Newsletter
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Spring 1997
@CONCORD.ORG
PREMIER ISSUE

INSIDE

Welcome to the Concord Consortium

An Educational Technology Lab

by Raymond Rose

Welcome to the first issue of @CONCORD, the newsletter of The Concord Consortium. We want to share with our readers the work that we're doing on educational technology issues, and the ideas and experiences we've encountered while developing these projects.

Inside our newsletter are editorials, personal experiences, project descriptions, and ways to get involved.

Some people are just beginning to think about education and technology issues. They may have logged on to the World Wide Web for the first time this year. Others are actively involved in educational projects that use computers and electronics.

Our audience includes a diverse group of professionals who share the desire to develop and enhance technology in the classroom. We want to discuss the complex issues surrounding the concepts of *netcourses*, *asynchronous communication*, and *virtual classrooms*. And we hope our audience will weigh in on the issues.

The premier issue of @CONCORD focuses on the use of digital networks, such as the World Wide Web, as a medium for offering expanded course offerings. The article "The Future Is Now" explains how a nationwide cooperative of schools is

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The Concord Consortium is dedicated to educational innovation through the use of creative technologies.

LINKS ON THIS PAGE
@CONCORD—www.concord.org

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Welcome to Concord Consortium

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developing courses to be offered over the Internet. For the more technologically oriented, "Technology Makes INTEC Run Faster" explains the computing power behind a math and science teacher professional development course offered in part online. And "Netcourses Reform Education Using the Power of the Internet" explains what a netcourse is and how it's different from traditional classroom instruction. Get our opinion of the issues by reading the "Perspective" editorial in each issue. This month, "Ensuring Quality Netcourses" presents the possibility of standards for online course offerings. Is it needed, and even essential?

These are just a few of the articles inside @CONCORD. There is something for almost every level of technological know-how. This publication strives to balance technical jargon and straight talk, research and opinion, hands-on and theoretical. When we succeed or fail in accomplishing our goal, we hope that our readers will tell us. Reader feedback is essential to making @CONCORD a useful tool, and not just another piece of junk mail. We want to hear from our readers about the newsletter and the issues it contains. Call, write, send us e-mail. (See contact information left.)

So, who are we? The Concord Consortium was started in 1994 by a group of Concord, Massachusetts, educators who share Concord's long tradition of progressive, independent thinking. Our president, Robert Tinker, is one of the founding members. Put simply, we believe in educational innovation through the development of creative technologies. What does that mean? We believe in utilizing the vast power of electronics, computers, and digital networks to create innovative solutions to educational problems.

What is our track record? With help from the National Science Foundation, we have developed several projects. Hands On Physics (HOP) is a refreshing alternative to standard high school and college courses. It uses low-cost kits, software, and video to teach physics. HOP also uses easy-to-build technology developed in a collaborative HazeS-PAN project to scientifically measure haze in the atmosphere. (See "Here Comes the Sun.") A new hand-held computer interface developed in conjunction with the Science Learning in Context (SLiC) project has expanded the notion of the traditional classroom to include the Central American rain forest. (See "Power and Portability" and "MayaQuest.") We have also developed a network-based graduate level course that addresses reform of mathematics and science teaching. The International Netcourses Teacher Enhancement Coalition (INTEC) course is offered in part over the Internet, but it has developed an innovative mix of online and face-to-face meetings. (See "Personal Inquiries in Mathematics.") Our most recent project, funded by the U.S. Department of Education in coordination with the Hudson, Massachusetts, public schools, is to develop an online or "virtual" high school. (See "VHS Netcourses Give Teachers TLC.")

> **"We use digital networks to create innovative solutions for educational problems."**

Related Web sites are listed under "Links On This Page" at the bottom of each page and are referenced in color in each article. Send your comments to info@concord.org and let us know what you think of @CONCORD. @

LINKS ON THIS PAGE

Concord Consortium Staff—www.concord.org / edtech_staff.html

The Future Is Now

Virtual High School Extends Course Offerings to Schools Nationwide

by Carla Melluci

Imagine a low-cost way to vastly expand course offerings. Imagine world-class teachers. Imagine access to unlimited informational resources.

Imagine no longer.

The Virtual High School (VHS) Cooperative project, funded by a Technology Challenge Grant from the U.S. Department of Education to the Hudson, Massachusetts, public schools, is bringing the future to 43 high schools from 13 states by offering innovative courses over the Internet. Teachers from the cooperative schools are designing the courses offered to students from other cooperative schools. VHS is the first time anyone has attempted a large-scale project in Internet-based courses at the pre-college level.

The VHS project is creating a low-cost means of augmenting the range of courses a school can offer without expanding enrollment. In exchange for contributing a small amount of teaching time to the cooperative, a school will be able to offer its students netcourses ranging from advanced academic courses and innovative core courses, to technical courses and specialized courses for language minority students. As this approach gains popularity, each school can contribute more teaching time, enroll correspondingly more students, and help make a wider variety of courses available. The resulting scheduling flexibility will greatly help schools match their teaching talent to the needs of students. In the past, the only way to achieve this range of courses and scheduling flexibility was to create huge regional schools, which have proven hard to manage and too impersonal for most students.

The VHS Cooperative will also provide assistance in implementing educational reform by putting a premium on student inquiry, interdisciplinary courses, and student-centered, collaborative learning. The issues of curriculum reform and technology utilization are intertwined in complex ways. Many of the new educational demands on schools are related to the needs of the technology-rich work environment that students need to master. There are pressures to make better use of information technologies, but their best use often requires substantial changes in teaching style, in ways that are consistent with the educational reform movement. It is very difficult for individual schools to undertake these interdependent changes. The VHS creates a technology-based cooperative of schools and expert teachers, world-class professional development opportunities, and access to national leaders in technology and educational reform, all of which will greatly help schools undertake significant reform.

In this first year of the project, 28 cooperative schools are participating, offering 27 innovative, exciting netcourses. Students will also have the opportunity to take courses being offered by volunteers from the educational community. The Concord Consortium is offering two courses: “Hands on Physics,” taught by Bruce Seiger and Robert Tinker, and

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Selected VHS 1997 Netcourses

Business in the 21st Century
La Connection Francophone
A Model United Nations Simulation Using the Internet
Earth 2525: A Time Traveler’s Guide to Planet Earth
Explorando Varios Aspectos de Culturas Hispanas Atraves del internet
Bioethics Symposium: Investigating the Biological Revolution
Eastern and Western Thought: A Comparison
Creative Problem Solving in Math and Logic
Poetics and Poetry for Publication
The Native American Experience
Russian, Soviet and Post-Soviet Students
Writing: From Inner Space to Cyber Space
Folklore and Literature of Myth, Magic and Ritual

LINKS ON THIS PAGE

Technology Challenge Grant—www.ed.gov / Technology / chalgrnt.html
Virtual High School—www.concord.org / vhs / summary.html

The Future Is Now

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"Music Appreciation and Composition," organized by Kathryn Costello in collaboration with professional musicians and instructors. Bill Aldridge, former Executive Director of the National Science Teachers Association, is offering "Learning Science In-depth Through Its History."

