arduinos are great tools for getting students (and teachers) excited about engineering. This one-day, hands-on workshop gives you the opportunity to explore different ways to use your Vernier sensors with an Arduino.

You will learn the fundamentals of programming the Arduino and be introduced to the sample code available on our website.

Some of the topics that will be included
- Connecting and calibrating Vernier sensors
- Writing programs (called sketches for Arduino) to read Vernier sensors
- Logging data with Arduino and exporting data to Logger *Pro* for analysis
- Creating interactive Arduino projects

July 17, 2015
Vernier Software & Technology, Beaverton, Oregon
The $99 registration fee includes lunch, a SparkFun® Arduino RedBoard, and a Vernier Interface Shield, a $50 value.

Vernier
MEASURE. ANALYZE. LEARN.™

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Go Wireless® from Vernier

Works with iOS®, Android™ and LabQuest® 2*

NEW Go Wireless® Link
Wirelessly transmit data from a supported Vernier sensor to tablets and other mobile devices.
www.vernier.com/gw-link

Go Wireless® Temp
Collect and analyze temperature with this watertight sensor.
www.vernier.com/gw-temp

Go Wireless® pH
Conduct wireless pH investigations in the classroom or in the field.
www.vernier.com/gw-ph

NEW Go Wireless® Heart Rate
Monitor heart rate before, during, and after exercise.
www.vernier.com/gw-hr

* See www.vernier.com/til/3427 for current compatibility details.