Globisense

2013

High School Science with the Labdisc

Dov Bruker

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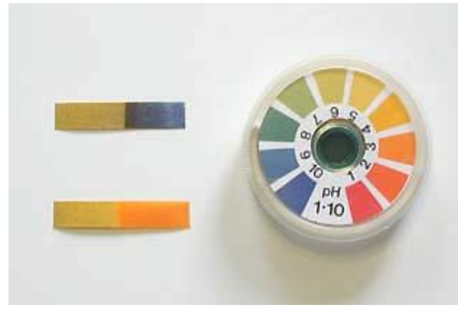
What High School Science Students Learn

Manual science experiments



Most high school students perform science by recording data “manually” - a very different thing from experiencing science “hands-on”. Take chemistry - acids and bases – where litmus paper is used which changes color when immersed in acidic or basic liquids. The paper must be removed immediately, kept in good conditions and the color scale read accurately. Any number of mistakes can be made, so ruining the outcome of the experiment.

When studying Newton’s laws of motion high school physics, geometry and algebraic equations are required to calculate complex concepts such as initial velocity and acceleration. Yet students often only have a marble, stopwatch, measuring tape and graph paper to achieve it. It’s the same story when studying a pendulum where the sophisticated concept behind the experiment shows the earth completes one rotation a day, proving the mass of the earth and acceleration due to gravity. However, by the time students have repeatedly collected and recorded data manually, there’s not much of the 45 minute lesson left to understand the real science behind the experiment.

Chemistry high school students know that a change in temperature is always a clue that a chemical reaction has occurred. When measuring an exothermic reaction manually, only semi-accurate readings can be taken with a thermometer, so students will need to repeat experiments a number of times to get a more successful outcome. But can class time, school supplies and student attention spans stretch to this?

Above we’ve described some typical experiments where data can be collected manually. But what about all the exciting science concepts that can only be explored with digital data collection, such as recording a sound wave, or a transient response in an electrical circuit. These experiments are beyond the reach of most high school science experiments, simply because in order to measure such fast changing phenomena, students would need to collect thousands of samples per second. Equally very slow acting phenomena which require data collection over an extended period of time are not feasible for manual data collection. An example of this would be changes in temperature, humidity, light and sound over a 24 hour period.

Students find collecting data manually boring

The challenge for teachers to engage high school science students go beyond the limitations of which activities they can explore, the inconvenient, time consuming and tedious experiment processes and disorganized methods for a typical class of 30+ students, not to mention how inaccurate and imprecise experiment results often are.

The biggest problem is that high school science students are bored and convinced that science has no relevance in their lives.

Since the 2002 implementation of the No Child Left Behind Act (NCLB) in the USA and other similar programs worldwide, schools must demonstrate "adequate yearly progress" with test scores, in order to obtain federal and state funding. Science is being tested, but how well are science concepts being understood? Many schools find time and budget limitations have focused education on a narrower set of learning outcomes and as a result most children are dropping out science and math. A Youth United for Change Studies report show the number one reason students drop out is because they're bored. The Bill and Melinda Gates Foundation's study supported this and showed students feel classes are not relevant to their lives or career aspirations.

The fact is, these same students are very technologically savvy and this can be used to science and math learning's advantage, helping to cultivate in high school students the desire to learn. Hand-held technology tools help science students make real-world connections so they understand how science and math concepts are relevant to their lives and futures.

Data Logging Technology Revolution

Twenty five years ago data logging technology began to enter high school systems, offering educators ways to make science experiments easier and cheaper to do. Today, data loggers and sensors are highly featured and able to take thousands of measurements per second, critical in performing simple or complex experiments within the parameters of a 45 minute science lesson. Data logging technology has made a huge contribution to science education. Students have been saved from the tedious and time consuming tasks involved in manual data collection. Instead science educators have been able to focus on the two elements which hold the greatest pedagogic value for any science activity: Experiment design and data analysis.

However, "time constraints" have limited how widely data loggers are used by high school science teachers. Typically one data logger is used by a pair of students. On average every data logger connects to two sensors, with two sensor cables and one communication cable to each pair's computer. So a typical class uses: 15 data loggers + 30 sensors + 45 cables.

On average it takes teachers 1.5 hours to test, calibrate and position a total of 90 items before every Lab lesson, then collect and put everything away afterwards.