The project kicked off in March with the Teachers Learning Conference (TLC), a graduate-level netcourse for teachers designed to get them ready to offer an unprecedented range of VHS netcourses starting next fall. Over 40 teachers and site coordinators are taking this 21-week netcourse being taught by top educators in the fields of technology and learning. Subjects range from "Educational Technologies and Reform" to "Graphics and Tools Resources." Halfway through the TLC, teachers start designing their own netcourse, with the help of the faculty and outside consultants.

Student registration also began in March. Juniors and seniors from the 28 participating schools are browsing course descriptions online, and asking questions. Miramonte High School in California has developed a Web site that maps the location of each VHS participant and describes many of the Virtual Courses, which include everything from developing a model United Nations to hyptertext writing. In September Miramonte will join students nationwide in taking netcourses.

Let the future begin! @

VHS Netcourses Give Teachers TLC

The Olympic Peninsula Reaches Out to the World

by Bruce Droste

Located on the Olympic Peninsula near a magnificent temperate rain forest, Forks, Washington, is the furthest northwest town in the continental United States. While most people think Seattle's 32 inches of annual precipitation is more than enough rain, Forks receives almost four times as much.

Forks is a timber industry town at heart which has been reduced to a shadow of its former self due to past overcutting and current environmental considerations. With a population under three thousand and an economy that has experienced serious decline, this small, remote town doesn't have the educational resources available to more urban areas. The Forks High School serves a relatively small population of students, most of whom plan to spend the rest of their lives in the area.

For John Jones, Forks' Superintendent of Schools, the Virtual High School (VHS) netcourses are a dream come true. He sees VHS as a ticket to the rest of the country and eventually the world for his students. When he heard that for every netcourse offered by Forks High School, he could then enroll about twenty local students, he asked to contribute as many netcourses as possible.

In additional to learning about technology, Jones explained that he saw three benefits to VHS: local students would receive course offerings that his school could not provide; those same students would make meaningful contacts with other cultures as they "converse" with teachers and students in distant places; and his participating teacher(s) would be part of a pioneering effort that would create a ripple effect throughout his small school system.

The ripple effect was poignantly confirmed in my meeting with Marsha West, the first Forks VHS teacher. "If VHS hadn't come along I think I would have taken early retirement," explained West. "I have been longing for a new and interesting intellectual pursuit and this is it!" West is developing two sections of an advanced placement English course entitled "A Web-based Course in Literature and Composition" and "Graeco-Hebraic Foundations for Literature." Her seminar class includes readings and discussion of works in several genres, including epic, tragedy, narrative, drama, and poetry.

West's first step towards offering a netcourse will be to join over thirty other teachers from twelve states for a graduate level professional development workshop on netcourses, taught by the Concord Consortium. Since the professional development course is taught over the Internet, she will probably never meet her fellow teachers in person. She will experience first hand the challenges of distance learning.

The 25-week Teachers Learning Conference (TLC) begins with an introduction to technology and lessons,

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LINKS ON THIS PAGE

Virtual High School—www.concord.org / proj-vhs.html

Teachers Learning Conference—www.concord.org / vhs / tlc /

Virtual Courses—www.cccoe.k12.ca.us / miramnte / play / virtmaps / vcourse.html

Professional Development Netcourse in Math and Science

by Raymond Rose

The International Netcourse Teacher Enhancement Coalition (INTEC) was developed to provide secondary math and science teachers with a graduate-level professional development course that will increase their knowledge of inquiry and project-based instruction. INTEC, funded by the National Science Foundation (NSF), is designed to be an alternative to the summer residential professional development institutes that NSF has funded for many years.

INTEC's approach to professional development is unique. Participants join the project in teams of four or more. Though the 'net is a critical component of INTEC, it is not used exclusively. Books, software, and manipulatives are shipped to participant teams through traditional means. Participants engage in inquiry-based activities, face-to-face meetings with local peers, as well as in Internet-based discussions and off-line activities.

Participation in INTEC (see "Personal Inquiries in Mathematics") is not a casual commitment. The INTEC course is the equivalent of a four-credit graduate level course. (Graduate credit is available through Fitchburg State College in Massachusetts for $200.) The 125-hour commitment is spread across the equivalent of three academic semesters. A primary requirement for team participation is an organizational commitment to systemic improvement of math and science programs. In addition, each participant must have graphical Internet access, a personal e-mail account, and access to a VCR and a computer with a CD-ROM.

INTEC will start new sections of its course this summer and again in October. Any school site that meets the basic requirements is welcome to participate. There is no cost to the participants for taking part in INTEC. If you are interested in more information, contact Raymond Rose (ray@concord.org), INTEC Project Director. @

Major Topics

Zero	Building Basics: Getting Started . . .	3 activities	15 hours
	Feel comfortable with simple Web terminology and confident composing and posting messages that include graphical elements to threaded discussion groups.		
One	Personal Experience of Inquiry	6 activities	30 hours
	Personally experiencing inquiry in math and science.		
Two	Pedagogy in Support of Inquiry	4 activities	20 hours
	Understand educational issues relating to inquiry, alternative explanations, effective pedagogy, and math and science standards.		
Three	Tools in Support of Inquiry	4 activities	20 hours
	Learn experimental, mathematical, and computer skills related to data acquisition and analysis.		
Four	Content Support for Inquiry	6 activities	30 hours
	Become familiar with a recent technology rich project in mathematics or science for which there is extensive curriculum support for student investigations. Support participants to challenge themselves to learn in new ways.		
Five	Practicum	8 activities	40 hours
	In the classroom, pilot extended inquiry using technology. Contribute pages to the INTEC demonstration site on the results of student inquiry.		

LINKS ON THIS PAGE

International Netcourse Teacher Enhancement Coalition—www.concord.org / intec / intec.html

National Science Foundation—www.nsf.gov

Fitchburg State College—www.fsc.edu

Personal Inquiries in Mathematics

by George Collison

The basic unit of an INTEC course is the activity. Each activity takes five hours, over one or two weeks. The first part of an activity consists of approximately one hour of reading or hands-on work with a simulation or instructional material. A second hour is devoted to reflection and composition and posting on the Web. A third hour is occupied by a site based face-to-face meeting at which a local discussion leader, using materials delivered through the Web, leads a discussion. At some face-to-face meetings participants use manipulatives, at others they work with software, or view videos like "Private Universe." The last two hours of the activity are devoted to reflecting on what was learned and interacting with other members of the virtual group who have done the same readings, simulations and face-to-face sessions. The discussion that follows was the first face-to-face session for one such group.

