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1998

Virtual Architecture: Designing and Directing Curriculum-Based Telecomputing

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From the Publisher

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About the Author

Judi Harris taught at the elementary school level for six years before completing her doctorate in instructional technology at the University of Virginia. She currently is working as an assistant professor of instructional technology in the Department of Curriculum and Instruction at the University of Texas at Austin. Her teaching and research interests include instructional applications of and professional development with Internet-based telecomputing, the nature of online conversations among adults and children, and emerging trends in the design of contexts and roles for computer-mediated teaching and learning.

Harris writes a column entitled "Mining the Internet" for *Learning and Leading With Technology* and coordinates a number of educational telecomputing projects on the Internet. One of these projects is the Electronic Emissary (http://www.tapr.org/emissary/), a service that matches volunteer subject matter experts (SMEs) with teachers and their classes studying topics in the SMEs' fields of expertise so that teaching and learning can occur asynchronously via electronic mail.

Harris offers Internet-related presentations and workshops at state, national, and international educational computing conferences, such as the Texas Computer Educators' Association Annual Conference, the National Educational Computing Conference, and Tel•Ed. She also teaches a "mostly online" Internet-based telecomputing graduate course each year at the University of Texas at Austin.

Acknowledgments

This book would not be in your hands right now if it weren't for the unwavering support and tireless efforts of many talented people. Realizing that, I wish to express my heartfelt thanks to and sincerest admiration for Anita Best, Jean Hall, Ron Renchler, Corinne Tan, and Kate Pryka at the International Society for Technology in Education; the book's reviewers, Teri Metcalf and Lena Rotenberg; plus the hundreds of teachers and students online who have taught me so much by sharing their educational activities so generously with the Internet community.

What follows is written to honor my primary mentors, whose wisdom, nurturing, affection, and living examples have done much to inspire and influence my professional and personal growth during the last 11 years. I dedicate this work to those who helped to inspire and shape it:

- Glen Bull, whose vision is exceeded only by the genuineness of his gracious heart.

- JoAnn Cutler Sweeney, whose administrative skill was exceeded only by the magnitude of her active caring.

- John, whose clarity, compassion, and dedication to truth cannot possibly be exceeded.

<div align="right">

Judi Harris
Austin, Texas

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Introduction

Before we begin (Oops! I guess we just did. <grin>), you have a decision to make. Is this book appropriate to your needs and interests at this point in your learning and teaching? Let me assist you in answering this question by asking you to consider four more questions:

- Would you like to learn more about using Internet tools and resources for educational purposes in elementary, middle-level, and secondary curricula?

- Are you comfortable and competent in your use of electronic mail, World Wide Web browsers (e.g., Netscape or Internet Explorer), and World Wide Web search engines (e.g., Alta Vista, Yahoo!, or Lycos)?

- Are you a classroom teacher or someone who teaches teachers, either formally or informally?

- Are you supportive of the use of active, project-based learning in the elementary, middle-level, and secondary classroom?

If you can answer "yes" to these queries, this book will probably be helpful and interesting to you right now. If, instead, you are new to the Internet, it would probably be a good idea to give yourself some time to explore at least electronic mail and World Wide Web tools and resources before immersing yourself in the ideas expressed and examples appearing in this book. There are many ways to do this. Why not:

- ask a student to teach you?

- ask another teacher to guide you?

- use an online guide, such as Margaret Riel's WebTour "Mind Travels"? (It can be found online at http://www.iearn.org/iearn/webtour/.)

- use one of the introductory-level books the International Society for Technology in Education makes available to educators internationally? (ISTE's publications are indexed, and can be ordered, online at http://www.iste.org/publish/pub.html.)

If you're still reading this introduction, then perhaps you suspect that this book will indeed be helpful to you. If so, great! Before we go on, though, I have a request to make. In the words of Anita Best, ISTE's editor, "This is a book to be read." Although in the succeeding pages there are *many* examples from real classrooms that support the design and implementation ideas shared (all of which can be conveniently accessed online at http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/), this book is not meant to function as a project directory, computer-using teacher's manual, or general reference. The chapters build upon each other conceptually, so, as Anita says, you will probably get the most out of the book if you read it at least once *non*hypertextually, or from start to finish. (Is it old-fashioned to suggest doing this in the Information Age? I hope not!)

As you read it in this manner, stop along the way to explore in more depth several of the projects mentioned that particularly intrigue you. The book may then serve you well as a reference on the design and direction of curriculum-based telecomputing projects. It may also be helpful as a teaching tool for you to use with colleagues interested in learning about what you have discovered with *Virtual Architecture*'s assistance.

In the meantime, I hope your virtual journeys will be enjoyable ones, online and off. If you'd like to share your perceptions and reflections along the way, I can be reached at jbharris@tenet.edu.