Rejecting Hands-on Teaching Practices

The pressure of standardized governmental tests, together with technology setup and maintenance means they don't have time to use data loggers. That's even assuming the teacher feels confident to use complicated technology successfully in the classroom. These factors all contribute to perfectly good teaching tools wasting away in Lab closets, far from the hands of high school science students.

In today's science learning environment the critical features in data logging are: IMMEDIACY CONNECTIVITY and EASE OF USE.

Labdisc - it's Time for Something New!

Globisens has listened to educator needs with the Labdisc - applying latest 21st Century technology to resolve the limitations of current data logging solutions for high school, right up to university level science. Four models, with up to 14 built-in sensors, enable science investigation in various fields including environmental science, physics, biology and chemistry.

Globisens has packed a complete laboratory into a single small disc

The Labdisc replaces a big box of up to 20 individual items - data loggers, sensors, sensor cables and communication cables with a single device. Since all built-in sensors are automatically tested and calibrated, the Labdisc saves teachers hours of setup and calibration time every week.

The Labdisc is a truly plug n' play solution as it:

- ✓ Delivers a complete Lab on a disc with up to 14 sensors built-in
- ✓ Offers very high accuracy, high sampling resolution and fast recording – essential for high school and university science studies
- ✓ Saves teachers lab setup time – requiring only 15 Labdisc units to be handed out
- ✓ Ensures lessons run smoothly and calmly as teachers don't need to manage between 60 and 100 different items on the Lab table

Configurations for Every Science

The Labdisc middle and high school line includes **4 unique models** dedicated to the broadest range of school science, with **10 to 15 built-in sensor** configurations. (The Labdisc Primo is also available for elementary school science with 7 built-in sensors).

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<tr>
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<td>Labdisc for environmental studies built-in sensors include:

Ambient Temperature, Barometer, Colorimeter, Disolved Oxygen, External Temperature, GPS, IR Temperature, pH, Relative Humidity, Sound Level, Turbidity, UV.

Typical activities include:

Temp/light over 24 hours, acid rain, turbidity, water quality, temp./RH in urban areas using GPS, altitude and air pressure, heat absorption and cloud warming effects.</td>
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<td>Labdisc for general science built-in sensors include:

Air Pressure, Ambient Temperature, Current, Distance (Motion), External Temperature, GPS, Light, Microphone, pH, Relative Humidity, Sound, Universal Input, Voltage.

Typical activities include:

Travelling speed with GPS, Newton's Laws, sound waves, electrical currents, pH titration, endothermic and exothermic reactions Boyle's Law, specific heat and microclimate.</td>
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<tr>
<td></td>
<td>Labdisc for biochemistry, biology and chemistry built-in sensors include:

Air Pressure, Ambient Temperature, Barometric Pressure, Colorimeter, Conductivity, Dissolved Oxygen, External Temperature, GPS, Heart Rate, Light, pH, Relative Humidity, Thermocouple, Turbidity and Universal Input.


Typical activities include:

Skin temperature, pulse rates before and after activity, sweat production and photosynthesis, solid, liquid and gas phase changes and pH titration.</td>
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<td>Labdisc for physics built-in sensors include:

Accelerometer, Air Pressure, Ambient Temperature, Current, Distance (Motion), External Temperature, Light, Microphone, Universal Input, Voltage.

Typical activities include:

Lenz and Boyle's Laws, resistor networks, light source efficiency, light vs. distance, sound beat and wave superposition, Newton's Second Law and free fall acceleration.</td>
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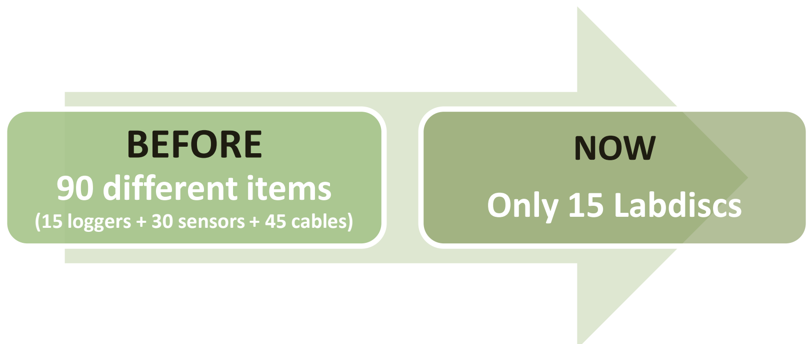
Labdisc Features and Benefits

All-in-one Disc

Teachers' preparation time for a Lab work is dramatically reduced, no longer having to deal with cables and sensors etc. Preparing for class couldn't be more convenient.

