Leveraging Technology for a New Science Learning Paradigm

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Abstract

The Global Lab Project, the first full-year, online, interdisciplinary, high-school science course, pioneered a learning paradigm called telecollaborative inquiry. Piloted worldwide in the mid-1990s, the project engaged students in a virtual learning community that conducted synchronized, collaborative investigations. Despite its effectiveness, Global Lab was far ahead of the available technologies of the day, and was relaunched in 2005 as a pilot in Russia <www.globallab.ru/>. *The Global Lab Project 2.0 uniquely capitalized on cloud computing and social networking to advance the project's telecollaborative inquiry model. Its model, however, by its very nature, conflicts with the traditional practices of science classrooms. To more effectively position the curriculum in the core of science instruction, Global Lab 3.0 tightly integrates content and curriculum at the granularity necessitated by daily instruction. Future innovations will further build on cloud computing to advance Global Lab's telecollaborative inquiry paradigm for 21st century science education.*

Today in Russia, the International Laboratory for Advanced Education Technologies (ILAET), in collaboration with the Moscow Institute of New Technologies, is piloting a new learning paradigm called telecollaborative inquiry in the Global Lab Project. An upper elementary-school integrated Earth and physical science curriculum, Global Lab harnesses social networking, cloud computing, and new technologies to engage students in distributed, synchronized, hands-on investigations that uniquely build content mastery and foundational skills. The current Global Lab Project is version 3.0, reflecting its past and future scope and its leveraging of twenty years of evolving computer technologies and pedagogical strategies that, when integrated, afford secondary schools entirely new ways of inquiry learning.

Inquiry is a pedagogical strategy that focuses students on constructing their own knowledge through hands-on investigative projects. When done by an individual classroom, however, inquiry can be limited if not parochial. For example, to explore a topic as simple as the relationship between latitude and the angle of the sun, a single classroom has to take measurements throughout the school year, which conflicts with a teacher's need to ensure each class period meets its objectives and outcomes. As a result, such inquiry projects can stop abruptly halfway before students become aware of the discoveries afforded by the investigation. When many classrooms that are geographically-distributed worldwide measure the angle of the sun on the same day and share their findings, students then have a body of data that they can analyze immediately. They can explore the data's statistical validity and obtain meaningful results.

We use the word "telecollaborative" because Internet connectivity changes the nature of inquiries, multiplying the power of individual inquiries [1]. Telecollaborative inquiry enables students to leverage the community of inquiry's findings to make the data more meaningful and the learning deeper, more immediate, and more efficient. Students conduct one experiment or collect one set measurements, but in return they then have everyone's data to study. In addition, immersing students in a distributed community of learners better deploys the social aspect of learning: students feel needed and valued as they begin to appreciate the importance of their data to the entire community.

Telecollaborative inquiry also teaches the processes of science. When a teacher tells students to make measurements in a specific location following a strict protocol, students can conclude that these instructions are arbitrary and irrelevant. But when they understand that many other classes are making the same measurements and they will then compare their findings, the need for rigorous protocols and common standards becomes almost intuitive. Students also can begin to grasp that the essence of science is collaborative knowledge construction. Telecollaborative communities of inquiry, for example, provide a critical audience and rationale for peer review.

Global Lab 1.0: launching telecollaborative inquiry

Launched in 1990, the Global Lab Project was an eight-year effort at TERC and the Concord Consortium, funded by several grants from the National Science Foundation, that explored the use of new technologies for engaging students in authentic, collaborative scientific investigations. The project culminated in the first yearlong, middle-school, interdisciplinary science curriculum that implemented online collaborations for student inquiries. The curriculum used the Internet, affordable tools, and scaffolding to link teachers, students, and scientists into an international community united by common goals, curriculum, and technologies and engaged in real-world, open-ended investigations. Four hundred schools in almost 30 countries on five continents participated in the project [1].