"What does it mean to factor a polynomial?" I asked.

The eight high school teachers seated around the seminar table had ready answers. "Factors are multipliers. When you multiply them, one gets the original back again." "Factoring is the reverse of multiplying."

This was a well trodden path. General chat brought a few examples of factoring methods and procedures to multiply polynomials. The group had received a package of manipulatives, colorful Multi-link Cubes, for use with this activity, and they were not excited by the prospect of algebra with "kid's toys."

The challenge in the first topic of the INTEC course is personal experience of inquiry. Finding inquiry in the pedagogical graveyard of algebraic polynomials was our task. This kick off meeting, held during an inservice day, held much expectation. Inquiry had many meanings for this group. Technology as a tool for inquiry was a prime interest. Tools such as Maple, Theorist, or Mathamatica offered the promise of technological inquiry that was attractive. These symbol rich powerhouses purported to teach algebra and symbol manipulation. But in using symbol manipulation packages, do educators presume an understanding of what they are trying to teach?

Is there a meaning beyond manipulation of symbols to polynomial factoring? With our "kids' toys" in hand we walked together straight into the graveyard of polynomial pedagogy.

"Let's view the process of factoring of polynomials with a new representational tool—algebra as seen through quantity," I suggested. "These methods treat algebra as a language of symbols."

In recent research an understanding of quantity has been shown to be key in conceptualizing algebraic relationships (*Early Algebra, James Kaput, ed.*). These authors hold that multiple representation of a process such as factoring can be a bridge to building conceptual understanding. The language of "quantity" and "multiple representation" carried little meaning for my audience. Something concrete was needed.

"Consider the polynomial X^3-1. Who can factor it?" I said.

Not much challenge there. An algebra teacher confidently took some chalk and wrote $X^3-1=(X-1)(X^2 + X + 1)$.

"How do you know that these expressions are the factors?"

She responded, "You just multiply them. I teach them that multiplying polynomials is like a dance. Each term must partner up with every other. We call this the distributive law also." Her voice was assured, her method well practiced. "Each term matches every other." She continued the "dance" of the matching terms. Negatives and positives canceled to reveal X^3-1.

The dance metaphor was popular. I had encountered it on many other occasions within the same context. The dance was a bridge to procedural competence, not conceptual understanding. The teachers realized this.

I asked, "Do your students believe this, or do they just do it?"

Everyone nodded knowingly, and offered a resigned assent: the students know the procedure but not why it is true.

"What other ways can you show that these terms are the factors of X^3-1?"

Someone responded that she sometimes used manipulatives like Algeblocks but they did not seem to help here.

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Technology Makes INTEC Run Faster

HyperNews and Domino Are Setting the Pace

by Raymond Rose

A netcourse is only as good as the technology that supports it. Most of the short history of netcourses has depended on text-based documents used with electronic mail and primitive conferencing software. Research on projects using those technologies has shown that netcourses are feasible. More recently, the World Wide Web has begun to make hypermedia available. Imagine how much better netcourses will be when the medium becomes even more expressive, robust, and flexible.

The netcourse design we use in all our work, including INTEC and VHS, involves creating virtual spaces where participants construct a shared understanding through thoughtful discussions. It would be an impossible burden for participants spread coast-to-coast and globally to talk online at the same time (synchronously). And it would be a logistical nightmare for us. So netcourses presuppose asynchronous communications—discussions that do not require the sender and receiver to be present at the same time.

Our first application of netcourses was in our INTEC project. Initially the materials were prepared and presented as HTML files. (HTML or HyperText Markup Language is the language of the World Wide Web.) We also needed a way to present a Web-based threaded discussion (a flexible, organized question and comment format.) An e-mail-based listserv, while easy, provides no organization of messages—each message, whether a new topic or a response to someone's new topic, arrives in every member's mailbox. The lack of organization inherent in a listserv creates an added burden for users trying to follow conversation threads. Our search for a program which would be easy for users as well as easy to administer lead us to HyperNews.

INTEC had another major need: the ability for participants to include images in their Web-based communications. The Web, after all, is a visual medium. INTEC's curriculum includes discussions of concepts and ideas most easily conveyed as pictures or program files. (A few examples include spreadsheets, concept maps, and landmass photos from satellites.) Because we are committed to using the Web as our medium for offering INTEC, we are also restricted to what's available for current Web technology and Web standards. Because Web-browsers (e.g., Netscape and Internet Explorer) cannot include a file when communicating to the HyperNews discussion, INTEC's systems administrator built a program that participants could use to upload graphics. The process required a number of steps, but it provided our participants with the ability to share graphics with others.

When all the course material and the various programs associated with the specific services needed for offering INTEC were presented on a single LINUX server (a shareware version of the UNIX operating system), INTEC was up and running.

Though INTEC is built on an asynchronous model, there is a schedule. It is not self-paced. INTEC is based on a seminar model in which participant discussion leads to shared learning. INTEC first presented a calendar using HTML tables. It quickly became apparent that editing was an administrative headache. We found a scheduling program that presented a calendar display of information to a Web browser. The program ran on a Macintosh, so we added a Mac to our server pool.

HyperNews, however, proved to be brittle, quirky, and inflexible. It was almost impossible to change a message after it was posted. The technologies available had also changed by then. Lotus had introduced the Domino™ server. Domino now gives us the ability to transmit a Lotus Notes database dynamically to a Web browser and it includes a threaded discussion database template. In five minutes we can create a new threaded discussion area on the Web. Customization of the database is also possible. With a database as the underlying structure, the format can be modified while it's being used—without data loss.

The Future

Netcourses need software support for the same administrative functions that any course needs course planning, assignments, enrollment, and student records. Because of our asynchronous design and the teacher not being present in the classroom, it is particularly important to be explicit about assignments, due dates, and evaluation criteria. In addition, each netcourse needs a special library in which copyrighted material can be made available on a limited basis to the class.

It has to be easy for non-technical teachers to set up a VHS netcourse. In addition, we anticipate a very large number of courses and a large total student enrollment. If our software is not reliable and simple to use, our technical staff will

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LINKS ON THIS PAGE

INTEC—www.concord.org / intec / intec.html

HyperNews—union.ncsa.uiuc.edu / HyperNews / get / hypernews.html

VHS—www.concord.org / vhs / summary.html

Domino—domino.lotus.com

Power & Portability

The Educational Impact of eProbe™

by Kathryn Costello

To provide equitable and far greater access to information technologies, educators don't need more powerful computers, they need more economical ones that have useful tools. In a few years, kids will have inexpensive, portable, networked computers that could transform education. These computers will belong to students who will finally have sufficient access to master complex applications so they can apply the power of information technologies to their learning.