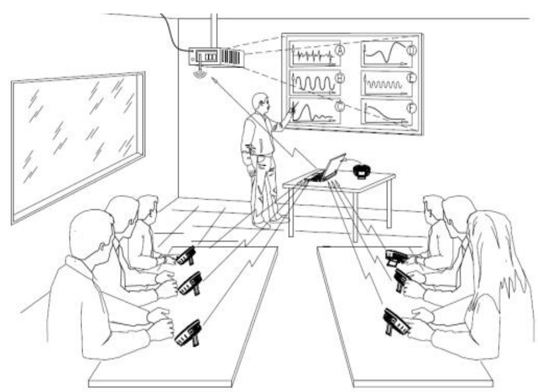


Wireless

The hand-sized Labdisc data logger is a single, cable-free device that acts as a complete Lab with up to 14 built-in wireless sensors. Bluetooth wireless communication fully integrates with all key school technologies and appliances. Connecting to computers, netbooks, interactive white boards, PDA's and even cell phones, the system delivers increased mobility in a cable-free Lab environment.

Technology Consolidation

For so many schools with interactive board technology already a part of the classroom, up to 8 Labdiscs, measuring real scientific reactions, can wirelessly communicate with class interactive board via a single teacher's computer. This opens the door to collaboration, hands-on and inquiry-based learning, while saving the cost of many computers.



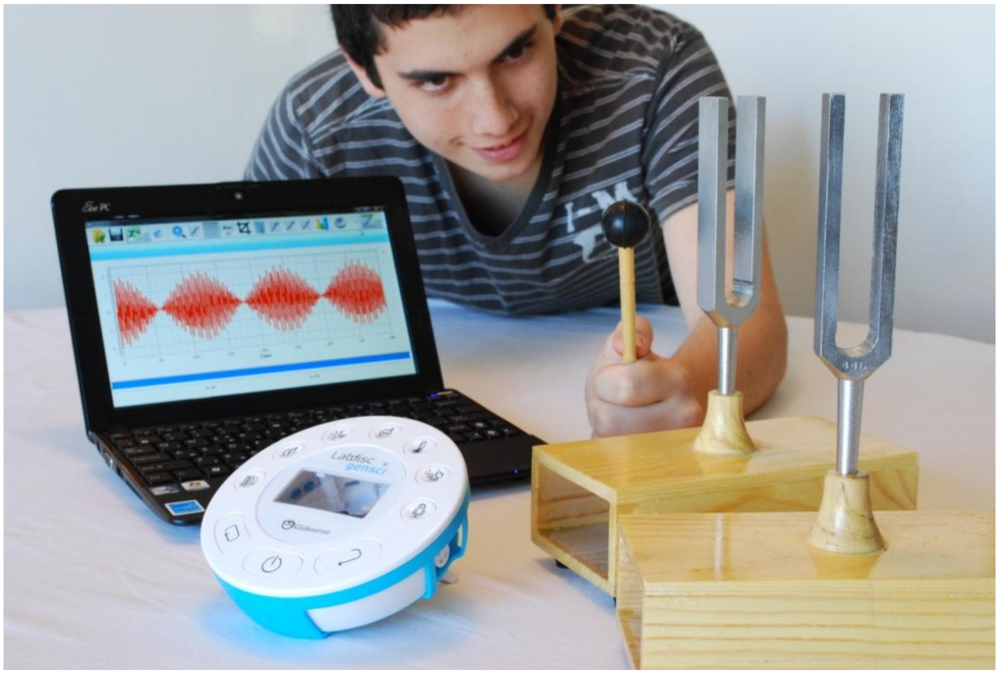
High Resolution Accurate Data Recordings

Measuring data at a very high resolution of 12-bit enables a wealth of experiment experience previously unavailable to students. High resolution sampling has a specific pedagogic advantage when attempting to measure very small changes in sensor values. High school students can digitally perform classic experiments in sound waves, electricity, mechanics collisions and more.

The Labdsisc also has high sensor accuracy at +/-2% on most sensors, many of them digital sensor, which are much more accurate than analog.

