Globisens

“Live Science”

Mobile science laboratory for K-12 schools

x15

Contents

The Country's Future Scientists

Sustainable national economic growth can only be achieved by an ICT industry, supplied with a steady flow of engineering, medical and science graduates. These university feeders must emerge from a K-12 education strong in Science, technology, engineering and mathematics (STEM). This is particularly acute when many more university science and technology graduates are needed for a expanding economies in countries that still face insufficient high school science and math enrolments.

Despite studies showing that the next decade will bring an increasing demand for science graduates, fewer students are opting for STEM-oriented degrees. Addressing the lack of motivation and engagement of young people with STEM subjects is critical to nurturing the next generation of scientists, doctors and engineers who can contribute to the country's productivity, growth and future role in globalization.

Abstract science concepts cannot come alive for students when they are taught via text book or manual experimentation. Endless research has proven that science is most successful with students when automated data loggers and computerized devices are used in a hands-on learning environment. However, to create such learning environments schools have had to invest in school labs which must be outfitted with thousands of dollars worth of equipment. The school must then coordinate lab time for different classes throughout the school day, while highly trained teachers must devote hours of preparation time per lab lesson.

Clearly, this traditional approach is not only expensive, but also inconvenient and time-consuming. As a result, despite its minimal effectiveness, manual experimenting remains the most commonly applied method to teach science in most schools.

The Rural Education Challenge

In rural areas the difficulties further increase with particularly low science student achievement levels and problems regarding teacher training, research and evaluation at the national and state level.

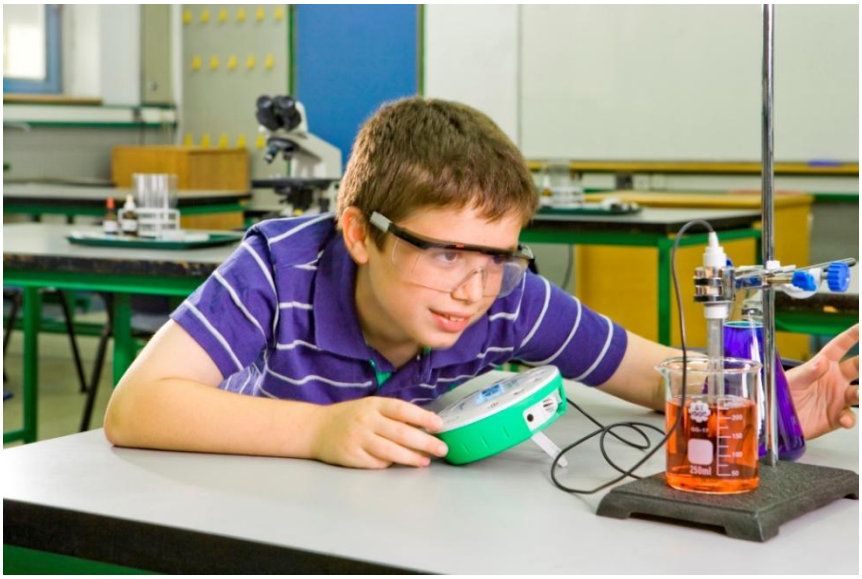
Whilst in much of the world, education is now both free and compulsory; in practice rural children find they have less access to a quality education than their peers in urban areas. Rural teachers also pose a major challenge regarding support, training and access to resources. Not only is the distance from training programs and centralized resources problematic, but also the teachers are often already overworked with additional duties and required to teach multiple grades and subjects.

Given the remote nature of these areas it is difficult for governments to supply quality education services, tools and training, which effectively weakens the quality of teaching and limits the potential for young scientists to blossom. Research shows that the quality of a teacher depends in a large part on the quality of their preparedness. Today more software and Internet implementations exist, however if teacher training and support is neglected, or technology tools are too difficult to use, then field programs in subjects like science and math will be of a low standard – effectively wasting the precious resources provided.

Importance of Hands-on Science

As mentioned above, most science students perform science experiments by “manually”, measuring different parameters such as: Temperature, light levels, air pressure etc. This not only bores students, but has a huge potential for failed experiments and doesn’t leave much of the 45 minute lesson left to understand the real science behind the experiment. Hands-on science reverses this: Making students behave like real scientists they activate the process of hypothesis, data measurement and collection, followed by data analysis and reporting. Automating repetitive manual data collection increases the rate of experiment success and allows students to focus on the pedagogically valuable elements of the process: Data analysis, result prediction and scientifically evaluated conclusions.

When science experiments are convenient to perform and used to solve every day challenges then students can grasp the importance of the discipline as a whole and the younger this starts the better. Hypothesizing and analyzing with early hands-on science builds a key foundation for logical and reasoning skills and helps motivate high school and university students to choose STEM subjects.