One of the most profound changes this will create is that students will no longer have to go to a specific place to learn. Students will be able to learn wherever they are; their learning can be in any context that stimulates their interest. The Concord Consortium's Science Learning in Context (SLiC) project is an attempt to peer into this future and study today the educational implications of developments that are only a few years away.

The project, funded by the National Science Foundation, is now in its second year. In collaboration with the University of Michigan and the Global Rivers Environmental Education Network (GREEN), three test sites are helping explore various applications of this technology: an elementary school in Hudson, Massachusetts, a middle school in Ann Arbor, Michigan, and a high school in Deming, Washington.

Inquiry-based Investigations

We began the project using Apple Newtons™ equipped with probes. They enabled students at our test sites to leave the classroom to conduct water quality investigations. Our Michigan school has been studying the quality of their local stream using temperature, light, pH, conductivity, and dissolved oxygen probes. In Washington, using similar probeware, one group of students, along with middle and high school students, has been studying and documenting which factors indicate a healthy salmon habitat. Another group of students in Washington has been monitoring the local Cain Lake. In addition to the probes mentioned above they have been using colorimeter probeware to study turbidity, phosphates, and nitrate levels. These students provide their data to the Washington State Department of Ecology, which is interested in the effects of increased population around the region's lakes.

Scientific phenomena are around us all the time, but it often takes guidance, observation, instrumentation and measurement, combined with informed visualization, to bring the phenomena to our attention. When equipped with portable, networked personal computers capable of immediate data representation, students are free to conduct richer inquiry-based investigations. Using this approach we expect the learning to be more immediate, enabling students to develop good investigative skills.

Research

Our primary research goal is to look for improvements in student learning and investigation skills that can be attributed to our technology. Under the direction of professors Joseph Krajcik and Mary Starr at the University of Michigan School of Education, researchers at two test sites are documenting student learning. What is immediately evident is that the technology takes kids out of the classroom to collect real world data for scientific investigations and allows them to immediately analyze their results. The students are excited about the process and highly focused on their work.

Future Directions

The technology is becoming increasingly more powerful and affordable. The new Apple eMate™ is the first U.S. computer designed for students. While it may not be the leading desktop computer model, or the most powerful, it is ideal for our current research. Like the Newton, the eMate has a touch screen, handwriting recognition, is portable and runs a Newton operating system. Yet eMate borrows features of a laptop such as a keyboard and larger screen.

To support our needs, the SLiC project has developed probeware for the eMate, now sold by Knowledge Revolution, as a line of hardware, software and curricular activities called eProbe™. The software, which builds upon Newton software developed by SLiC, calibrates and records readings from probes and displays the data in multiple symbolic representations. The eProbe software and interface accepts all Vernier probes. An eProbe starter package, marketed by Apple as an optional accessory, consists of

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LINKS ON THIS PAGE

SLiC—www.concord.org / proj-slic.html
GREEN—www.econet.apc.org / green
eProbe—www.concord.org / eprobe
Apple eMate—www.newton.apple.com / newton / ProductInfo / emate / eMate300.html
Vernier—www.vernier.com

Here Comes the Sun

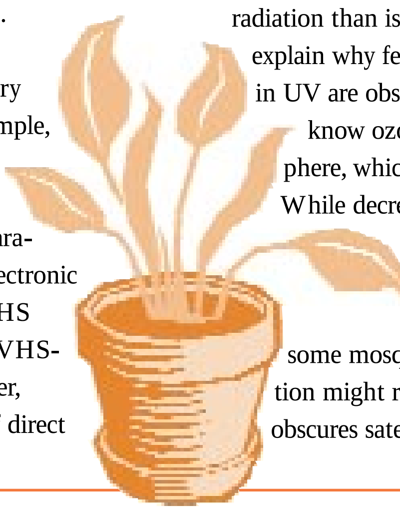
You Can Help Scientists Measure Haze in the Atmosphere

by Carolyn Staudt

I recently flew across the country to work with one of the Concord Consortium's research sites. Mt. Baker High School is nestled in the pristine mountains just outside of Bellingham, Washington, where the skies are blue and the clouds circle snow-capped mountains that appear within walking distance. When you breathe the air, your lungs beg for more. Furthest from my mind were the sulfur and nitrogen oxide gases, carbon monoxide, hydrocarbons, and airborne particles that often reduced my former home state of Ohio to only seventy clear sunny days a year.

Haze is a result of the natural suspension of water vapor, windblown dust, pollen, and volcanic ash in the air. However, much of particulate matter floating in our air—and throughout the world—is a hallmark of the industrial age. These airborne particles interfere with our vision and the level of visibility by scattering, obscuring, refracting, or reflecting sunlight and moonlight. Look toward the horizon. Are you fortunate to live in a location that is free of haze?

Thanks to Forrest M. Mims, III, students and teachers across the country are able to construct a simple, inexpensive instrument to measure haze. The Global Lab VHS-1 apparatus he developed is an electronic kit assembled inside a VHS video cassette box. The VHS-1, called a sun photometer, measures the intensity of direct sunlight. Since haze interferes with the transmission of direct sunlight, this instrument can also measure the amount of haze. Particles in the air scatter more at the blue part of the spectrum, so if the light being measured has gone through a lot of hazy air, the registered signal is noticeably reduced. Forrest has been using photometers like this for years and is confident that, if used carefully, they can be accurate to within a few percent.



On my way to Mt. Baker High School, I made a short detour to Las Vegas, Nevada, where I visited Bill Aldridge, the architect of National Science Teachers Association (NSTA) Scope, Sequence and Coordination project. He couldn't wait to show me his sun photometer. As he opened the box he exclaimed, "I built this. This is mine!" His enthusiasm reflects that of many teachers and students who have built this simple device from instructions now available on the Web.

Much more data about haze are needed. Daily observations at many places would help enormously. These data might find and track thin haze "clouds" which might be filtering out more ultraviolet radiation than is realized. This might explain why few ground-level increases in UV are observed, even though we know ozone in the upper atmosphere, which blocks UV, is thinning. While decreased UV sounds good, UV also kills infectious agents like bacteria and viruses and even repels some mosquito larvae, so its reduction might result in illness. Haze also obscures satellite photographs. These photographs can be greatly enhanced if the amount and distribution of haze in the pictures was accurately known.