Global Lab was one of the first classroom communities of practice to deploy a curricular structure and community-building techniques. Students communicated with their peers worldwide, engaged in building their own community, and learned both science skills and content. Rather than individual classes trying to understand natural phenomena using a single set of locally-collected data, Global Lab classes examined datasets from the entire community, accelerating and deepening students' understanding of key science concepts. This model of telecollaborative inquiry delivered on the promise of Internet connectivity to enhance education and justify the enormous costs of wiring classrooms for computers.

Structurally and metaphorically, Global Lab was organized as an international networked science laboratory with every participating class having its own presence. All interactions between schools were computer-based, and each school was a fully-functional node on the network. The community was supported by a virtual library where project data and background resources were kept, a project-wide electronic bulletin board for announcements, and online discussion groups for students and teachers. Students teleforums allowed classes to post their findings, ideas for further investigations, and research plans. In their own online discussions groups, teachers reflected upon their practices and shared tips and advice.

Pioneering networked science

The Global Lab Project advanced the networking learning projects of the day, which began with the 1983 Kids Network Acid Rain unit [2, 3]. By 1986, TERC, working with the U.S. National Geographic Society, developed NGS Kids Network, the first telecommunications-based curriculum material and the first curriculum to use student data sharing over the Internet. Students participated in large-scale, cooperative experiments, shared their data on a computer network, and consulted with scientists. Each Kids Network unit involved making a measurement that students shared with other students performing the unit simultaneously. Worldwide, thousands of elementary-school teachers inserted Kids Network modules into their classroom instruction [4].

Global Lab adopted the Kids Network model, such as the clustering of schools into work units to facilitate collaborative investigations. Each Global Lab cluster had 20-25 schools that featured geographical diversity and were moderated by teachers, giving students a sense that they belonged to an electronic neighborhood. Global Lab also sought to improve upon Kids Network by delivering more content, but its seminal innovation was the use of study sites.

The study site is the object of focus during the Global Lab year. It is usually a piece of land or a body of water in proximity to the school, and students study its physical, chemical, biological, cultural, and historical characteristics. The use of study sites impacted student learning in vital ways.

The study site engendered in students a sense of ownership in their work. Too often, they are told what they must study. Instead, Global Lab allowed them to choose what to study. By focusing on a student-selected object of study from the world outside the classroom, the project made learning hands-on, relevant, and motivational. Early on in the Global Lab school year, students knew that their studies would be rooted in the real world.

The study site also provides an almost Hegelian dialectic of similarities and dissimilarities [5] that exemplifies the pedagogical value of telecollaborative inquiry. Global Lab emphasized uniformity; students used the same tools and strict protocols at the same time to collect data on their study sites. This uniformity enabled them to study their local environments in precisely the same way, thus allowing for comparisons and analyses. Yet, while sharing common methodologies, the Global Lab community was geographically, ecologically, and culturally diverse, and represented many unique social and historical perspectives. When students, therefore, placed their findings into regional, national, and global contexts [1], they inevitably discovered that their data differed from each other. Why, for example, did one study site have higher levels of particulates in its air than others?

When students explored the causes of these differences, the interplay of uniformity and diversity yielded a dynamic and stimulating learning environment. Students learned about statistical variations, the reproducibility of data, and metadata. They experienced how science operates, which, by its nature, is collaborative. And as they sought to account for the differences in their data, they learned to separate facts from inferences, and how some phenomena must be reproduced by distributed peers.

Building a collaborative learning community

The project was structured, in effect, as an educational funnel, guiding learners from qualitative descriptions to quantitative data collections, and then to investigations bound by genuine rigor. The Global Lab year was divided into three progressively sequential phases, each with its own objectives and goals. The first phase, *Meeting Your Global Lab Community*, focused on building a virtual international learning community and developing in students local, regional and global perspectives. It instilled in them a sense of community and built the skills, familiarity, and trust they would need for telecollaborative inquiries. Students gradually gained the ability to compare and contrast their findings and place them into regional and global perspectives.