Conventions Used in This Book

Quotations from print sources appear as indented nonitalic type. Quotations from e-mail messages and Web sites appear as indented *italic* type. `Courier` font is used for quotations from Gopher messages and other instances where nonproportional type was originally used.

All quotations from Web sites, e-mail messages, and other material published online have been left in their original, unedited form.

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What have you already learned to do with the Internet? Please take a moment to remember and make a list. (Go ahead! I'll wait. <grin>)

Does your inventory look something like this?

- ◆ information searching

- ◆ online publishing (e.g., creating World Wide Web pages)

- ◆ using electronic mail

- ◆ using discussion forums, such as newsgroups

- ◆ realtime chatting

- ◆ audio/video conferencing

- ◆ exploring online simulations, such as MUDs

- ◆ writing acceptable-use policies

In reviewing the list, do you see any patterns? I see at least one that is important to our thinking as educators, and which points to the purpose of this book. Most of our Internet-related learning to date has been about *tools*, specifically, software that can help us locate and create information, either individually or collaboratively. When we've been learning about the Internet, for the most part we've been learning to *operate* Internetworked tools.

Yet, as teachers, we know that tools, no matter how powerful their educational potential, don't directly help our students to learn. What's important is how we *apply* the tools to assist teaching and learning. In other words, there is a big and important difference between using the *tools* (operation) and *using* the tools (application).

This book is about the latter. It acknowledges that being able to *operate* Internetworked tools is an important but merely prerequisite step toward creating powerful telecollaboration and teleresearch in our classrooms. How to

apply the tools in curriculum-based educational activities, although less frequently the target of careful thought and in-depth investigation, is a much richer, more complex, longer term, and more critical area for educators to explore at this point in time.

Why haven't more of our workshops, conference sessions, and Internet-related publications addressed the application of Internet-based tools in elementary through secondary curricula? There's a common, but usually unstated, assumption that presumes that learning to operate hardware and software is most of what is involved in successfully integrating the use of computer-mediated tools into our classrooms. How to create and enact successful educational applications that integrate the use of software and hardware is assumed to be obvious, once the tools themselves are known. This is part of what Seymour Papert (1987) long ago dubbed "technocentric thinking" (p. 22). The tool, in and of itself, no matter how powerful its features, cannot make learning happen. The tool's user/teacher, no matter how technically competent, enters a related but distinct realm for inquiry when he or she plans for the educational application of any new tool. It is into this *educentric* realm that I invite you as we explore the design, development, and direction of curriculum-based educational telecomputing activities.

Lesson Plans? Not!

Did your list of what you have already learned to do with the Internet include any curriculum integration work? By now, I'll bet that some of you *have* participated in professional development activities designed to help you consider how to use Internet tools and resources in your curricula. Since I'm already wagering here, I'll speculate some more. In these curriculum integration sessions, were you told about successful projects that worked well in other classrooms? Shown places to go online that contained large collections of lesson plans and project examples? Encouraged to try these ideas in your own classroom?

"What's wrong with that?" I hear you thinking. "Real-world applications that work in real classrooms with real students are far more helpful than college professors' theories!" (Don't worry; I won't take that thought personally. <grin>) I agree with part of what you may be thinking on this issue. Stories of activities and projects that worked well in other teachers' classrooms are indeed helpful to us, but in a manner perhaps different than the one with which you may be familiar.

Can you remember an instance in which you "borrowed" an idea for an activity or project that had worked well in another classroom? The idea might have been successful with students of similar ages, backgrounds, and interests as your students'. The curricula for both groups of pupils might have been comparable. And yet, think back and remember what happened when you last tried to "plug and play" an idea from another classroom into your own. How well did it work? How well did it *really* work? Not so well, eh? If it was successful, think carefully about what you did while you were planning its implementation. You had to

change it a bit to get it to work well with your students, didn't you? And, if you didn't think to do this—perhaps when you were much less experienced as a teacher or when you were particularly pressed for preparation time—the activity fizzled, now didn't it?

Why is this so? Why does the same educational activity triumph in one classroom and falter in another, even when the students, curriculum, and materials are very similar? As teachers, we know the answer to this question is obvious. Conditions among classrooms are quite variable. Students are different; teachers are different; resources available for teaching and learning are different. Prior experiences and content-related comprehension for both teachers and students are different. Group dynamics are different. Differences can even be caused by the time of day, week, month, or year at which a new activity is introduced. Think about what your students are like at the beginning of the day, just before lunch, just after lunch, and at the end of the day. If you didn't know better, on some days you might suspect that they weren't the same people with whom you had been working since the beginning of the year. Now contrast the students as they behave during the first week of school, the last week before the winter holidays, and a week in late February. Same class? Not really. If we know of these biologically, psychologically, socially, historically, and temporally rooted differences among students' receptivity to educational activities, then *why* do we believe, even for a minute, that we can successfully "plug and play" someone else's wonderful project into our classroom?

