Empowering Science Education

ward's science

What K-12 Science Students Learn

Manual science experiments

Most K-12 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, to calculate complex concepts such as 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.

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 K-12 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. A typical example of this would be changes in temperature, humidity, light and sound over a 24 or 48 hour period.

Students find collecting data manually boring

The challenge for teachers to engage 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 K-12 science students are bored and convinced that science has no relevance in their lives.

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. Research shows 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 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 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 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 science students.

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

Datahub - it's time for something new!

Wards Science has listened to educator needs with the Datahub - applying latest 21st Century technology to resolve the limitations of current data logging solutions for K-12 students, right up to university level science. Five models, with up to 15 built-in sensors, enable science investigation in various fields including environmental science, physics, biology and chemistry.

Datahub has packed a complete laboratory into a single small disc

The Datahub replaces a big box of more than 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 Datahub saves teachers hours of setup and calibration time every week.

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

- ✓ Delivers a complete Lab on a disc with up to 15 sensors built-in
- ✓ Offers very high accuracy, high sampling resolution and fast recording – essential for K-12 science studies
- ✓ Saves teachers lab setup time – requiring only 15 Datahub 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
- ✓ Saves precious school resources being wasted on multiple small items (like sensors and cables) which inevitably get mislaid and lost during the lab learning session.

Configurations for Every Science

The Datahub K-12 line includes **5 unique models** dedicated to the broadest range of school science, with **7 to 15 built-in sensor** configurations.

	Datahub for **environmental studies** built-in sensors include: Ambient Temperature, Barometer, Colorimeter, Dissolved Oxygen, External Temperature, GPS, IR Temperature, pH, Relative Humidity, Sound Level, Turbidity, Universal Input and 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.
	Datahub 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.
	Datahub 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.
	Datahub 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.

Datahub features and benefits

All-in-one disc

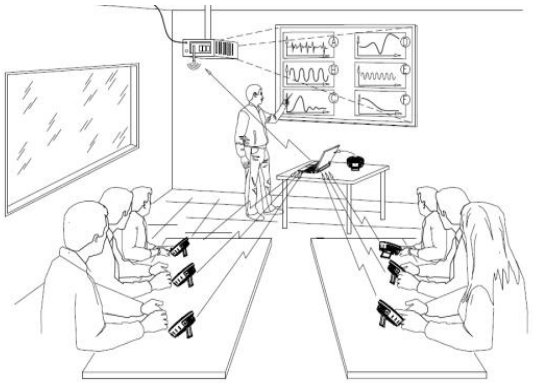
Teachers' preparation time for a Lab work is dramatically reduced, no longer having to deal with cables and sensors etc. Preparing for class couldn't be more convenient.

Wireless

The hand-sized Datahub data logger is a single, cable-free device that acts as a complete Lab with up to 15 built-in wireless sensors. Bluetooth wireless communication fully integrates with all key school technologies and appliances. Connecting to computers, netbooks, interactive white boards, and tablets, 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 Datahubs, 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.

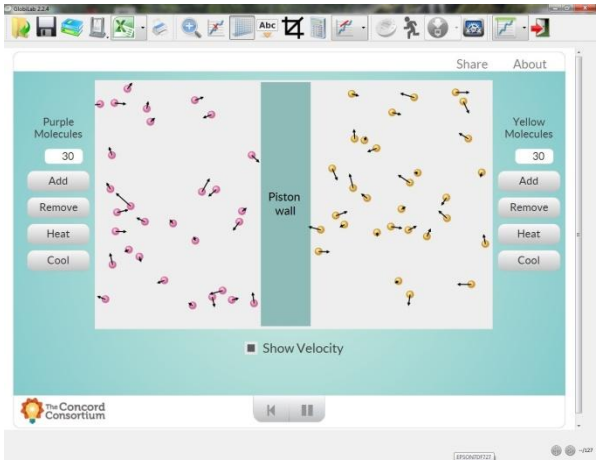


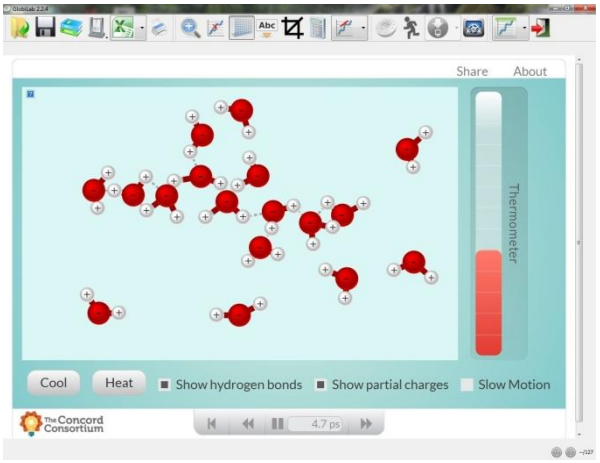
High resolution accurate data recordings