Haze-SPAN (Sun Photometer Atmospheric Network) is an informal collaboration that has sprung up for students and amateurs to collect haze data as a part of their learning. Anyone can join, so feel free to do it yourself, with your family and friends, or with your students and colleagues. The Concord Consortium maintains the Haze-SPAN Web site where new data can be contributed and the database can be viewed. In addition, there are links to background information, discussion groups, and related curricula. Mims and other scientists will be available to converse with students about the haze data and related issues through this Web site. The effort to enlist amateurs in measuring haze got a huge lift when the sun photometer was featured in the May 1997 *Scientific American* "Amateur Scientist" column edited by Shawn Carlson.

The following describes some of the ways Haze-SPAN is being used in education. We hope readers will add to this list.

Global Lab

Forrest designed the sun photometer for the TERC Global Lab curriculum

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Are you fortunate enough to live in a location that is free of haze? Collect haze data and compare.

LINKS ON THIS PAGE

Haze-SPAN—www.concord.org/haze

National Science Teachers Association—www.nsta.org

TERC—www.terc.edu

MayaQuest Expedition

The Science Learning in Context (SLiC) project developed five activities designed for exploration in the rain forest. These activities are being used by scientists on the MayaQuest Expedition, which is gathering data from the rain forests of Mexico, Belize, and Guatemala. Although the experiments were designed for the rain forest, they can be used anywhere. Students conducting experiments using similar equipment can share their data and compare results with those of the MayaQuest scientists, and with students from other schools. Some experiments use probes to study how physical variables influence light and temperature variances around a forest, to examine relative humidity changes throughout the day, and to investigate the process of photosynthesis in an aquatic ecosystem. For a complete description of the experiments and for information on how to participate, go to the MayaQuest Web site listed at the bottom of this page.

Teachers Get TLC

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and includes understanding netcourse instructional theory and practices, and course design. While developing their own lessons aimed at inspiring and educating high school students, participants will engage in discussions about the differences between classroom teaching and teaching via the Internet.

Teachers will also learn to use Domino™ and Learning Space™. Domino was developed by Lotus Development Corporation as a means to "serve" their Notes™ product on the World Wide Web. Learning Space™, another product contributed to the VHS project by Lotus, is a set of templates that streamline technical authoring so that teachers can focus more on the content of their lessons.

The TLC culminates in the teachers offering a first round of VHS courses in the fall of 1997, when over 600 students from around the country will join the teachers and their fellow students in their virtual classrooms and move ahead in a collaborative educational adventure.

INTEC Runs Faster

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be overwhelmed by putting out fires and answering technical questions. Our experience with the brittleness of HTML pages indicated that they were not practical. We examined some interesting systems used at several different universities but found them to be insufficiently robust for large scale use.

Our final choice for these administrative functions was Learning Space™, a set of applications in Notes that can be served as Web pages using Domino. Learning Space has five interrelated databases that provide many of the functions we need. Lotus Development has worked with us to modify Learning Space for our needs.

We are looking at ways to make netcourse discussion groups even more expressive. One experimental approach is to invert the current threaded virtual discussion group, which permits graphics to be attached to text. GrafittiTree puts the graphics up front and allows users to append text: a threaded graphical annotation system. As a user, you can see a thumbnail sequence of graphics showing how the original has been modified by each commentator. At any point a participant can jump into this graphical "discussion" and make his or her own modification, which starts a new thread. A nice set of graphics tools, including shapes, color palette, and brushes, are provided. The stamp tool can take a rectangular section of any graphic on the Internet and stamp it over the graphical workspace.

The editing tools use Java applets which are not yet quite stable under the Macintosh OS. You can view GrafittiTree with any browser, but to edit a graphic, we recommend using a Java-enabled browser on a non-Mac computer. Because of this limitation, we are waiting until these system bugs are fixed before we incorporate GrafittiTree into our netcourses.

This graphics capacity is now used for art critiques, collaborative creation of graphics, and generating maps of environmental study sites with overlays showing various features and collection sites. If you have the current release of any of the major Web browsers you can visit the GrafittiTree Web site to view and modify one of their public discussions.

LINKS ON THIS PAGE

MayaQuest—www.mecc.com / maya97 / news / news.html
SLiC—www.concord.org / proj-slic.html
Domino—domino.lotus.com
Learning Space—institute.lotus.com
GrafittiTree—ac.rosebud.com

Personal Inquiry

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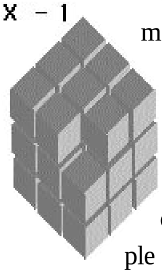
I asked the group to explore the meaning of the expression $X^3-1=(X-1)(X^2 + X + 1)$ using the Multi-link cubes. We explored the expression for X=3. Can you build a representation of X^3-1 when X=3? We stared at the blocks. There was a clatter of plastic, and pairs began their constructions. X^3-1 could be viewed as a cube with one block removed.

$X^3 - 1$



"What does a 'factor' mean?" I asked.

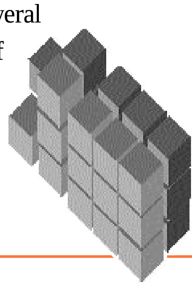
There were many responses. "Factors are parts of numbers." "They are related to addition, or rather addition a multiple number of times." In this case one of the factors is $X^2 + X + 1$.

"In what sense is $X^2 + X + 1$ part of X^3-1?" I asked.

"You should be able to take $X^2 + X + 1$ out of X^3-1," one teacher responded.

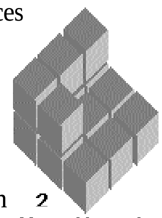
"Let's do it."

Crafted cubes were ripped apart. The X^2 term was a square of nine blocks, the X term was a bar of 3. "What have you got and what is left?" Several different organizations of the pieces emerged. Two people recombined their blocks to produce a paired structure. "How is this structure related to X^3-1?" I asked.



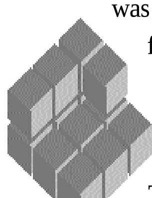
Two teachers struggled with their cubes to produce a segment of the original that had some of the cubic shape. The remains of the cube minus one unit were slowly reassembled into something similar to the first piece.

"How are these two pieces related to each other, and to X^3-1?"



$X^2 + X + 1$

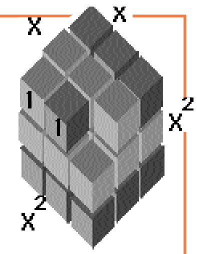
Someone's face gleamed when the two pieces fit like parts of a Soma cube. When flipped, the second piece fit right on top of the first one. Factoring was now a puzzle solved in a different way. The -1 was a hole in the middle. Other representations showed the hole in the side or on the edge. Three teachers grouped their pieces horizontally. Two others produced another format to visualize X^3-1. This view was layered. There were two X^2 pieces on the bottom. The two X terms were on the top along with the two units.