The second phase, *Building Investigative Skills*, prepared students to conduct investigations by carefully scaffolding the acquisition of basic inquiry skills. Students began by making drawings, maps, and qualitative observations of their study sites. Then, with guidance from instructional materials, students worldwide used similar tools and instruments and followed the same schedule, protocols, and standards to make environmental measurements of their study sites. They then reported their findings via the Internet to a community-wide database. Soon, every class collected a rich set of data on the soil, water, and air of its study site and sent its findings to the Global Lab database for comparison and analysis with peers. Students placed their local environments into a global context.

After introductory data-gathering activities, the community participated in a series of synchronized skill-building procedures called Global Lab Snapshots, which were inspired by the International Geophysical Year of 1957. Snapshots are the quintessential telecollaborative inquiry events over the Global Lab year. At the same hour on prearranged days, all schools made identical measurements on their study sites. These and other directed research procedures prepared students with invaluable skills in collaborative techniques and data-collection, and added to the growing functionality of the community.

Global Lab's final phase, *Extended Investigations*, engaged students in open-ended, telecollaborative investigations. The curriculum supported fields of study that were drawn from the students' own observations of environmental phenomenon on their study sites. Each class was asked to select one of these fields in which to perform an investigation. The community then reconfigured itself from one that was curriculum-directed to one that was student-directed. Research topics included air and water quality, tracking pesticides, nitrate studies, butterfly migrations, lichens and other bioindicator plants, and UV and stratospheric ozone.

Students were called upon to pose a research question, identify the data they would need to answer it, develop a research strategy with which to acquire this data, and then perform investigations collaboratively. Throughout the process, classes were asked to peer review each other's work for accuracy to ensure scientific vigor.

Similarities & dissimilarities

The duality of similarities and differences in data offered learning opportunities that sometimes impacted students' lives. A Global Lab class in San Antonio that was part of a cluster studying CO_2 levels, for example, determined that its classroom had relatively high levels of CO_2. Its students assumed that the CO_2 had caused observed classroom illnesses, but the moderator explained that a correlation does not necessarily mean causality. The real cause was inadequate ventilation in the classroom. Pressured by the students, the school's administrators called in environmental professionals to take their own CO_2 measurements. Indeed, their findings correlated to the data that the students obtained using the project's tools and protocols. For these Global Lab students, it was, in the words of their teacher, "a moment of glory" [6]. In a reflection of how science is generally taught in secondary schools, the same teacher, in a personal communication, noted that her students assumed science was just memorizing content from textbooks and eagerly engaged in Global Lab activities to avoid doing "real science."

When performed by a single classroom, hands-on science inquiries deliver limited experiences. But when performed simultaneously by a hundred of networked schools, they provide a rich set of data that can be the source of many interesting discoveries and conclusions. Global Lab demonstrated that distributed, synchronized investigations in virtual communities offer more powerful learning opportunities than small or individual inquiries.

The Global Lab Project's innovations were effective and widely praised by teachers and the education community. Based on surveys, classroom observations, and teacher and student interviews, Global Lab enabled student inquiry. Students demonstrated increased abilities to design, execute, and interpret experiments. Network-based peer review was particularly effective. Learners enhanced their abilities to evaluate experimental design and benefit from criticism. They better appreciated science and ethics, and became more aware of their accountability to their peers. Significantly, they also acquired science process skills like the abilities to articulate research problems, create procedures, and analyze data. Teachers also reported that the project motivated at-risk students and other typically under-served groups. In all participating classes, students' attitude towards science improved and their curiosity of world problems related to science appeared to increase. [1, 7].

Thanks to these accomplishments, Global Lab was featured in *Science* [8], *Wired* [9], and *Fortune* [10] magazines, National Public Radio. The White House's National Information Infrastructure 1994 Agenda for Action report cited Global Lab as an exemplar of online K-12 education in America [11].

Ahead of its time

Upon completion of its developmental stage, Global Lab and all of its materials and resources were handed over to textbook publisher Kendall-Hunt for publication. Yet despite its many innovations, successes, and accolades, the curriculum languished. Why?