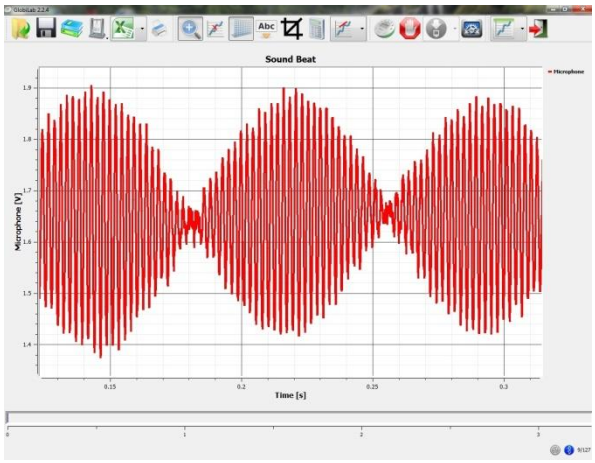
Measuring data at a very high resolution of 12-bit enables a wealth of experiment experience previously unavailable to students. K-12 students can digitally perform classic experiments in sound waves, electricity, mechanics collisions and more. The Datahub also has high sensor accuracy at ±2% on most sensors, many of them digital sensor, which are much more accurate than analog.

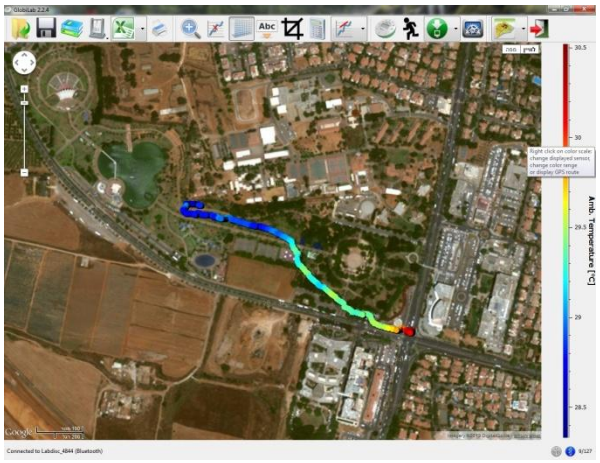
Unique analysis software

The Datahub data analysis software carries all standard features including: Multiple displays, Datahub setup, functions for mathematic manipulations and Export to Spreadsheets, as well as some unique features including integration with Google Maps, markers, data annotation tools and sophisticated data analysis features. Using the software simulation module, students can compare mathematical simulation to real measurements done by the Datahub sensors.









Broadening the Datahub Offering

Wards Science strongly believes in delivering an all-in-one wireless science laboratory. However, some key sensors require large casing and to maintain the compact and portable nature of the Datahub, they cannot be included in the Datahub housing. As a result, Wards Science has completed the Datahub built-in sensor range with some carefully selected external sensors to broaden the range of possible experiments for inquiry-based learning. Among the new and high accuracy, quality sensors are Force, Magnetic Field, Respiration, CO2, Voltage and Heart Rate.

Force is one of the key sensors required for experiments in physics. For many sensors wireless communication is an important feature for enabling mobility. However, for a Force and Acceleration sensor, wireless is a “must”: It allows students to connect to moving objects without the need to connect a cable to the sensor which can interfere with the object motion