Live Science: Globisens 21st Century Digital Mobile Lab

Globisens offers an all-inclusive mobile lab solution to bring advanced hands-on science to remote schools. Now every student can gain ICT skills and embrace the national science curriculum, keeping up with the highest international technology standards. Everything required for STEM-based hands-on activities are stored in a mobile, wireless science station on wheels (science cart). Not only providing safe storage and inbuilt solar-charging facilities for every unit, the carts also enable easy parts inspection and auditing.

Every mobile lab station includes:

- **16 Labdisc data loggers** (15 student units and 1 teacher unit)
- **16 Android Tablet computers** (15 student units and 1 teacher unit)
- **15 science kits** – experiment consumables and equipment

15 student Labdisc data logging devices plus an additional teacher unit

The wireless Labdisc from Globisens, **2012 winner of both international and prestigious Worlddidac and Technology and Learning awards for innovation and pedagogic value** is a single device with 15 built-in science sensors, every one replacing a different expensive Lab meter. The Labdisc long sensor list includes: Temperature, humidity, voltage, current, distance, air pressure, acceleration and more. This broad sensor selection enables students to perform real experiments in physics, biology, chemistry, environmental science and geography. The Labdisc automatically measures the different experiment parameters and can collect up to 24,000 samples per second. Applying latest 21st century technology to resolve the limitations of expensive dedicated Lab rooms, the Labdisc brings multidisciplinary mobile science directly to students in any location.

Immediate and convenient:

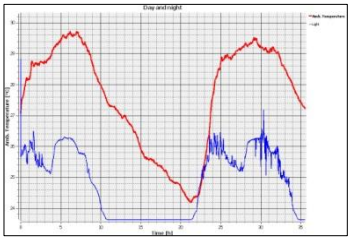
1. Delivers a complete Lab on a disc with up to 15 sensors built-in (replaces boxes of expensive traditional equipment and cables)
2. Offers very high accuracy, high sampling resolution and fast recording
3. Saves hours of setup and calibration time (all sensors automatically tested and calibrated)
4. Incorporates sophisticated GlobiLab analysis software for setup, display and analysis
5. Aligning with the national curriculum with a complete set of interactive multidisciplinary science activities for teachers and students

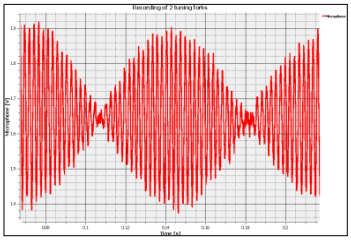
15 Android tablet computers for data analysis, plus an additional teacher unit

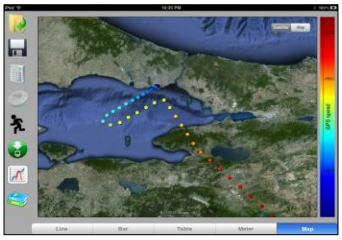
A very lightweight tablet PC with a large display screen, Android is known for high spec with affordability. Specifications include high resolution touch screen display, minimum initial 4 GB storage space, Wi-Fi and wireless Bluetooth connectivity.

The web accessible Android tablet can be applied for any research or self investigation project; students can even watch the curriculum video at their own desk. As part of the Globisens mobile lab, the Android tablet carries GlobiLab data analysis software, enabling students to measure their world and analyze real-time data samples in multiple displays.

GlobiLab software incorporates sophisticated data analysis with advanced functions and graphical tools, lab reporting features, plus wireless communication for full setup and control of the Labdisc data logger and built-in science sensors. The Labdisc GPS option also allows students to integrate GPS data logging, plotting real data over a Google map.







15 Science Kits – Consumables and equipment suitcase satisfying full local curriculum standards

Whether measuring Newton's 2nd Law of Motion with a ping pong ball, coil and resistors to test electricity, or chemicals to test endothermic reactions; specialized science kits for Physics, Biology and Chemistry each cover 8-10 activities.

The Globisens mobile lab solution contains every necessary technology tool and piece of equipment to perform advanced science experiments and then analyze the results. Science at this level would otherwise be impossible for remote school students because of the required investment for a dedicated Lab room, the necessary teacher science knowledge and time involved in setup and preparation.

With the Globisens mobile Lab not only are the savings significantly less than the traditional lab investment, but any teacher can feel confident in guiding an inquiry-based science lesson.

Globisens Technical and Pedagogic Support

Rural teachers must have broad multi-subject coverage which limits their ability to confidently explore complicated science concepts hands-on. With the Labdisc this issue is resolved, allowing teachers even with minimal science experience to adapt sophisticated science concepts for lesson practice and to meet the individual student needs.