One key reason was the limited technologies of the mid-1990s were insufficiently robust to support such an advanced learning endeavour. Classroom connectivity was limited to modem dial-up access and computers were still pokey, impeding data sharing and communications across the Global Lab community. When the project's evaluator asked teachers why their classes communicated with other project classes, 29 percent said to ask for help in addressing technology-related problems, indicating the limitations of the period's computer-mediated communications [7]. Moreover, with the World Wide Web still in its infancy, the project lacked easy-to-use, graphical, function-rich, interactive user interfaces to facilitate students' work.

Additionally, network-based inquiry curriculum was still a novelty then and many teachers were ill-prepared for delivering inquiry-based pedagogy and using computer-based communications. They struggled to integrate Global Lab into their classroom practices, which was evidenced by the project's various implementations [7]. Some classes used Global Lab as intended—a full-year science curriculum—but most teachers inserted the project's curriculum units into their regular Earth science, biology, physics, chemistry, and environmental science courses [12], generally one day a week on a part-time basis. They still based their assessments on what their students learned from standard textbooks, making the project, in effect, an extracurricular activity.

Finally, Kendall-Hunt, like virtually all other textbook publishers of the day, was ill-prepared to market Global Lab to school districts. It was a new kind of curriculum that demanded new ways of teaching, highly unlike traditional textbook products. Moreover, the publisher was not in the business of providing the hosted infrastructure that Global Lab demanded.

Although Global Lab 1.0 withered, it influenced then-emerging educational projects. Global Learning and Observations to Benefit the Environment (GLOBE), for example, initiated by the office of then Vice President of the United States Al Gore, built upon its innovations, including the use of study sites, to forge a networked partnership between students worldwide and leading scientists to monitor key environmental parameters. But Global Lab's bottom line is it was an entirely new learning paradigm that fell victim to convention and its own farsightedness.

Global Lab 2.0: relaunched with new technologies

By 2005, Web 2.0 technologies and social networking sites were emerging, and many schools had reasonably powerful computers and broadband Internet access. Dr. Boris Berenfeld, the principal developer of Global Lab 1.0, and his colleagues at the Concord Consortium decided that the project's time had finally arrived. With support from the Russian National Training Foundation, they developed Global Lab Project 2.0. They targeted upper-elementary students (grade 5) with interdisciplinary, introductory Earth science learning, and piloted the project in 30 schools across Russia from its cities to its villages. Russia was chosen as a testbed because of its broad environmental diversity, ranging from deserts in the south to tundra in the north and all manner of terrain and climates in between, and for its traditional use of synchronized curriculum.

The Global Lab Project 2.0 <www.globallab.ru/> used the pedagogy and strategies of 1.0, but with major upgrades. The Concord Consortium remotely hosts the project's curriculum, content, applications, and many of its resources, and the developers built an innovative web portal along with support for project coordinators and teacher trainers. Refining the original project's structure, Global Lab 2.0 is divided into seven month-long modules: Building a Global Community; Selecting and Exploring Life at our Study Site; Signaling Seeds: from Dormancy to Germination; Down the Scales to Molecules; Earth History Recorded in Rock; The Global Lab Snapshot: Sun, Light and Heat; and Our Study Site in Time. They are sequenced like chapters in a book to provide an overall narrative to the Global Lab year.

The core Global Lab paradigm remains, but with advances often driven by the availability of new technologies. Now, during community-building, for example, when a class joins the project, a star at its geographical location on a map of Russia automatically appears, giving students a view of the location and distribution of project classes throughout the country. Every class uses tools embedded on the web site to construct a multimedia presentation to introduce itself, its school, its community, and its region. Each class has a public space in the portal dedicated to its presentation, and with video, audio recordings, and images, each introduction is far richer and engaging than the plain text messages of Global Lab 1.0.

The project developed a tool called the Annotator that enables students to very easily annotate their photos and images with text captions. This functionality is useful for communicating with images, particularly when describing the characteristics of study sites.

Classes also work with a much more advanced, project-wide database. Students can search the database using such environmental and geographical parameters as latitude, region, elevation, average air temperature, and average precipitation. For example, they can identify the data from schools within certain ranges, such as +/-10 degrees of latitude, which facilitates both data analysis and finding collaborators within the community. Moreover, once they identify the desired data, they can visualize the information in a variety of ways to identify trends and bolster analysis.