$X^2 + X + 1$

"What would you like to view next?" I asked. Pairs formed again to explore different values of X. More models were built and ripped apart into their factors.

"Where did the hole show up?" was a common question. A layer cake model generalized well for X=6. Different grouping strategies invented by several pairs were shared. A new way to see what indeed the factors of X^3-1 emerged.



"What was the central insight that aided you in seeing a new way?"

"Seeing the (X-1) in $(X-1)(X^2 + X + 1)$ as one quantity multiplying another. It is more than just a symbol."

After fiddling with the cube puzzles someone else entered the discussion. "X^3-1 is $(X-1)(X^2 + X + 1)$ because it simply couldn't be anything else." He demonstrated by taking apart pieces of the X=3 and X=4 representations. "If you used $(X^2 + X + 2)$ or $(X^2 + X - 1)$ the amounts would not be correct."

We ended the inquiry with more conjectures: What do prime polynomials look like quantitatively? Do prime polynomials evaluate to prime numbers? What do other factorable polynomials look like when viewed as quantitative representations? Are there general patterns? We've demonstrated this factoring for a few integers, but can we show it's true for all integers without using the notation of synthetic multiplication?

We agreed to continue our discussions online using the INTEC discussion server. The polynomial graveyard was not so dead after all, when viewed in light of the quantities it contained. @

Power and Portability

continued from page 8

three probes (temperature, light and voltage) an interface box, and 25 activities, which use the three probes to conduct scientific investigations of every day occurrences around the home, in the car, by a stream, or in the classroom.

It may, however, be hard to interest educators in smaller computers like the eMate. They fail the features race: they are not bigger, faster or more expansive than their predecessors. Yet, computers like the eMate may be far more valuable educationally than the increasingly powerful computers designed for business. We hope our initial research with this new class of computers stimulates the interest of educators and provides guidance for informed decisions both by designers of the next computers and educators who will use them.

We are moving beyond the scope of our test sites to disseminate our initial findings and technology. This summer, the SLiC project is offering several teacher professional development workshops. The workshops, which run from three to five days, shows teachers how to create effective inquiry-based learning using eMate and eProbe. In collaboration with GREEN, group workshops will be offered to instruct teachers on the technology with a specific focus on water quality investigations.

If you are interested in hosting or attending a workshop, please contact us (slic@concord.org). @

Netcourses Reform Education Using the Power of the Internet

by Robert Tinker

Netcourse (nĕt´kōrs) n. A body of study offered via worldwide digital electronic communications; derived from network, referring to a system of associated computers for sharing information.

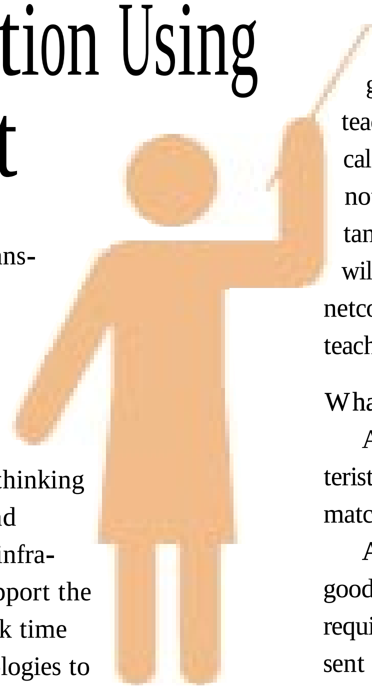
When a set of ideas becomes sufficiently mature, important, and distinctive to deserve its own moniker, new terminology is necessary. This premier issue of @CONCORD is devoted to encapsulating the "netcourse" concept, its definition and significance.

Netcourses are not new. Over a decade ago, as soon as the first dial-up connections began supporting electronic mail and conferencing, a few college-level educators started incorporating netcourses into their teaching. Since then, there has been a slow growth of networked courses of various kinds. Only within the last year, however, have technologies emerged that can support scalable, high-quality courses. Only recently, too, has research and experimentation with netcourses matured to the point that we can formulate a set of netcourse design principles that result in effective learning in a format that is scalable.

> The network is very good for communications that do not require the sender and receiver to be present at the same time.

What it is NOT

When new technologies become available, it takes time to realize their potential. Hence, the first use of steam in boats was only to steam wooden boats out of the doldrums. The first use of engines for personal transportation was horseless carriages. The full utilization of a new technology requires re-thinking the problem and developing an infrastructure to support the solution. It took time for new technologies to result in large, all-metal steamboats and modern automobiles. Large steamboats had to wait for the development of deep-water ports and efficient transshipping facilities; automobiles needed paved roads and neighborhood service stations.



The first idea that pops up for the educational use of networks is a simple transfer of traditional courses into the net environment. Future commentators will judge these courses to be as misguided as steam sailboats. One often hears about the need for full-motion video in the same breath with educational applications of the Internet. Presumably, this is because the underlying educational model is to use full-motion video to reproduce classroom interaction. This is not feasible on a large scale and it is not pedagogically sound. Our goal is not to reproduce the lecture hall on the 'net, but to do something far better.

Another misguided idea too often voiced is using the network to replace teachers. There is no "teacher-proof" technology that can replace the thoughtful attention and educational guidance provided by an experienced teacher. The network removes geographical constraints on interaction but it does not change the teacher's central importance in learning. Student-teacher ratios will probably not change as we move to netcourses. But there may be many more teachers as well as students.

What it IS

A number of netcourse design characteristics have emerged that are a good match of technology and quality education:

Asynchronous. The network is very good for communications that do not require the sender and receiver to be present at the same time. So called asynchronous technologies include electronic mail, conferencing, and news groups. Synchronous technologies, such as two-way voice and video, real-time chats, and shared applications, require two or more users to be present at the same time. Asynchronous communication is more convenient, more adaptable to a person's schedule, works far better internationally, can result in more thoughtful interactions, and usually requires less and lower bandwidth technology. Some synchronous technology is useful in netcourses, particularly for group-building, decision-making, and formal presentations. The best design probably relies primarily on asynchronous communication but occasionally moves into synchronous forms for special events.

Seminar model. Many teachers who experiment with online courses report being overwhelmed with enrollments as small as ten or twelve because they set up e-mail conversations with each student. "It's like having unlimited office hours," one professor reported. This model, which places the teacher in the center of numerous private conversations, is not feasible, nor is it necessarily good teaching. (See Fig. 1.) The better model is more like a seminar, where the teacher determines the topic and activities, encourages substantive interactions among students, monitors and shapes the conversation, but refrains from extensive direct interactions. (See Fig. 2.) This model is scalable, results in more conversations, is far more likely to be constructivist, and is able to take advantage of the rich learning that takes place in groups.