Pedagogic Support:

Globisens support enables educational institutions to easily incorporate digital, online and mobile learning structures into the technology and pedagogic infrastructure. Labdisc implementations are streamlined with a minimal footprint. All built-in sensors are fully localized as well as pre-calibrated and tested ready for use. Additional interactive curriculum in the local language and are developed to support national learning parameters and targets in high school physics, biology, chemistry, geography and environmental science.

For teacher training support programs Globisens has developed a video training series, along with Webinar training, workshop sessions and interactive training and curriculum materials. The Globisens training platform can conveniently be delivered centrally.

At Globisens, we understand that faculty preparedness and training are essential to a successful implementation. Our pedagogic instructors are highly skilled in the area of digital science content development and teaching in an online environment, as well as traditional teaching methods. The mobility and easy integration of the Labdisc allows teachers to continue to apply existing course content

in a familiar environment. Labdisc training therefore focuses on acquiring new pedagogic strategies which can maximize class time and make the teaching process more convenient.

Comprehensive training workshops provide a full working knowledge of the Labdisc hardware and GlobiLab software. Localized curriculum activities are explored to reach the curriculum benchmarks necessary in each learning session. To ensure a consistent teaching standard is maintained, Globisens training offers ongoing refresher workshops where educators can learn from pedagogic and technical experts how to use the data logger and software for optimal science learning outcomes.

Technical Support

In additional to pedagogic training and support, local technical support is constructed to serve the needs of both the administrative and education populations. Globisens provides full technical support in the form of a complete warranty of hardware products against defects in materials and workmanship for a period of one year, together with free software updates. First level phone support by phone and email is also available.

Proven Success

Despite the fact that the Labdisc was only released in early 2011, 27,000 units have already been adopted worldwide by large Ministries of Education. Today more than 100,000 students, spanning three continents are using the Labdisc to improve their individual and national science prospects. The following two case studies from Russia and Chile explore how the Labdisc helped students and teachers overcome local educational challenges to experience successful learning outcomes, making hands-on science convenient, intuitive and immediate.

Labdisc Helps Meet New Russian Science Education Standards

Once a scientific and technology powerhouse, the dissolution of the Soviet Union and the 10 year recession that followed damaged science and math education in Russia. Now the country is committed to restoring the rich tradition of scientific excellence and training a future labor force of innovative scientists. A unique series of educational institutions have also been established for science and math distinction, their function being to drive achievement in the wider education system.

The Challenge:

Many teachers struggle to find appropriate technology that is easy-to-use for teaching science. Complicated, bulky data loggers connected by cable to various sensors and accessories are not a realistic option for engaging students in hands-on activity. Teachers need tools that can be applied immediately and don't require too much time in setup and preparation. In order to teach advanced math and science students need digital lab technology to read graphs, understand coordinates, decimal fractions, negative numbers and round physical quantities.

Sergey Lowjagin, curriculum developer and teacher at the School of the Future using the Labdisc in science classes, believes the product has something very unique to offer education:

"***Connecting concepts*** - Watching a graph building on a screen while the sensor takes the temperature of water all the pupils immediately realized where the temperature increased and decreased... they could read a graph! By showing a PROCESS of construction of an event they easily understood difficult content.

Multidisciplinary - GPS facilities and Google integration showing data automatically on the map introduces geography into science study.

Wireless connectivity - Via my computer I can connect to every pupil's device and see the data they are recording from their built-in sensors, or their graph analysis on a big screen for all the class to learn from.

All-in-one Lab - Advanced features, but simply built into one small machine makes a perfect tool for inquiry-based science education.

Easier to teach - My explanations can be brief, I can give students a task and they can work in groups independently.

Increased motivation - My class is attentive and excited to use the Labdisc, one boy even asked me after the first lesson: "Can I take it to home?"

As I teacher I only need to invent a good tasks and the learning process will proceed automatically. The Labdisc initiates this creativity."

Chile Raises the Nation's Science Awareness

Chile's national science education trends have greater ambitions that just to produce tomorrow's scientists, doctors and researchers. In fact the aim is to create a whole generation of citizens with a higher scientific consciousness and awareness of their surroundings. Based upon this, the Chilean national curriculum requires technology that can support experiential learning that places science in a real-life context.

The Challenge:

As part of raising the national bar in scientific understanding, 5th grade students are required to master reading charts and graphs, as well as manipulate data collectors. Unfortunately data logging devices and analysis software are often very complicated and awkward, making it difficult for teachers and students to meet these learning directives

The students of Reina de Suecia elementary school in the Maipú urban area of Santiago are motivated and excited to use the Labdisc, white teachers have found a solid channel to deliver inquiry-based learning approach and meet national standards.