Additionally, Global Lab 2.0 enhances the delivery and availability of project-focused content by providing a digital primer. With a Russian name that basically translates to “verbal portraits,” the primer provides the scaffolding to describe study sites and qualitatively and quantitatively identify its flora, fauna, and terrain. It includes terms to build students’ vocabularies and annotated images of the flora and fauna students might find on their sites. For example, the resource features illustrations of birds that identify all of their defining characteristics. It empowers students to more accurately describe birds by the size and shapes of their beaks, the colors of their features, and characteristics of their tails. Or describe rocks by their lustre and hardness, or seeds by their size, shapes, and defining characteristics. They learn that science, as in many endeavors in life, begins with careful observations.

While Global Lab 2.0 has yet to be formally evaluated, the response from teachers was very positive, just as with version 1.0. Many said that their students looked forward to their Global Lab work because they liked its authentic, hands-on investigations in a distributed community of peers [13]. When asked for his opinions of the project, one student inadvertently summed up the project’s educational success by declaring that he disliked Global Lab because it made him “think all the time” (a video of this comment and Global Lab students in the field is available at <http://www.globallab.ru/en.htm>). The project is scaling its efforts to meet growing demand for participation among Russian teachers, even though awareness of the project has been spread only through word of mouth.

Yet, the project continues to grow and innovate.

Global Lab 3.0: going to the heart of classroom instruction

In 2009, ILAET launched the Global Lab Project 3.0 as a pilot project in 100 Russian schools (schools can apply at <http://www.globallab.ru/join/en.htm>. This version further refines 2.0 with additional technologies and functionalities to support science learning. Students, for example, will be able to directly upload data from a wide range of inexpensive, commercially-available digital probes, streamlining data collection and enabling realtime graphing and visualizations of phenomena. Such a capability further reinforces the project’s portal and web-based tools as an entire ecosystem for learning and teaching.

One of the developers’ primary objectives was to structure Global Lab’s telecollaborative inquiry model so teachers could use it in the core of their daily instruction. The pedagogy of telecollaborative inquiry conflicts with the structure of science classrooms, which tend to be insular, textbook-centered, and demand definitive answers in accordance with course scheduling. Typical science classrooms function with daily granularity; each class is predictable with its activities and outcomes, a characteristic that true collaborative investigations often fail to produce. Global Lab 1.0 and 2.0, like Kids Network, GLOBE, and other similar projects, ran into this contradiction. As a result, they remained as ancillary instruction to mainstream science classes, used after school or with motivated students.

Accordingly, Global Lab 3.0 adapted its telecollaborative inquiry model and open-ended investigations to the realities of classroom practices. The project offered a new framework, which functioned at the granularity of daily instruction, that addressed teachers’ needs to present designated content areas and build specific science process skills. Key to this effort was the delivery of content. There have been widespread demands for schools to adopt digital textbooks to avoid the costs of print textbooks and ensure students always work with up-to-date information. Indeed, the primer of Global Lab 2.0 was an example of digitally-delivered content in scrollable and searchable book form. Version 3.0, however, took another approach for presenting content.

Granular teaching & learning

Global Lab 3.0's main innovation is its conversion of traditional instruction, content, and scaffolding into granular telecollaborative units. Although it uses the same overall eleven-stage structure of its predecessor, it breaks down each stage into Global Learning Units (GLUs™). The project does so to tightly integrate content with curriculum and activities.