Technology-rich. Few current courses can presume that all students have easy access to computers and the network. But access is a requirement for netcourses, making available a large number of other options that have the potential to transform the learning experience. All the rich resources of the Internet—data, images, references, current events, expertise—can be utilized. Students can collect data and publish their results. Teachers can create gaming simulations. Netcourses assume all students have comparable computer software, so shared graphics, music-generating software, or hypertext authoring software can be used.

Netcourses have some obvious disadvantages that also need to be addressed:

Lack of face-to-face communication. Personal communication is far richer than electronic communication. Responses are immediate, non-verbal cues enhance communication, and group dynamics become an important part of the message. Learning often requires taking risks, and personal communication can be used to reduce the risk and avoid misunderstanding.

Hands-on activities. Labs and real-life investigations are an important part of learning, but they are harder to arrange for a single learner at the end of a wire. Equipment costs, safety concerns, and the need for adult supervision all mitigate against attempting to provide hands-on experiences in netcourses.

To date, the most successful netcourses have found ways of avoiding or ameliorating these shortcomings. In the INTEC professional development netcourse (see "Professional Development Course in Math and Science") at least four teachers within a school work as a unit within larger virtual groups. In the Virtual High School (see "The Future Is Now"), we encourage several students from a school to take a netcourse together. Our Hands On Physics project specifically addresses the laboratory question by integrating into the netcourse safe, low-cost kits with detailed instructions.

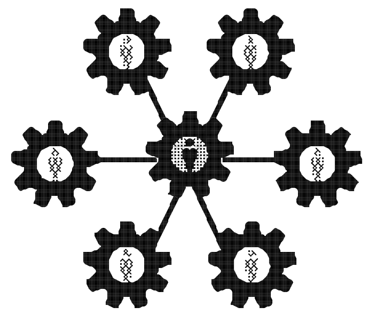


Fig. 1

When the teacher is the focal point of all communication, teaching is cumbersome and less productive.

Potential Reach

Netcourses have a number of built-in advantages compared to traditional courses: the asynchronous communication can be richer and more inclusive than classroom discussions, the seminar model provides for richer cross-cultural and international collaborations, and the full use of information technologies yields many advantages. But the largest advantage is that they can be offered anytime and anyplace. This freedom from time and place makes netcourses uniquely able to reach new audiences, utilize new teachers, and tailor instruction to specialized groups.

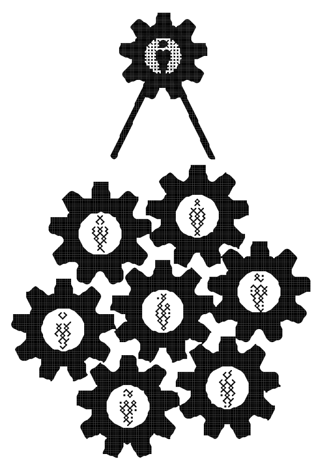


Fig. 2

Using the seminar model, the teacher facilitates learning and communication among students.

Netcourses can utilize interesting combinations of experts as faculty. The faculty of a netcourse can easily be a worldwide team of experts in teaching, technology, group dynamics, and various sub-specialties. The best people can be "assembled" for the task. Retirees, industry specialists, experts in developing countries, field biologists, recent students, jungle explorers (see "MayaQuest"), and astronauts, all can be part of teaching teams. This means that netcourses make it feasible for far more people to share their time and knowledge with many more interested learners.

Netcourses free learners from the constraints of place and time. A busy professional can squeeze a refresher course into a hectic schedule. A worker can find time to complete netcourse work during off hours, or even on the job during down time. Migrant laborers can finally have continuity in their learning, for themselves and their children. Students in small rural schools and run-down urban schools can choose from the same rich curriculum as anyone else. Finally, life-long learning and adult education can be made universally available.

Because netcourses can reach anyone, they can be tailored to reach very specialized groups of learners. Although very few high schools offer the physics of relativity, a netcourse on this subject has been offered and filled. One can imagine a netcourse fulfilling the academic component of a specialized school-to-work program or providing courses for native Haitian Creole speakers. Potentially, netcourses can be inexpensively delivered to a small group of learners who have unusual learning interests or time constraints.

Of course, just because netcourses can have these advantages, does not mean that they will. Doubtless, there will be many

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Here Comes the Sun

continued from page 9

which includes haze studies. Global Lab provides the curriculum base for extended student investigations, one of which is haze research.

Scope, Sequence, and Coordination

Last summer Mims tested an easily-built version of the sun photometer in NSF/NSTA teacher workshops with 84 teachers, and with students from ten nations at the University of Nations. Clearly defined protocols for calibration, data gathering, and calculations developed by TERC and NSTA enabled students to take on the role of the scientist.

Blue Skies

Forrest and I are developing a three-part atmospheric science unit for the Kids as Global Scientists project at the University of Michigan with Nancy Songer and Perry Sampson. One goal of this project is to develop large scale Web-based curricula that use data collection. Under development are activities that allow students to take measurements of the atmosphere with simple equipment, such as colored filters and, of course, the sun photometer. The plan is to make a souped-up model of the sun photometer that will measure haze as well as ultraviolet light.

Net Adventure

Starting this summer, we are offering informal learning opportunities over the net (see “Join Net Adventure”). One of the Net Adventure activities will be to build and use a sun photometer.

Hands On Physics

We are creating a new, online, project-based approach to physics called Hands On Physics. One of the eight units uses haze measurements as a way of introducing the basic physics of light and the technologies of light detection.

Haze-SPAN is part of a growing effort to use technology to engage students in authentic science as a means for learning about important science content as well as the process of science. The Haze-SPAN Web site contains pointers to the growing literature on this topic and lists examples of where these “student scientist partnerships” can be found.

By arming students with a powerful scientific tool and linking them throughout the world, we hope that learners everywhere can become empowered to better understand the impact forces impacting their environment. @

Netcourses Reform Education

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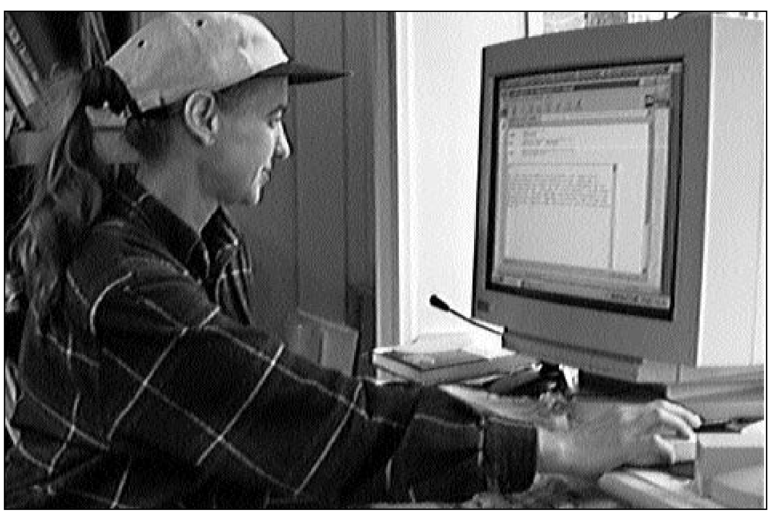
examples of unqualified netcourse teachers, poor pedagogy, and bad content. There is a need for independent reviews, accreditation, and consumer education. But, as with any other marketplace, with the right infrastructure in place, the efficiencies of competition can be realized.