The answer, of course, is that most teachers *don't* really believe that learning to apply a new tool educationally is just a matter of "plug and play." Most teachers know to "tweak" an idea to fit the unique nature of the context (learning styles and preferences, teaching styles and preferences, past experience, resource availability, and other factors) in which they work. We expect to learn from mistakes and unexpected reactions when an idea is first implemented. Yet we know from both experience and research (e.g., Rogers, 1995) that tweaking someone else's idea isn't nearly as satisfying, or as effective, as *designing* an activity that fits the unique combination of factors that present themselves in any particular classroom at any particular point in time. Reinvention—the process of taking something like a new tool or idea and making it our own in its application—is very important to both teachers and students. Feelings of ownership are crucial if new tools are to continue to be employed in ways that will benefit users. This is what is known as adoption of the innovation (Rogers, 1995). Think about it: which is more satisfying—watching an original idea that you created succeed, or observing someone else's idea that you borrowed and tweaked get a good reception?

When we are asked to wade through large collections of lesson plans, replicate projects from other classrooms, or follow overly prescriptive directions for educational activities written by folks who can't possibly know our students as we do, we are asked to ignore much of what experience and reflection have taught us. Using Internet tools and resources in our classrooms in ways that will

benefit students and teachers—in ways that are truly worth the time, effort, energy, and expense—call upon us to function more as *instructional designers* than direction-followers. Creating and implementing learning activities as a designer is an artisan's endeavor. In this book, I speak to you as that artisan—analogically, as chef rather than cook, conductor rather than metronome, educator rather than automaton. Specifically, I speak to you as *architect* of your students' learning opportunities.

I can hear what some of you are thinking now: "I don't have time or space in my curriculum to be an artisan!" It's true that as the years pass and our schools and communities change, preparation time for teachers dwindles, while demands for additions to our curricula increase in number and complexity. So, I won't be asking you to create every Internet-infused activity from scratch or add anything more to your already-crowded program here. Instead, I will offer you some "wetware tools"—thinking apparatus that will help you engage in the important design processes that we know are essential to powerful, regular use of new hardware and software tools in our classrooms. These thinking tools are created in such a way that they can assist your design work in a time-efficient, energy-conserving manner.

Is It "Worth It"?

Speaking of efficiency, and as long as we're being frank here, let's put another real-world issue on the table. No matter what the imagined potentials are for *any* new implement or idea, whether or not it truly gets *used* in our classrooms is largely a matter of our professional decisions. Yes, curriculum mandates, teacher evaluation procedures, peer influence, and community pressure can appear to "force" us into change before we are willing to choose it ourselves, but let's speak directly, shall we? We all know that once the administration and/or parents are at least temporarily appeased (and, in most cases, it takes relatively little to appease them), we are still left with a good measure of academic freedom—even if it feels as if we have to exercise it in secret. Once we close the doors to our classrooms, what happens (and what doesn't happen) inside are still largely results of our decisions. As professionals functioning in democratic societies, that is, in my opinion, the most appropriate arrangement.

So if *any* new tools, including Internet-based telecomputing tools, will become everyday implements in the learning and teaching that occur in our classrooms, they will only do so as a result of our conscious choices to make this happen, and only to the extent that we deem suitable for our students and ourselves. Whether or not any new tool is appropriated in a permanent way depends upon this decision-making process, whether it is conscious or unconscious, well informed or ill informed, emotional or logical, capricious or long considered.

Upon what might we justifiably base this decision? In a phrase, whether the application is *worth it*. In other words, is a particular use of an Internet-based tool or resource in a particular situation for a particular group of students and

teachers worth the time, effort, and expense it will take to use the tool or resource in this particular way? Note that this is not a definitive decision about all Internetworked information and applications for all time. Instead, the "Is it worth it?" test is applied *each time* the use of the Internet is considered in an educational situation. That implies that answers to the "Is it worth it?" question will change as people and resources change. The ease and speed of Internet access in your school and classroom will continue to change. What is possible and available on the Internet will continue to change. As you and your students learn more about and do more with Internetworked tools and resources, you will continue to change, too.

How can we best make this decision each of the many times we will be called upon to do so? I suggest that, keeping in mind a specific, feasible educational use of the Internet, and in terms of both content and processes that students need/want to learn, we consider the honest answers to two questions:

1. Will this use of the Internet enable students to do something they *couldn't* do before?

2. Will this use of the Internet enable students to do something they *could* do before, but better?

If the honest answer to both of these questions is "no," there is no reason to use Internet tools or resources in this particular way. Our time, effort, and resources would be better used in other ways. In any particular instance, if students can learn just as well or better with traditional tools and approaches than they can with new ones, it doesn't make sense to use new tools in traditional ways. It isn't "worth it" to do so, for students *or* for teachers.