Unique Analysis Software

The Labdisc data analysis software carries all standard features including: Multiple displays, Labdisc setup, functions for measurements mathematic manipulations and Export to Spreadsheets, as well as some unique features including integration with Google Maps functionality, markers, data annotation tools and sophisticated data analysis features.



Appendix 1: High School Science Experiment Table

Subject	Activity
Biology	**"Skin Temperature"** Comparing skin temperature after putting our hand in cold water, exposing our hand to the sun etc. Discover if skin temperature is the same as body temperature.
	"Sweat Production" Covering our hand with a plastic bag, while measuring temperature and relative humidity to explain the principle of the body's cooling system – sweat**.**
	"Photosynthesis" Recording air pressure and light level, while using an Elodea water plant sealed in a test-tube - to measure the effect of photosynthesis and the relation between light intensity and oxygen production by the plant.
	"Our Heart Rate" Measuring the heart rate before and after exercise and recording useful information to determine physiological parameters.
	"Photosynthesis" Same as previous activity with the use of DO2 electrode instead of the air pressure sensor.
Chemistry	**"Phase Changes: Solid, Liquid and Gas"** A classic activity measuring the freezing and boiling point of water.
	"Specific Heat" Heating different liquids to the same temperature (70˚C) and comparing the cooling curves of these liquids to explain which has the higher specific heat.
	"Endothermic and Exothermic Reactions" Performing different measurements to examine which reactions release or consume heat.
	"pH Titration" Classic Acid and Base titration - measuring pH and temperature change (also using an external temperature sensor).
	"What Do We Drink?" Measuring the pH of different soft drinks.
	"Boyle's Law" Measuring the connection between volume and pressure: PV=NRT, by using a syringe to show the linear relation between volume and air pressure.
	"Lambert-Beer law" Determining the relationship between a solution concentration and its light absorbance
	"Altitude Effect on Boiling Point" Measuring the boiling point of water at different altitudes using the external temperature and barometer sensors.
	"Candle flame" Exploring the temperature zones of a candle flame.
	"Diffusion" TBD

Environment /Biology	**“Altitude and Air Pressure”** Using the Barometer and GPS sensors to travel from high to low places, measuring the change in air pressure and altitude.
	“Cloud Effect on a Winter’s Day” Measuring the sky’s temperature on a clear sky day and on a cloudy day and explaining how clouds keep ground heat from radiating into the atmosphere.
	“Day and Night” Recording the variations of temperature and light during a period of 24 hours to establish relations between them.
	“Acid Rain” Collecting rain in different area and verifying the acidity of the rain as it relates to pollution.
	“Water Bodies” Measuring temperature and humidity near rivers or other water bodies to determine their effect on temperature and humidity.
	“City Micro Climate” Measuring the changes in noise, temperature (and humidity) in different urban areas.
	“Water Quality” Comparing drinking water turbidity to other water taken from lakes and ponds.
	“UV & Sun Block” Measuring and comparing the level of ultraviolet radiation, resulting from the intervention of sunlight beam through different types of filters such as sunglasses and sun blocks.
Physics	**“Lenz Law”** The connection between electric and magnetic fields.
	“The Principle of Resistor Networks” Measuring the current and voltage of two simple electric circuits (in series and parallel) and determining the differences between them
	“Light intensity” Measuring and comparing the luminosity of a candle, a flashlight and natural day-light.
	“Light Versus Distance” Recording light intensity while moving away from the light source.
	“Travelling Speed” Using the GPS sensor to measure walking speed, running and/or biking speed, ideal activity for creating a contest between students.
	“The Laws of Motion” Determining the relationship between speed time and distance as part of understanding Newton’s mechanics principles.
	“Free Fall ” Measuring the free fall acceleration using a ping-pong ball.
	“Sound Level Versus Distance” Measuring sound level decay over distance.
	“Sound Waves” Recording sound waves and sound wave interference.
	“Absorption of Heat” Measuring and comparing the internal temperature of different colored containers full of water after being exposed to sunlight.
	"Hooks Law" Using a metal spring to investigate the spring coefficient K and the equation $F = -kx$.
	"Friction" investigating the static and dynamic friction of a body moving on different surfaces.
	"Harmonic motion" Investigating the motion of a mass on a spring.
	"Newton 2nd Law" - Using a cart pulled by a constant weight to prove Newton Law of motion - $F = ma$.