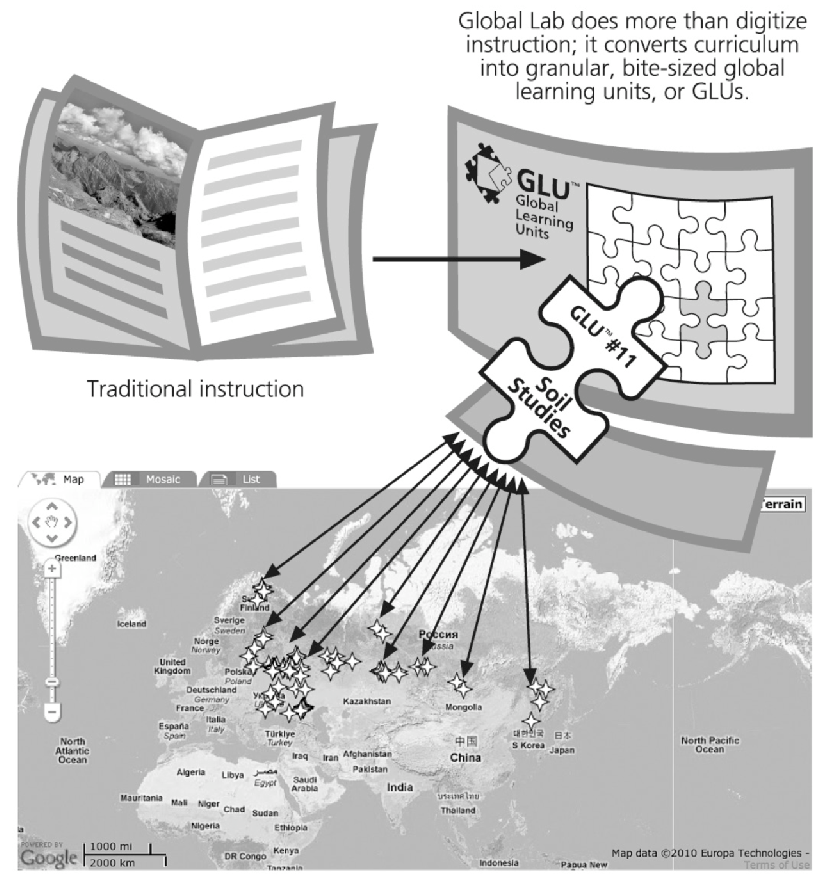


Figure 1. Global Learning Units (GLUs™) are performed synchronously by a worldwide community. Every star on the map represents one of 100 participating schools.

Every GLU is a set of dedicated, web pages linked by onscreen icons and all share the same eight components (see the figure below for the components and the student interface). Each offers several days of classroom investigations on a primary topic within the module's domain.

The first component, "Introduction," introduces students to the GLU's topic and inquiries. "Glossary," the second, borrows from 2.0's a primer to provide the vocabulary and concepts that the GLU addresses. Unlike 2.0's primer, this component offers interactivity; students can add to it as needed to support their learning.

"Resources" provides the GLU's content and concepts. Students click on this icon to access all relevant content. Content is no longer elsewhere in another chapter, book, or web site; it is always one click away. Content and curriculum are now seamless. Additionally, Global Lab takes advantage of Internet advances, such as Web 2.0 technologies, hyperlinks, wikis, and multimedia, to present traditional content digitally.

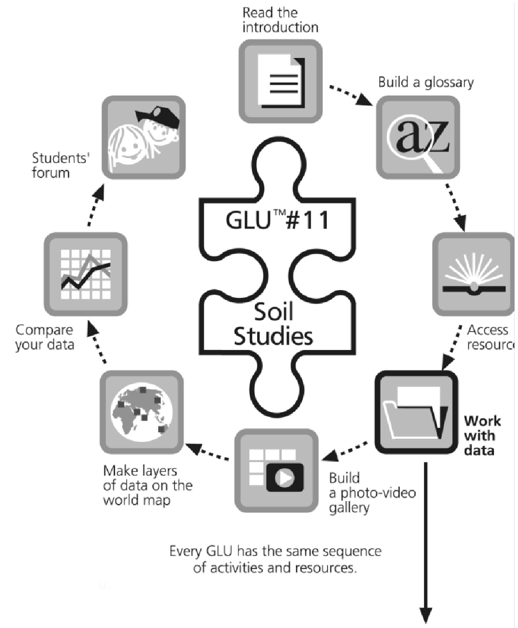
The "Work with data" component engages students in observations and data collection. They upload their findings into the project database and visualize their data. To make investigations as rich and engaging as possible, students post video, photos, artwork, metadata, and anything else about themselves and their investigations in “Our gallery,” which all other schools can freely access. Classes can exchange visual data and maintain a true presence within the community.