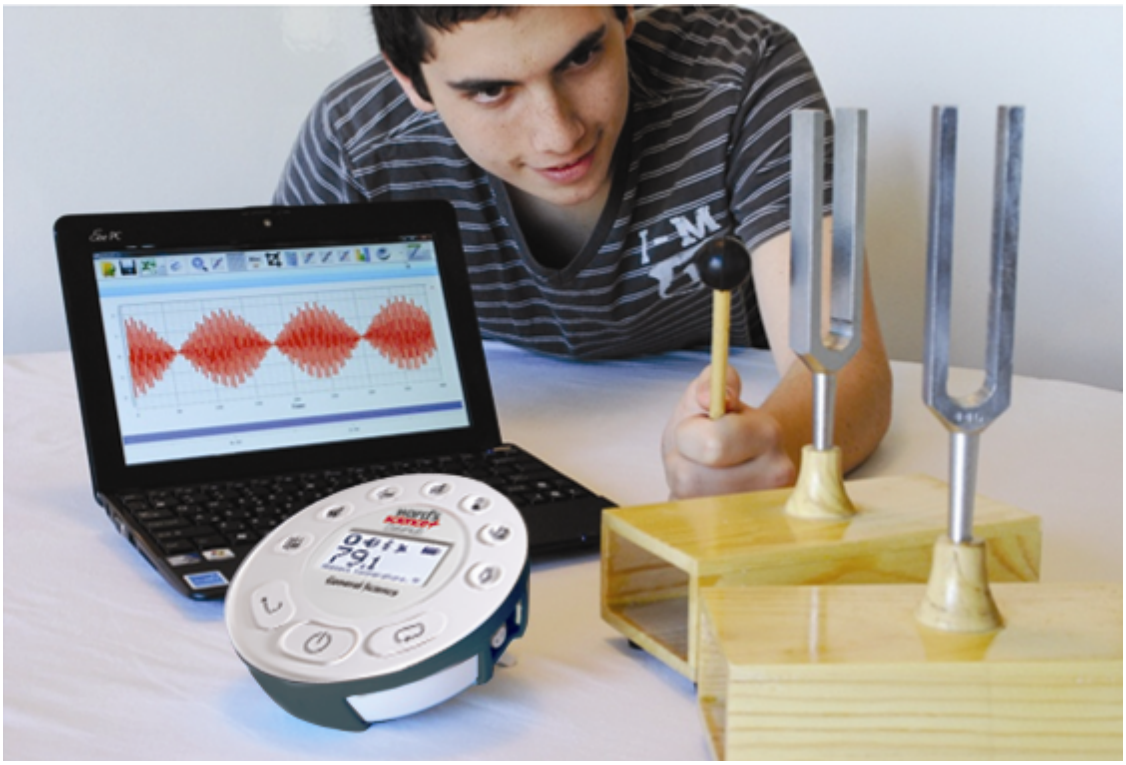
By incorporating the Force sensor as a stand-alone unit, wirelessly sending data measurements directly to the Datahub software, Wards Science has made a world of experiments possible in mechanics and physics. The sensor measures force at a range of ±50N, 3-axis acceleration at a range of ±8g and has a sampling rate fixed at 500 samples per second. Whether exploring simple harmonic motion, friction, collision, impact and momentum or centripetal force, students can easily attach the Dymo to portable Lab trolleys and dynamic carts.

The additional external sensors ensure any curriculum requirement can be satisfied by combining the Datahub models with a wireless external sensor. It also maintains the unmatchable price-point per sensor. The Datahub automatically identifies external sensors, displaying data measurements in the relevant sensor units both on the LCD display and in the data analysis software.

Experiment Materials and Kits

As a single multi-meter device, the Datahub replaces all traditional meters and sensors in the Lab. Yet, the Datahub does not replace experiment materials and accessories such as glassware, chemicals, tuning forks, weights etc.

As part of the Wards Science mission to provide complete science solutions to schools, a series of science kits have been created. These science kits contain all the experiment materials needed to cover the K to 12 science curriculums. Using our experiment cookbooks, students are able to conduct experiments, connect the Datahub to the experiment materials and measure parameters such as temperature, air pressure, speed, light level and sound waves, to name just a few.