This implies that usually it will be "worth it" for us to use these new tools only if they can be applied in *new* ways to help new and worthwhile things to happen in our classrooms. "Well, that's obvious," you might be thinking. Perhaps. Yet, whenever we are offered new tools, something interesting happens. Most of what we initially do with the new tools looks very similar to what we did with older tools that were functionally similar to the innovations. When teachers first began to use electronic mail and electronic bulletin boards in elementary, middle-level, and secondary classrooms in the early 1980s, for example, what kinds of projects were most prevalent? *Keypal* projects! This pattern makes sense if we realize that electronic mail was first seen with reference to its similar predecessor, surface mail. Penpal projects, in which students used paper, envelopes, and stamps, were successful educational activities in classrooms long before networked computers were in the world. At first, electronic mail was seen as faster surface mail. Later, as users continued to experiment with and exploit this global communications tool, our visions of how e-mail could be used for educational purposes expanded. Now there are at least seven different ways (of which keypals is only one) that interpersonal exchanges can help students to learn. More about this in Chapter 2.

How can we, as teachers, use telecomputing tools and resources in powerful, curriculum-based ways that are "worth it," making sure that we function as instructional designers without overburdening an already-challenging workload and schedule? We can consciously utilize a set of design tools, along with a wealth of corresponding real-world, classroom-tested project examples, to efficiently and effectively create curriculum-based activities for our unique classrooms. These design tools are not prescriptions, or step-by-step directions, or blackline masters. They are a special type of thinking tool that I call an *activity structure.*

Wetware Tools—Activity Structures

What's an activity structure? Let me begin by telling you what it's *not.* It's not a model, template, plan, mold, or example. It's a flexible framework, much like the wooden frame of a house or the skeletons in our bodies. Its basic shape is clear, strong, and simple, but, as with houses and humans, the same frame can support a myriad of different architectural or bodily expressions. The structure literally holds up the house, creating *spaces* for living. In a similar way, activity structures can support the generation of powerful educational environments, or spaces for learning and teaching, which are constructed, decorated, and used in customized and ever-changing ways, according to the needs and preferences of their inhabitants.

Want an example? OK. Please think of one of your very favorite educational activities to do with students, one in which the students are *actively* involved with their learning. (Now, *really* think of one, OK? I'll wait.)

In a moment, I will ask you to work with that sample activity in a particular way. To show you how I would ask that you examine it, I will give you an example from my own middle-level teaching experience. I taught sixth grade, all academic subjects, in a school just outside of Philadelphia, Pennsylvania. In my language arts class, instead of asking my students to memorize and use predetermined lists of vocabulary words, I helped them form personalized vocabulary lists each week that were drawn from both their individualized and common reading in all subjects. In addition, to help them develop their skills in recognizing and deriving meanings of words unfamiliar to them, we did "vocabulary sniglets." You remember sniglets, don't you? Rich Hall (1984), their creator, says that a sniglet is "any word that doesn't appear in the dictionary, but should" (book cover). Here are a few examples, excerpted by an anonymous "Internet Angel" and shared on the Web by Tina Mancuso, at http://data.club.cc.cmu.edu/~tina/ humor/sniglets.html.

> ACCORDIONATED (ah kor' de on ay tid) adj.
> Being able to drive and refold a road map at the same time.
>
> CARPERPETUATION (kar' pur pet u a shun) n.
> The act, when vacuuming, of running over a string or a piece of lint

at least a dozen times, reaching over and picking it up, examining it, then putting it back down to give the vacuum one more chance.

ELECELLERATION (el a cel er ay' shun) n.
The mistaken notion that the more you press an elevator button the faster it will arrive.

PHONESIA (fo nee' zhuh) n.
The affliction of dialing a phone number and forgetting whom you were calling just as they answer.

Do you see how examining the different parts of a word, and also their linkages, give us an understanding of the meaning of the whole word? I invited my students to construct sniglets out of phonemes in the same way, sharing them with each other and with me, emphasizing the resulting meanings that were created when different word parts were concatenated. We even wrote programs in Logo so that sniglets would be randomly generated by the computer. Our challenge was to deduce the meaning of the new "words" and find good uses for them in sentences and stories.

Now, how might educators typically classify that activity? As a language arts activity? A vocabulary activity? A middle-level activity? Let's study this example differently so that you can understand what an activity's *structure* is. Let's "extract" both the content and the grade level from our description of the activity and see what's left. In this "vocabulary sniglets" example, students individually used units of meaning as building blocks in combinatorial action, then deduced definitions from the playfully formed concatenations according to what they knew about the meanings of the individual units and their placements with reference to each other. (Can you see how this description of the activity depicts only what the students do, without reference to the content area or level of learning occurring?)