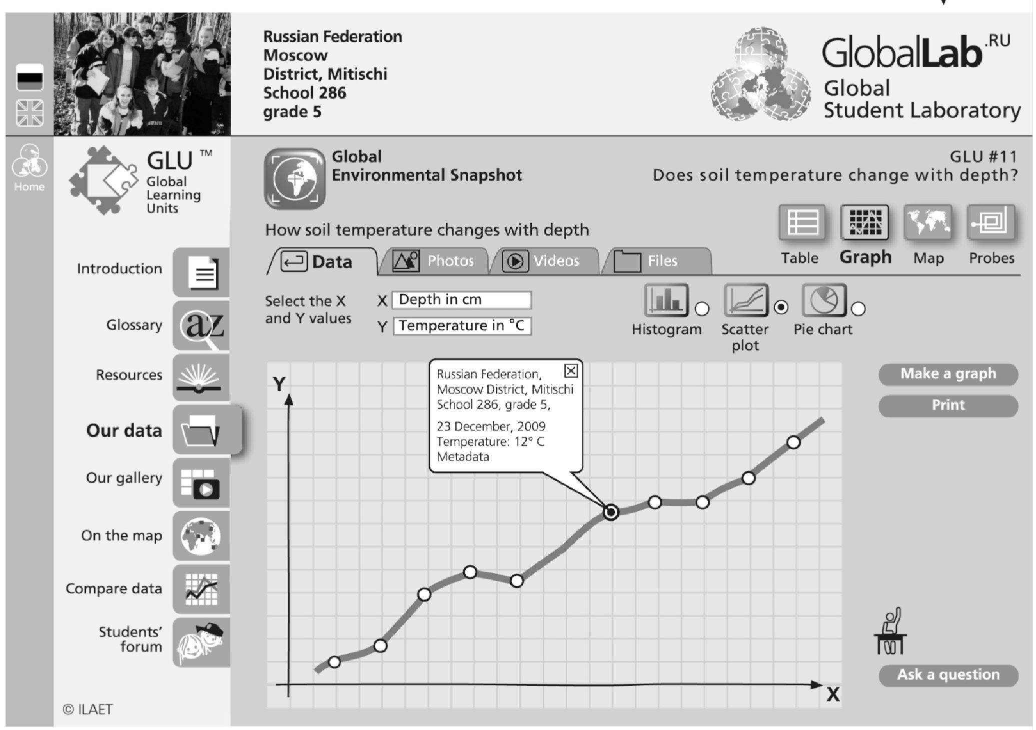
In “On the map,” students place their data on a global map of the Global Lab community and view the findings of other project schools. The map emerges as both an investigative and community-building tool. Clicking on any star on it brings up an image of that site’s students and basic metadata of its environmental circumstances.

Once they work with their own data, classes then compare their findings with other schools in the “Compare data” component. They still select data from schools by using parameters and ranges, enabling a reasonable level of data mining, and they visualize how their local environmental characteristics compare with any single school, any group of schools, or all schools.

Figure 2. **Structure & workings of a GLU**
On the right is the structure of every Global Learning Unit (GLU). GLUs are each comprised of eight components that introduce, support, and guide students through a collaborative investigation.

Below is the user interface for data acquisition and analysis of the GLU's "Work with data component." Users can visualize data as a graph, as a layer on a map of Global Lab schools, or as an image gallery.





"Students' forum" allows students to discuss their work and investigations. A ninth component for teachers only, "Teachers' forum," permits instructors to share ideas and practices, offering needed support and professional development.

Thanks to GLUs, Global Lab 3.0 consolidates content, curriculum, tools, and resources within a synchronized community using a remotely-hosted student-friendly interface. It calls into question the need for packaging content into textbooks, even when they are digital. The project delivers a complete learning ecosystem with which teachers can ensure their students master content and gain skills through authentic collaborative investigations.