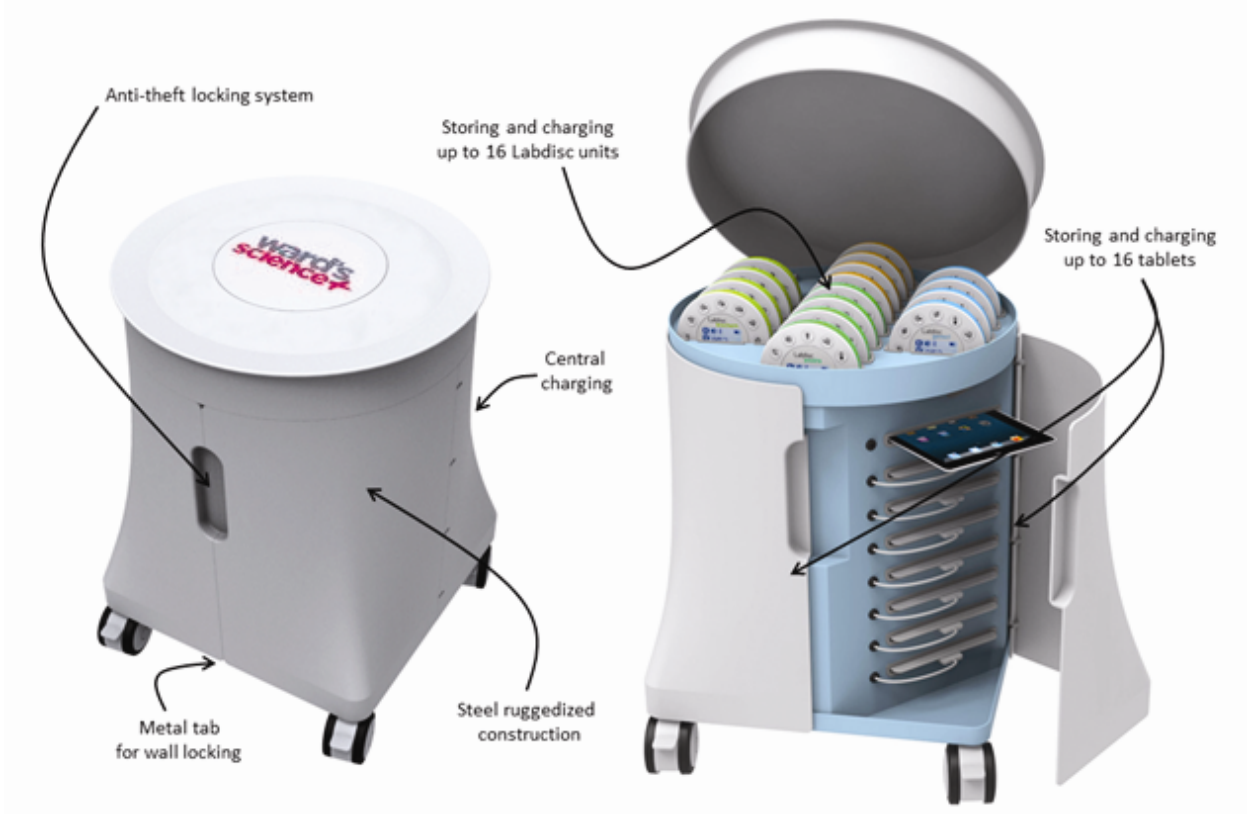
A Complete Mobile and Modern Science Laboratory

Limitless research supports the significant learning gains brought by probeware and data logging technology, helping children experience and understand abstract science concepts (See Appendix 1: What the Research Shows). However, to truly experience hands-on science every student needs access (whether individual, in a pair or in a small group) to a data logging device.

Currently schools attempt to achieve this with a dedicated computer science laboratory: A congested, cluttered and often old-fashioned looking room, outfitted with tens of thousands of dollars worth of equipment. Teachers must then mobilize groups of students to this science lab. They are always limited by the availability of this room (and often the support of a Lab technician), every time they want to introduce curriculum-required experimentation and inquiry-based learning into the science lesson.

Addressing this issue, Wards Science has expanded the same concept of convenience, immediacy and ease-of-use that made the condensed wireless Datahub so successful.

The Science Mobile Cart



Wards Science has developed the Science Mobile Cart in order to mobilize an entire computerized science laboratory to K-12 students wherever they are in school. This not only dramatically reduces the cost of equipping and running a full science laboratory, but also resolves the logistical challenge of transporting the entire class to a different room just to learn science.

Now schools can far more conveniently and affordably develop ICT skills and allow teachers to provide real inquiry-led experimentation to students: Delivering a complete, consolidated and clean digital science learning environment to anywhere in school.

The mobile cart solves the limitations on science learning in school. Storing and charging up to 16 Datahubs and 16 tablets; this mobile laboratory delivers digital inquiry-based science to every class.