What follows is what is most powerful about an activity structure. How might the structure just described be used in a *different* content area and at a *different* instructional level? (Yes, I'd really like you to pause and brainstorm answers to this question. I'll wait.) One way might be in secondary-level chemistry classes, when students are introduced to the periodic table and the way elements combine to form compounds. What if these students could creatively form compounds and then research their stability (or lack thereof) according to the patterns of protons, neutrons, and electrons in each element being combined? Do you think they might enjoy deducing what kinds of compounds (and chemical reactions) are formed (or not formed) when they combine elements of different types in differing amounts?

The same activity structure could be used at an early elementary level in an art activity in which students combine paint in different primary colors to see what secondary colors are formed, and discover if they can predict, before mixing the colors, the hue that will result. In a middle-level music composition class, students could similarly experiment with note combinations to form resonant or

dissonant chords. In a high school geography class, students studying the development of different civilizations could use a simulation program to help them create differing patterns of historical development that have their roots in geographic regions, weather patterns, natural resources, population densities, and other sources. Do you see how the same activity structure can be used for creating powerful, similarly structured learning in many different content areas and at many different levels? How might the structure of the activity that *you* remembered be used successfully in different curriculum areas and at different grade levels?

The activity structure, then, is a teacher's instructional design tool. It is a way for us, in our conversations with ourselves and others, to capture what is most powerful in a particular type of learning activity and communicate that in such a way as to encourage the creation (not replication) of individualized, context-appropriate environments for learning. It's as if the activity structure is the frame of the house, resting firmly upon the conceptual foundation in this architectural approach to building potentially powerful learning spaces. The frame gives shape and strength to the actual learning activity, but it is completely flexible so that the walls, roof, doors, windows, and decor are content-specific, student-centered, individualized according to preference and past experience, and reflective of locally available resources. The same frame can support many houses whose external appearances and intended functions are actually quite different. Which do you think would result in houses that are maximally serviceable and aesthetically appealing: limiting architects to a standard procedure for design with little room for variation, or inviting the exercise of their expertise and creativity? Would you rather live in one of many "little boxes," or in a more expressive creation?

> Little boxes on the hillside,
> Little boxes made of ticky-tacky
> Little boxes, little boxes,
> Little boxes all the same.
>
> There's a green one, and a pink one,
> And a blue one, and a yellow one,
> And they're all made out of ticky-tacky,
> And they all look just the same.
>
> "Little Boxes," song by Malvina Reynolds, circa 1965

I suspect that our students would rather learn in spaces that are as unlike "little boxes" as possible. It is essential, therefore, to all the inhabitants of the space, for us to practice instructional design in the traditions of architecture and crafting rather than replication and assembly.

Telecomputing Activity Structures

Some of you may be wondering why I am emphasizing this notion of flexible frameworks for instructional design so forcefully. When you thought about the previously mentioned sniglets example, did you figuratively shrug your shoulders and fail to be impressed with the notion? Did you think that activity structures need not be consciously processed because we use them quite effectively without realizing that we do so? This may be so, with one important proviso. *Specific activity structures are often limited in scope and application according to the tools and resources available for their implementation.* In other words, existing activity structures are often best applied using existing instructional tools. Remember the "is it worth it" test? If a particular educational use of Internet tools and resources is going to be "worth it" according to the definition I previously suggested, it must enable students to do something they need or want to do that they haven't been able to do before or haven't been able to do as well. Using *new* structures to design curriculum-based educational telecomputing activities can help us increase the chances that these applications will be both "worth it" and custom tailored to the unique combination of characteristics that describe a particular group of students, working with a particular teacher, in a particular classroom, school, and community context.

Have I convinced you of the importance of approaching the curriculum-based application of Internet tools and resources in our classrooms in this particular way? I hope that I have, or, if I haven't, I hope that the activity structures, examples, and implementation tips that follow in this book will help you create and use an even more powerful method for your Internet-related instructional design work. In the chapters that follow, I will introduce the educational telecomputing activity structures I have discovered to date, illustrating each with curriculum-based project examples that were successful in K–12 classrooms and that the teacher-designers were kind enough to share via Web pages, discussion-forum postings, paper-based publications, or public e-mail.

Architectural Similes

In a sense, we will be building and exploring a house as we travel through this book together. What you have just experienced is the all-important *foundation* for the rest of what I will share with you. All the other spaces for exploration in this book are based upon the ideas you have just read.

In Chapter 2, we will explore activity structures for telecollaboration and telepresence (Riel & Harasim, 1994). Because these structures will probably be the tools you will use most often in your activity design work in the future, I will ask you to think of the space in Chapter 2 much as you would the kitchen in a large, comfortable home: a place where there are many tools and ingredients to create nourishing concoctions for loved ones, and a free and informal place where people frequently congregate to share with and support each other.

In Chapter 3, we will consider teleresearch, not as activity structures but as a set of purposes for inquiry, and in connection with and preparation for telecollaboration. I will ask you to think analogously of a well-stocked study in the house, containing a rich variety of resources such as books, magazines, diagrams, images, recordings, videotapes, and interactive software. It provides a

quiet, cozy, well-lit place for you to explore the contents of these treasure troves as you consider how information is transformed into knowledge.