Implications

The ability of netcourses to use new kinds of teachers to reach new, widely scattered and specialized audiences means that netcourses can have a huge impact on education. The monopolistic characteristics of many schools, and their legendary resistance to change, may have to give way to netcourses. Schools will have to offer better courses, or they will lose their clientele to the wide assortment of netcourse alternatives.

In effect, the semi-monopoly of place that much of education currently enjoys will crumble in favor of a rich marketplace of ideas and netcourses. Netcourses might contribute far more than vouchers and charter schools towards realizing the advantages of competition in education. As the challenges of lifelong learning, increased specialization, and the need for a better educated population become acute, netcourses offer endless new opportunities. @



Carolyn Staudt checks out the HazeSPAN Web site, where anyone can download instructions for building a sun photometer for measuring atmospheric haze.

LINKS ON THIS PAGE

Kids As Global Scientists—www-kgs.colorado.edu

Hands On Physics—www.concord.org / proj-hop.html

Perspective

Ensuring Quality Netcourses

by Robert Tinker

“If anyone can offer a netcourse, then the market will be flooded by netjunk.”

Netcourses and virtual schools will soon spark an educational revolution that will have a far-reaching impact. Netcourses will free education from the monopoly of place, creating a free market of courses and educational services. There will soon be thousands, perhaps hundreds of thousands of netcourses of every size and rigor, addressing every conceivable topic. As a result, education as a whole and the nature of public education will never again be the same.

The transformation of socialized education into a free market could be accompanied by great confusion and many abuses. The most troubling problems will be fraud and inferior quality. If anyone can offer a netcourse, then the market will be flooded by netjunk: netcourses that either do not exist or are of inferior quality, or use teachers who are inexperienced or poorly educated. It will be very tempting for the unscrupulous to create a Potemken Academy, an educational facade that looks and sounds impressive but lacks substance.

It is a problem that will have to be addressed the way the free market protects consumers, through a combination of evaluation, accreditation, and consumer awareness. Fortunately, the ‘net is an information rich medium, so it can be easy for a consumer to find out about a course and its teachers. Teacher credentials, records of past courses, expert critiques, and evaluations by prior students can be available for prospective students.

The best solution to the problem of quality is for the education profession to formulate and propagate a set of voluntary netcourse quality reporting standards. This solution shifts most of the responsibility for evaluation to the netcourse provider in much the same way that financial auditing standards shift the burden of accounting to companies. The profession still needs to spot check adherence to the standards, but it would not have to undertake a huge evaluation effort.

What would netcourse standards look like? We propose that if a netcourse provider adheres to the following standards, it could display a seal of quality.

Institutional information

What institution is offering the netcourse? What is the institution’s record for offering successful netcourses? Does it have a tuition refund policy? Who is responsible for netcourse quality and what is that person’s qualifications?

Teacher resumes

Each netcourse teacher must post a teaching resume listing degrees, certifications, and recommendations from colleagues and former students.

Netcourse syllabus

A detailed description of the course, including prerequisites, target audience, specific learning goals, activities, student evaluation criteria, and teacher responsibilities, must be posted.

Student evaluation

The institution promises to administer and post the results of a standard student evaluation form, including a survey of dropouts.

Netcourse audit

Each netcourse has a designated auditor from another institution. The auditor must certify that the netcourse content is accurate and reasonable, that good teaching strategies are employed, and that the self-reports are accurate. The credentials of the auditor must be posted.

This information would help protect the public, particularly if institutions offering netcourses were actively encouraged to follow these standards. Their widespread utilization would greatly facilitate the compilation of reliable and standardized information about netcourses.

We urge the profession to proactively adopt standards such as these. Let’s avoid creating inferior offerings that degrade the netcourse idea. We need to quickly develop high-quality offerings so we can expand educational opportunities for all. @

info@concord.org

Join Us Online

Moderators, Interns, Sabbaticals

We are always seeking moderators of online conversations, faculty looking for an interesting sabbatical opportunities, and interns. There is always more work to be done, more interventions to study, more groups to guide, and more technology to develop. For the right person, we provide great opportunities to learn and contribute.

intern@concord.org

Collaborators Needed

We are launching two projects that need collaborators. The Concord Consortium is starting a long-term study of the educational impact of ubiquitous technology. We are looking for partner schools who can provide one portable, networked computer per student to explore the curriculum change that this level of technology would enable. We provide curriculum support, research, and information sharing. The computers will be either an eMate or NETSchool. While the school needs to supply these computers, we can help identify funding sources.

A second project involves technology-enhanced curricula for sustainable development and futures education. We plan to collect, modify, develop, and test materials in this general area that can be used as supplements to existing courses or as new courses. We are particularly interested in adding technology and a sustainable development perspective to existing ecology materials. The technologies might involve modeling, gaming, data collection, online research and mentoring, and student-scientist partnerships. We also need collaborating schools who are able to implement, test and help develop these materials.

collaborators@concord.org

Net Adventure

The Concord Consortium is offering a series of intriguing science activities on the 'net this summer that should be fun for kids of any age. The goal of Net Adventure is to provide a rich set of engaging activities in math, science, and technology projects. We increasingly hear about kids who are bored with math and science, either because it is too easy for them or simply uninteresting. Net Adventure is the antidote—a plethora of opportunities that are a challenge to indifference.

The project will be an intellectual smorgasbord, far more than any one learner can absorb, offering something for almost anyone. Participants will be challenged with ideas, problems, contests, and opportunities. They can post their solutions and creations, work with other kids and scientists, and explore the world of ideas. Something new will be posted each weekday in July and August.

Kids wherever they are—stuck at home, bored by a cross-country driving trek, or just intellectually starved—will welcome the challenge of these activities. Along the way, there will be many opportunities to learn and appreciate one's own capacity for creation. Participants also gain new concepts and attitudes that will support their learning.

The course fee is $35/week per computer. Families can register just one computer. Individuals or entire projects can sign up. Internet access and a browser are required.

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