Carla Lueiza, Science Educator Trainer worked with local teachers, Eduardo Chicahual and Mabel Dueñas to explore with 6th grade students the following activities in biology, physics, and environmental science: Sweat production, the greenhouse effect, variation of light intensity, heart rate and environmental changes within the school. The teachers found the Labdsic made it possible for students to quickly accept complicated science hypothesis and apply them in a process of scientific discovery.

All the teachers involved described the following Labdisc qualities as crucial to the program's success:

"***Easy-to-manipulate hardware*** **-** The Labdisc device offers a more user-friendly way to approach science that can leverage children skills and physical dextral ability (large button size, easy manipulation).

Satisfy national curriculum directives - The GlobiLab analysis software makes it very easy to read charts and graphs and perform analysis. Data results are immediate and approachable; and are more significant since they speak to the student's experience.

Regenerating interest- Applying experiments with a product like the Labdisc was a totally new and engaging experience, far from the limitations of just text books and precarious laboratories.

Resource innovation – Solving the problem of lack of resources with an affordable and highly sophisticated solution.

Easy-to-transport – Mobility is key, we don't have expensive school laboratories, we need a light-weight and easy to hold device that allows science to be applied anywhere.

100% technological – Whether using multiple wireless sensors simultaneously, applying GPS functionality or sending all data via Bluetooth – the Labdisc incorporating the latest in technologies into one device."



"Our experimentation with the Labdisc generated positive emotions in students because they discovered science through their own hands and minds. They loved the process so much that created their experiments and conclusion on a poster, now hanging on the lab wall…. With drawings of each stage, together with experiment results to help others understand what they had done."

Appendix 1: Facts Matrix

Research Indicates	Validated Labdisc Benefit
The Mathematics, Science and Technology Education report highlighted the existing negative trends in the supply of human resources in Maths, Science and Technology (MST). *European Table of Industrialists, 2009*	The Labdisc engages and motivates students in learning STEM subjects and practicing hands-on science
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*	The Labdisc makes science teaching and learning easier than ever before. A compact hand-held laboratory makes inquiry-based education intuitive and immediate.
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*	The Labdisc learning environment engages and motivates students with fast and easy experimentation and a focus on analyzing data results in vivid easy-to-read graphs, meters and tables.

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*	The Labdisc records accurate data in real-time to provide an immediacy in learning, critical to understanding complex and abstract scientific concepts like velocity or sound
PISA results of student science and math scores in 2007 indicated students in countries like Japan and Korea scored highly in science and math as compared with other 1st world countries	Paralleling early science learning in countries like Japan and Korea, the Labdisc makes elementary science easy and engaging with large intuitive buttons and LCD screen and fun activity park science laboratory software
Of the fastest 20 employment projections for 2014, 15 of them require significant mathematical and scientific preparation to successfully compete for a job. *US Bureau of Labor and Statistics*	The Labdisc allows students to function as real scientists and parallels real scientific practices, activating the process of hypothesis, data measurement and collection, followed by data analysis and reporting. Workbook experiments offer a means to solve every day challenges, allowing students to grasp the importance of the discipline as a whole and for their future.
Successful science curricula ensure that students identify and use scientific methods. *Research Points: Science Education that Makes Sense (2007)*	The Labdisc portable science laboratory supports science at every grade level, with model configurations, data analysis software and experiment workbooks for every science subject and stage of learning.
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 perform hands-on science with the Labdisc can receive a coherent understanding of scientific concepts, rather than just fragmented ideas. They are able to develop scientific enquiry methods and higher order thinking skills.
Twelfth-graders who reported taking biology, chemistry, and physics scored higher than students taking less advanced science coursework. *Nations Report Card Science 2009*	The Labdisc enables the math and science learning process where knowledge is built on a series of foundations. By creating a platform of one skill in order to move on to the next level of learning students will perform more effectively in science throughout their learning careers.

Appendix 2: 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.
	"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.

Appendix 3: Labdisc Specifications

Labdisc Gensci Data Logger Specifications

Parameter	Labdisc 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
Remote Data Collection	Yes
Automatic Sensor Testing & Calibration	Yes
Size	ϕ= 132, H = 45 mm
Weight	200 gr.
Temperature range	-10 to 50 °C
Standard Compliance	CE, FCC

Labdisc 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 110 °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 100s/s, or download Labdisc stored data
Data Display	Line Graph, Table, Meters, Google map
Communication	USB, Bluetooth
Data Logging Configuration	Sensor selection, sampling rate, sampling points
Data Manipulation	Placing and moving up to 2 markers on the graphs zoom in/out, graph cropping, graph coping, functions such as: derivative and regressions
Data Export	Automatic export to EXCEL
OS	PC, MAC, iOS