No doubt, a single Datahub used by teachers during a science lesson can help conduct presentations. However, all the pedagogic research shows that it is the student who has to experience and perform hands-on an inquiry-based experiment in order for optimal learning to take place.

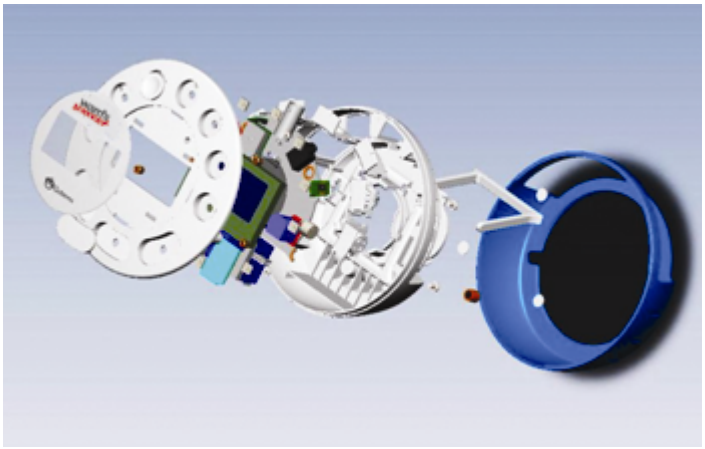
The mobile cart, storing up to 16 Datahubs is the ultimate solution for the classroom: One Datahub shared by two students as they conduct hands-on science experimentation. To conduct an effective Lab session, we recommend not more than four students per Datahub.

Production Reliability and Warranty

Wards Science is a US owned company that operates in more than twenty countries via a dedicated distribution network. The company has a total of 35 employees, more than 28 of whom work in our very modern hi-tech production facility.

Since being first launched in October 2011 the Datahub has shipped 40,000 units, won two international awards for pedagogic innovation and just been shortlisted for another this year.

The Datahub is comprised of 600 separate components, all of which are automatically assembled in less than a minute.



All boards must pass a thorough Automatic Optic Inspection (AOI) to confirm that every component has the correct part number and is assembled in its exact location on the board.

A strict quality analysis procedure ensures that 100% of all Datahubs are tested five times throughout their production. This modus operandi ensures the highest quality and reliability, resulting in a Datahub return rate of less than 0.1%.

Wards Science provides a 12 month warranty that covers all workmanship issues, but does not cover consumables such as batteries and electrodes which can be reasonably expected to last between one and three years depending on usage and storage.

Proposal

We are pleased to submit the proposal below for [Territory] school laboratories.

Our proposal suggests two types of solutions:

1. A comprehensive solution for the 1000 Schools, providing a modern solution at the student level. This solution enables each student to experience true hands-on experimentation in science. The solution is based on the Mobile lab with 5 General Science Datahub units, plus+ set of 5 Biology-chemistry and Physics science kits per class.

2. A lower cost, teacher demonstration lab for the rest of the 6000 A-Level schools. We will, supply here the Datahub General Science, plus one Biology-Chemistry and Physics science kits.

The proposal includes a full localization of our solution to meet [Territory] language and curriculum requirements. In addition we will conduct a teacher training course for 30 to 60 selected teachers, coming from all regions of the country. After being certified by Wards Science, these teachers will serve as trainers for their regions.

Pricing:

1000 Schools:

Product	Description	Price per unit	Number of units	Total price
Cart	Mobile science Cart	US$1700	1000	US$ 1,700,000
LD12-GenSci	Datahub General Science	US$500	5,000	USS 2,500,000
BC-Kit-GENERAL	Biology and Chemistry Science kits	US$260	5,000	US$ 1,300,000
PH-KIT-GENERAL	Physics science kit	US$535	5,000	US$2,675,000

As part of providing a complete mobile solution for Science, Wards Science can additional supply Tablet computers pre-installed with the Datahub analysis software.

Total President Schools: US$ 8,175,000

6000 A-Level schools:

Product	Description	Price Per Unit	Number of Units	Total Price
LD12-GenSci	Datahub General Science	US$ 500	6,000	US$ 3,000,000
BC-KIT-GENERAL	Biology and Chemistry Science Kits	US$ 260	6,000	US$ 1,560,000
PH-KIT-GENERAL	Physics Science Kit	US$ 535	6,000	US$ 3,210,000

Total A-Level Schools: US$ 7,770,000

All items carry a 12 month warranty against any workmanship or shipping defects. Warranty does not cover consumables such as batteries and electrodes and shall not apply in cases of product abuse.