In Chapter 4, we will overview the steps needed to take an activity's design and to put it into action—the "nuts and bolts" of telefacilitation. This will include investigating different means for telepublishing, focusing especially upon the World Wide Web as a place for students and teachers to share the knowledge they have constructed. In terms of our domestic analogy, I will ask you to think of the many important, but almost completely physical, actions taken in the bathroom of our home. These actions are necessary for health, comfort, and polite existence within a social group, but there is good reason that the bathroom is the smallest room in the house. Nevertheless, in here, people spend considerable time doing necessary things.

In Chapter 5, we will place educational telecomputing activities into larger contexts, considering how they often serve interdisciplinary, thematically focused, problem-based purposes, and how they can be used to meet educational standards that are either imposed or suggested by districts, states, and professional organizations. We will ponder the attributes of powerful educational activities and the assessment of their instructional designs. In this chapter, we will situate our now fully constructed and well-appointed house in relationship to the neighborhood surrounding it. In a like manner, we will consider the land upon which the house rests, the landscaping necessary to express both the uniqueness of the house and its inhabitants, and the ways in which it complements the other dwellings and natural spaces surrounding it.

See the Frame

By offering you the ideas, processes, and examples included in this book, I hope to assist your discovery and honing of a set of broadly applicable design tools you will be able and willing to use in current and future educational planning. My intent is not to motivate you to use the Internet in your classroom by making overstated promises or unrealistic generalizations. I don't want to impress you with anything except, perhaps, powerful ideas that apply to far more than educational telecomputing, and of which all I need do is remind you. This book is *not* a potpourri of Internet activity ideas any more than a home is a collection of rooms. I sincerely hope you will go away from this text noticing conceptually based, but authentic and functional, shapes and patterns rather than specific details or flashy attributes. As Aristotle wrote 17 centuries ago in his *Poetics*:

> The most brilliant colors, spread at random and without design,
> will give far less pleasure than the simplest outline of a figure.
> (Tripp, 1970, p. 452)

2

Why is it that in many homes, people seem to congregate most frequently and comfortably in the kitchen? Perhaps because it is here where food is prepared and shared, in both symbolic and actual expressions of nutrition and nurturing. The kitchen is also the one room in the house that offers the largest and most varied selection of frequently used utensils. It is appropriate, then, since we have laid the solid foundation for our approach to instructional design in Chapter 1, that we now explore in depth the mental instruments and ingredients used to plan projects in which online resources are used in educationally worthwhile ways. But, like any great chef, we won't be following recipes in this kitchen. Instead, we will come to understand the many possible dimensions that Internet-infused projects can assume by seeing them as flexible yet orderly concoctions. After all, isn't every casserole invitingly different, even though all involve combining ingredients and baking them in one pan?

Telecollaboration and Teleresearch

Since the early 1980s, telecommunications tools have been used by students and teachers to assist in curriculum-based inquiry. Implements such as electronic mail, electronic bulletin boards, realtime text chat, and more recently, audio/videoconferences, World Wide Web browsers, simulations, and remotely operated robotic devices allow learners to message, conference, locate information, and experience geographically distant and virtual worlds. What is possible educationally with this impressive and ever-expanding set of tools and functions, though, can be conceived as two different but inextricably linked processes: telecollaboration and teleresearch. As in the word *telecommunication,* the prefix *tele* denotes something done at a distance. So, for purposes of discussion, let's think of educational applications for Internetworked tools as either collaboration with distant colleagues or research using, at least in part, resources located elsewhere.

In this chapter, I will ask you to consider educational activities in which the primary focus for students' action is telecollaborative. Please be aware, though, that successful projects rarely involve telecollaboration or teleresearch exclusively. As you will see in Chapter 5, some of the most powerful educational applications of telecommunications tools are not only multimodal but also multidisciplinary and thematically conceptualized. Let's consider the difference between telecollaboration and teleresearch as an idea to think with (Papert, 1980) rather than as a constraint for the learning experiences we design for students. Separating telecollaboration from teleresearch is just a thinking technique to help us to be aware of the broadest range of possibilities for curriculum-based educational telecomputing.

Types of Telecomputing Activity

Telecollaborative projects typically focus upon at least one of three primary learning processes:

1. interpersonal exchange

2. information collection and analysis

3. problem solving

(Given the metaphorical setting for this chapter, I am tempted to ask you to think of these as breakfast, lunch, and dinner.) Like telecollaboration and teleresearch, these three processes for curriculum-based educational telecomputing projects are not mutually exclusive. Instead, a particular learning plan is usually situated primarily in one of these three genres, secondarily in another, and perhaps tertiarily in the last. More powerful educational undertakings tend to incorporate multiple aspects of all three.