Leveraging the cloud

Always intrinsic to Global Lab's pedagogical approach is networking among students and the fact that learning is a social endeavor. Even before the term "social networking" was coined, version 1.0 was relying on networked interactions among peers for science learning. As evidenced by the popularity of Twitter and Facebook, today's children are even more able and eager to communicate with each other. Yet, although their classrooms may be wired, students themselves are not connected.

Global Lab channels how they interact via online social networks to build virtual learning communities. When a class enrolls in the project, its students immediately see who is in the community they just joined. In every Global Lab class period, they are scaffolded by the structure of that day's GLU to conduct collaborative investigations into the GLU's topic. As they do the activities, they know that their peers throughout the community are doing the same work and will depend on them for data, ideas, and partnerships. As a result, students in Global Lab are truly connected and do not have to "power down" as they do for other classes. They now learn inside the classroom just like they learn outside the classroom.

Just as importantly, Global Lab 3.0 takes advantage of the economies, scalability, and functionalities offered by cloud computing. The project has always been dependent on remotely-hosted services and resources, even in the 1990s. It now demonstrates that clouds have many applications in education besides IT applications like remote data storage [14].

Schools certainly can use clouds as many business do. They can keep their curricula, applications, and data on clouds, obviating the need for in-house IT resources and robust but costly classroom computers. Because the cloud provider does all the computation-intensive processing, teachers and students can use thin clients or even iPhones to access resources. Schools, as a result, can gain productivity and much needed cost-savings, especially when content is digitally delivered.

Clouds, however, can do more for education than delivering software-, content-, or even infrastructure-as-a-service. They can change the very ways that teachers teach and students learn. Cloud computing enables telecollaborative inquiry in the form of synchronized virtual learning communities. The same curriculum is done synchronously by all schools worldwide, allowing for stimulating interactivity and discoveries. With such *cloud pedagogy*, students can become, in effect, learning entrepreneurs who actively construct and apply knowledge. They can build their knowledge of content while gaining skills vital to 21st century industries like critical-thinking, collaboration, communication, data assessment and analysis, and lifelong learning.

Global Lab 4.0?

The Global Lab Project 3.0 will continue to evolve, perhaps one day becoming version 4.0. It already is a laboratory that illustrates how advanced pedagogical approaches can leverage emerging technologies. Its developers are considering building into the portal voice and video IP conferencing to make collaborations easier and more vivid. Thus, within the globally-distributed learning community will be productive, globally-distributed student laboratories. Students thousands of miles apart will be able to collaborate on realtime experiments, viewing each others' classrooms, speaking to each other, and immediately accessing each other's data. Many professional science enterprises lack such functionality. To support cross-cultural investigations, the portal will also feature embedded translation tools to surmount language barriers.

The project will easily update content and provide curricula and on-demand learning and teacher training services. It will add an advanced molecular modeling application and other resources that teach new fields like nanoscience, biotechnology, and sustainable development, enabling schools to better prepare the next generation of workers.

Global Lab will embed assessments tools that allow instructors to determine if students grasp and can apply concepts and skills as well as if they have learned facts. Teachers will have additional professional development resources like webinars and just-in-time teacher training. They will be able to view a video of a master teacher delivering the next day's lessons, enhancing the curriculum's integration into daily practices and its educational impact on learners.

The project will even use cloud computing to better engage parents in their children's education. Developers envision enabling parents to access the project's portal to access a student's assignments, portfolio, and performance measures.

These and other future innovations are harbingers of how clouds and social networking can impact learning [14]. Dr. Berenfeld and his team at ILAET are globalizing Global Lab, making its resources available in English

<http://www.globallab.ru/en.htm> and, later, other languages. They also are scaling the project's capacity to many thousands of schools, permitting a truly global learning community of practice. While the project and its participating schools are presently supported by grants from the Russian Dynasty Foundation and Intel Education, the developers will build a sustainable model using school fees and grants. Moreover, the Global Lab's pedagogical framework can be applied to nearly all secondary-school curriculum. For several centuries, K-12 schools have prepared students for the Industrial Revolution and then for the Information Age. the Global Lab Project presents a new paradigm for educating students for the 21st century.

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