In addition to the above we will charge a one-time fee of $100,000 for the translation, curriculum correlation and teacher training needed for this project.

Appendix 1: What the Research Shows

Digital technologies can be used to support the development and implementation of high quality technology-enhanced (probeware) science lessons.
Technology and Reform-Based Science Education, Theory into Practice 2008

Computer-based technologies support active engagement and science concept understanding by collaborative learning, frequent and immediate feedback on data in a real world context
Roschelle et al., 2000

Results indicate that data loggers excited pupils and saved them time recording temperature readings. That time could be used to produce and interpret graphs.
Introducing Data Logging Equipment into Programmes of Study in Field Studies Centre: An Evaluation Horizons, n15 p12-16 Aut 2001

Simple quick experiments using data loggers lead to the refinement of the experiments, increased confidence in the measurements and improved understanding of the physics involved.
How Science Works" and Data Logging: Eleven Quick Experiments with a Kettle
Physics Education, v45 n6 p658-669 Nov 2010

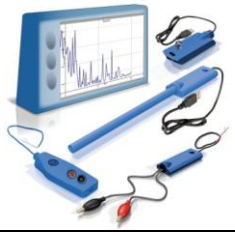
Science learning experiences with real or simulated investigation substantially improve understanding of complex ideas and lead to long-term understanding.
Research Points: Science Education that Makes Sense (2007)

Students who used computers and probeware showed significant learning gains.
TEEMSS, National Science Foundation, 2007

Countries like Japan and Korea (with early science learning) scored highly in science and math as compared with other 1st world countries.
PISA Results of Student Science and Math Scores, 2000

Students who had been exposed to hands-on science in pre-school performed higher than the national average.
Plank (2000, USA)

Appendix 2: Competitive Analysis

Item	Vernier LabQuest2	Pasco Spark	Datahub GenSci	Datahub BioChem
				
Data logging unit	$ 329.00	$ 495.00	1	1
Sensors:				
Voltage	$ 12.00	$ 145.00	1	
Current	$ 39.00	$ -	1	
Light Multi-range	$ 55.00	$ 81.00	1	1
Microphone	$ 39.00	$ 62.00	1	
Sound Level	$ 165.00	$ 173.00	1	
Barometer	$ 71.00	$ 123.00		1
Ext. Temperature	$ 29.00	$ 30.00	1	1
Thermocouple	$ 69.00	$ 69.00		1
Distance/motion	$ 79.00	$ 99.00	1	
Air Pressure	$ 83.00	$ 115.00	1	1
pH	$ 79.00	$ 99.00	1	1
Conductivity	$ 95.00	$ 137.00		1
Colorimeter	$ 115.00	$ 149.00		1
Dissolved Oxygen*	$ -	$ -		1
Relative Humidity	$ 69.00	$ 125.00	1	1
Human Pulse	$ 119.00	$ 149.00		1
Amb. Temperature	$ -	$ -	1	1
GPS	$ 64.00	$ 219.00	1	1
Turbidity	$ 112.00	$ 160.00		1
Universal Input	$ -	$ -	1	1
Wards Science SRP			**$ 570**	**$ 650**
Vernier			**$ 1,042**	**$ 1,289**
Pasco			**$ 1,643**	**$ 1,951**