But, as with our earlier delineation between telecollaboration and teleresearch, let's imagine these three processes as categories into which we can classify activities according to their *structures.* (Remember these from Chapter 1? If not, before going on, please reread that foundational material.) By examining thousands of curriculum-based telecomputing applications since 1986, I have discovered a total of 18 telecollaborative activity structures to date. Each of the three process categories encompasses either 5, 6, or 7 activity structures. Let's take a look at each now, using activity examples that have been enacted in primary, middle-level, or secondary classrooms.

Interpersonal Exchange

The oldest types of educational telecomputing activity are those in which individuals talk electronically with other individuals, individuals talk with groups, or groups talk with other groups. This can be accomplished using e-mail, asynchronous large-group discussion tools (such as Web conferences or newsgroups), or realtime text or audio/videoconferencing tools (such as IRC or

CU-SeeMe). There are six activity structures currently associated with interpersonal exchange processes: keypals, global classrooms, electronic appearances, telementoring, question-and-answer activities, and impersonations.

Structure 1—Keypals

This was the first commonly used telecomputing activity structure, similar in form to surface mail penpal activities. Students participating in activities formed according to this structure usually are paired off to communicate with each other electronically. The topics they discuss are often suggested by the students themselves.

Michelle Bodner (1997), for example, writes of her third graders' keypal work with a class in Perth, Australia (http://www.gsh.org/wce/bodner.htm), on the Well-Connected Educator's (http://www.gsh.org/wce/) Publishing Center and Forum. She says:

> *Letter writing via e-mail was a very motivating experience for students in both classes. For one thing, e-mail allowed us to establish a relationship with a classroom much different from ours. These exchanges gave my students a new perspective on the world and helped them realize that their keypals had lives much like their own. Opening the world to my students via this new technology demanded that they become articulate communicators. They had to learn to interact sensitively and kindly with people from other cultures. E-mail gave them a chance to be heard first without being judged by how they looked. The walls of prejudice did not have a chance to be built.*

Michelle goes on to enumerate many curriculum-related benefits her students realized in their year-long e-mail exchanges, including many specific writing and thinking skills. She illustrates a particularly creative form of keypal activity when describing a project in which each of her students created a personalized holiday story for a first-grade student in South Carolina. Here is how Katey, one of Ms. Bodner's students, began a story written for her keypal, Brittney:

> *The Easter Egg Scramble*
>
> *It was the day before Easter and Brittney Briggs, a six-year-old girl with black hair and brown eyes, was in her room listening to her favourite song "Killing Me Softly" when her two friends Jasmine and Diedre came into the room and asked her what she wanted for Easter. Brittney told them that she wanted a baby doll.*

Students and teachers in Year Four at the Hobart School in Tasmania chronicled, on a beautiful Web site (http://anfi.pacit.tas.gov.au/fahan/Compute/indo.html), their rich, year-long exchanges with similarly aged students attending the Malang School in Indonesia. Sharing messages, photographs, and artwork electronically, these students helped each other understand cultures, customs, and everyday life

in their respective countries, discussing such topics as native animals, traditional folk tales, daily schedules, homes, religions, traditional dress, school curricula, and what it "feels like" to be Australian or Indonesian. Why not take a moment now to explore this site and read Michelle's inspiring article so that you glean a sense of the potential richness of keypal interactions?

Keypal-like interactions can also occur in realtime, using text chat tools like Internet Relay Chat (IRC). You can learn more about how to access and use IRC by visiting IRC Users Central on the Web (http://light.lightlink.com/irc/index. html). In one example, students at the Leo Ussak Elementary School in Rankin Inlet in the Canadian Arctic communicated both with children in Hawaii and with two adults who had just completed a dog sled trip from Manitoba to the Northwest Territories. The following portion of their conversation was found on the Web in mid-1997. Personal and emergent topics were addressed in this exchange, as is common in all keypal communication, synchronous and asynchronous. Here is a sample from their discussion:

ArcPersp: *Greetings all!*

ArcPersp: *It is 80 F and crystal clear in Minnesota!*

Shaklee8:   *Hi Barb, Elsa here … im with martin and julie …*

Ussak: *Ublakut Will!*

Shaklee8:   *Ublakut Bill Belsey … greetings!*

Ussak: *Paddy wants to know if there are many swimming pools there? The kids here have all been swimming in our swimming pool. It was so warm this summer that people were even in the lakes and rivers!!!*

Mramirezm: *Sounds fun to swim in lakes and rivers around Rankin.*

ArcPersp: *Refreshing!*

Shaklee8:   *swimming pools galore! everywhere. There are probably twenty swimming pools here in the hotel! Lots of flowers, fruits … coconuts all kinds of neat things*

Mramirezm: *We are watching a slide picture of people in igloos—taken in Arviat.*

ArcPersp: *That was the elders of Arviat*

ArcPersp: *Who made the "igloo school" for the kids, I believe!*

Shaklee8:   *Do you sleep in the igloos … ? sounds like alot of fun*

Ussak: *Allastair has slept in an igloo before, it was quite warm inside.*

Ussak: *Wayne S. wants to know if you can swim in the ocean there?*

Mramirezm: *We have all been swimming in the ocean. It is quite warm and crystal clear.*

Additional examples of keypal projects, along with a list of Web-based keypal locator services for both students and teachers, are available for your perusal online at http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/.