Appendix 3: K-12 Science Experiment Table

Subject	Field	Lesson hours	Grade level	Datahub	Sensors
"Light intensity" Measuring and comparing the luminosity of a candle, a flashlight and natural day-light.	Physics	2	Middle school	Physio, Gensci	Light
"Day and Night" Recording the variations of temperature and light during a period of 24 hours to establish relations between them.	Environment/ Biology	2	Elementary/ Middle school	Gensci, BioChem, Physio, Primo	Light, Temperature
"What Do We Drink?" Measuring the pH of different soft drinks.	Chemistry	2	Middle school	Gensci, BioChem, Enviro	pH
"Water Bodies" Measuring temperature and humidity near rivers or other water bodies to determine their effect on temperature and humidity.	Environment/ Biology	5	Middle school	Enviro, Gensci, BioChem	Temperature, Humidity
"How Loud is Sound" Measuring the decay of sound level over distance	Environment/ Physics	2	Elementary	Gensci, Physio, Primo	Microphone
"Walk in the Park" Measuring temperature changes at a busy city junction, and in a nearby park or garden	Environment	2	Elementary	Gensci, Primo, Enviro	Temperature, GPS
"Travelling Speed" Using the GPS sensor to measure walking speed, running speed and/or biking speed – a great activity for creating a contest between students.	Physics	5	Middle school	Gensci, Enviro, BioChem	GPS
"Our Heart Rate" Measuring the heart rate before and after exercise and recording useful information to determine physiological parameters.	Biology	2	Middle school	BioChem (or Gensci with external heart rate)	Pulse
"The Laws of Motion" Determining the relationship between speed time and distance as part of understanding Newton's mechanic principles.	Physics	2	Middle school	Gensci, Physio	Distance

"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.	Environment	5	Middle school	Enviro	GPS, Barometer
"What is Distance" Examine the relationship between speed time and distance. Explore graphs of distance versus time	Physics	2	Elementary	Primo, Gensci, Physio	Distance
"The Temperature Around Us" Recording the temperature of different substances	Physics	2	Elementary	All	Temperature
"Absorption of Heat" Measuring and comparing the internal temperature of different colored containers full of water after being exposed to sunlight.	Physics	2	Middle school	All	Temperature
"Lenz Law" The connection between electric and magnetic fields.	Physics	2	High school	Physio, Gensci	Voltage
"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	Physics	3	High school	Physio (or Gensci with external Voltage)	Voltage, current
"Light Versus Distance" Recording light intensity while moving away from the light source.	Physics	2	High school	Physio, Gensci	Light
"Acid Rain" Collecting rain in different area and verifying the acidity of the rain as it relates to pollution.	Environment/ Biology	2	High school	Gensci, BioChem, Enviro	pH
"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**.**	Biology	2	High school	Enviro, Gensci, BioChem	Temperature, Humidity
"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.	Chemistry	2	High school	Gensci, BioChem, Physio	Air Pressure

"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.	Biology	3	High school	Gensci, BioChem, Physio	Air Pressure
"City Micro Climate" Measuring the changes in noise, temperature (and humidity) in different urban areas.	Environment/ Biology	4	High school	Enviro, Gensci, BioChem	GPS, Temperature, Humidity
"Lambert-Beer law" Determining the relationship between a solution concentration and its light absorbance.	Chemistry	3	High school	Enviro, BioChem	Colorimeter
"Free Fall" measuring the free fall acceleration using a ping-pong ball.	Physics	2	High school	Gensci, Physio	Distance
"Sound Level Versus Distance" Measuring the sound level decay over distance.	Physics	2	High school	Gensci, BioChem, Enviro	Distance, Microphone
"Sound Waves" Recording sound waves and sound wave interference.	Physics	3	High school	Gensci, Physio	Microphone
"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.	Environment	3	High school	Enviro	IR Temperature
"Candle flame" Exploring the temperature zones of a candle flame.	Chemistry	2	High school	BioChem	Thermocouple
"Photosynthesis" Using a DO2 sensor to check the Photosynthesis rate of an Elodea plat in different light intensities.	Biology	3	High school	BioChem	Dissolved Oxygen
"Phase Changes: Solid, Liquid and Gas" A classic activity measuring the freezing and boiling point of water.	Chemistry	3	Middle school	All	Temperature

"Impact and momentum" Using the distance sensor to measure the speed of two carts before and after a plastic collision.	Physics	3	High school	Physio, Gensci	Distance
"UV & Sun Block" Measuring and comparing the level of ultraviolet radiation, resulting from the intervention of a beam of sunlight through different types of filters such as sunglasses and sun blocks.	Environment/ Chemistry	3	Middle school	Enviro	UV
"Hooks Law" Using a metal spring to investigate the spring coefficient K and the equation F = -kx.	Physics	2	High school	Dymo	Force
"Newton 2nd law" - Using a cart pulled by a constant weight to prove Newton law of motion - F = ma.	Physics	3	High school	Dymo	Force, Acceleration
"Water Quality" Comparing drinking water turbidity to other water taken from lakes and ponds.	Environment/ Biology	4	High school	Enviro, BioChem	Turbidity
"Friction" investigating the static and dynamic friction of a body moving on different surfaces.	Physics	3	High school	Dymo	Force
"Harmonic motion" Investigating the motion of a mass on a spring.	Physics	3	High school	Dymo	Force
"Endothermic and Exothermic Reactions" Performing different measurements to examine which reactions release or consume heat.	Chemistry	3	High school	All	Temperature
"pH Titration" Classic Acid and Base titration - measuring pH and temperature change (Also using an external temperature sensor).	Chemistry	3	High school	Gensci, BioChem, Enviro	pH, Temperature
"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.	Chemistry	3	High school	All	Temperature

"CO2 production during respiration" Investigating bean seeds respiration, using the CO2 sensor.	Biology	2	Middle school	All with External CO2	CO2
"Earth Magnetic field" Using the Magnetic Field sensor to check the magnetic field of the Earth poles.	Physics	2	Middle school	All with external Magnetic Field	Magnetic Field
"Magnetic field of a coil" Using the magnetic field sensor to check the magnetic field inside a long coil.	Physics	2	High school	All with external Magnetic Field	Magnetic Field
"Mammal effect" decreasing the heart rate when seeming in cold water to preserve body heat.	Biology	3	Middle school	Primo, BioChem	Temperature, heart rate
"Doppler effect" what happens to a sound harmonic while in motion.	Physics	4	High school	Gensci	Microphone

Appendix 4: Datahub Specifications

Datahub Gensci Data Logger Specifications

Parameter	Datahub Gensci
Supported Platforms	Standalone, PC, MAC, iPad
Built-in Accessible Sensors	13 sensors: Air Pressure, Ambient Temperature, Current, Distance (Motion), External Temperature, GPS, Light, Microphone, pH, Relative Humidity, Sound Level, Universal Input and Voltage
Max. Sampling Speed	24,000/s
Sampling Resolution	12-bit
Internal Data Storage	100,000 samples
Internal Rechargeable Battery	LiPO 7.2 V
Battery life	> 150 hours
Display	Graphical LCD 64 x 128 pixels
Keypad	Yes
Communication	USB V2.0
Wireless Communication	Bluetooth V2.0 on all sensors
Remote Data Collection	Yes
Automatic Sensor Testing & Calibration	Yes
Size	ϕ= 132, H = 45 mm
Weight	300 gr.
Temperature range	-10 to 50 °C
Standard Compliance	CE, FCC

Datahub Gensci Built-in Sensor Specifications

Sensor Type	Max. Range	Accuracy
Air Pressure	0 to 300 kPa	±2.5 kPa
Ambient Temperature	-10 to 50 °C	±1°C
Current	-1 to 1 A	±2 %
Distance (Motion)	0.4 to 10 m	±2 %
GPS	N/A	±3 m
Light	Multi-range 55,000 lx	±15 %
Microphone	0 to 5 V	±2 %
pH	0 to 14 pH	±2 %
Relative Humidity	0 -100 %RH	±6 % (10%-90%RH)
Sound level	58 to 93 dBa	±4 dB
Temperature	-25 to 125 °C	±2 °C
Universal input	0 to 5 V	±2 %
Voltage	-30 to 30 V	±2 %

Analysis Software Specifications

Parameter	Description
Data Retrieval	Online up to 100 samples/second, or download Datahub stored data
Data Display	Line graphs, bar graphs, tables, meters, Google Maps
Communication	USB 2.0, Bluetooth 2.0
Data Logging Configuration	Sensor selection, sampling rate, sampling points
Graph Manipulation	Placing and moving up to two markers on the graphs, zoom in/out, graph cropping, graph color change, sensor legend (allowing graph show/hide and the selection of lines/icons for the graph samples)
Graph Annotation	Text and image annotations on the graph
Mathematical Functions	Derivative, linear regression, quadratic regression, FFT
Statistics	Min., max., average, standard deviation for a selected graph
Simulation	Gas and Liquid molecule behavior, with parameter control
Data Manipulation	Save/open experiment data, direct export to EXCEL, display hardcopy printout
Workbook	Full suite of built-in curriculum activities
Stored experiments	Full suite of stored experiment data
Configuration	Sensor calibration, change of sensor units
Firmware Update	Ability to update the Datahub firmware through a USB connection
OS	PC, Mac, Linux, iPad