Unfortunately, student-to-student keypal exchanges often involve more managerial work than many teachers have time for. The transfer and processing of multiple e-mail messages sent through a single class account or the monitoring of many messages by a single teacher if students have their own e-mail accounts to use can make keypal activity structures difficult to justify in terms of time and effort expended. Group-to-group exchanges, especially those with a particular curricular emphasis, can evolve into fascinating collaborative explorations without overwhelming the facilitators. These exchanges, called *global classrooms*, are described in the next section.

Structure 2—Global Classrooms

With this activity structure, two or more classrooms in different locations can study a common topic together during a previously specified time period. Global classroom structures are much more often used than keypal structures, probably because of the logistical difficulties of keypal activities explained in the previous section. Also, global classroom activities seem to lend themselves better to specific content foci and therefore may be perceived by teachers to "fit" better into the curriculum.

The simplest type of activity formed according to this structure is one in which in-classroom discussion of a topic is extended to other classes studying the same topic, thereby creating a virtual learning space. Glenda Scott, a secondary language arts teacher in Australia, for example, invited students in Years 8, 9, and 10 to join with her class as they read and discussed George Orwell's *Animal Farm* (http://archives.gsn.org/may97/0001.html). The Instructional Technology Development Consortium (ITDC) in San Bernadino County, California, coordinates similar literature study through its Read to Write Project (http://www.itdc.sbcss.k12.ca.us/projects/kreider/index.html) on an ongoing basis, organizing each project it sponsors by literary genre, such as historical fiction or biography.

The high priestess of global classroom projects, Margaret Riel (http://www.gsn.org/who/team/mriel.bio.html), has directed and supported many incredibly successful Learning Circles (http://www.iearn.org/iearn/circles/) for both AT&T and the nonprofit educational foundation I*EARN (http://www.iearn.org/iearn/). As Margaret writes on the Learning Circles Web site:

> *Learning Circles are highly interactive, project-based partnerships among a small number of schools located throughout the world. Each session is 14 weeks.*

Learning Circles are organized around three themes: MindWorks, Places and Perspectives, and Computer Chronicles. The Learning Circles Web site has much

of quality to offer. I highly recommend that you further explore this rich possibility for your students by making a virtual visit.

Although global classroom projects are most often completed according to a collaborative arrangement among several classrooms, some explorations of this type have participant groups that vary and the discussions hosted are generally of longer duration. UNICEF's Voices of Youth site (http://www.unicef.org/voy/), for example, offers a "meeting place" in which young people can discuss topics of international significance, such as children and war, cities and children, girls' maturation, and children's rights.

While some global classroom projects are structurally simple and short-lived, others are quite complex and can involve students from many countries for one or more school semesters. A particularly rich, interdisciplinary, secondary-level project called Utopian Visions (http://www.en.utexas.edu/uv/vision/) is a good example of how simple tools (electronic mail), a sophisticated vision, and active facilitation can combine to create exciting dialectical inquiry. The coordinators of the project describe it like this:

> *Ever wondered what it was like to live a century ago? Ever pondered what life will be like a century from now? This telecomputing project, created in 1995 by R.W. Burniske, a language arts teacher at the International School of Kuala Lumpur, and Lowell Monke, a computer science teacher in the Des Moines Public Schools, is designed to help students simultaneously reflect and speculate, considering their place in history's continuum.*
>
> *The pilot project, Utopian Visions '95, attracted participants from Asia, Europe, North and South America and earned first prize in the annual Sig/TEL Contest sponsored by the International Society for Technology in Education. The revised version, Utopian Visions '96, brought together residents of Budapest (Hungary), Cesky Krumlov (Czech Republic), Des Moines (Iowa, USA), Florissant (Missouri, USA), Kuala Lumpur (Malaysia), Milwaukie (Oregon, USA) and Verl (Germany) to collaborate in the construction of a digital time capsule which we'll build upon in this edition. Along the way, we've even made a cameo appearance in the 24 Hours in Cyberspace project, with students in the Nelson Mandela township reading some of our student reports.*
>
> (http://www.en.utexas.edu/uv/vision/)

Global classroom projects are often conceptualized not only as interdisciplinary investigations, as with Utopian Visions, but also as thematically organized inquiries. Hannah Sivan and David Lloyd, both in Sde Boker, Israel, coordinated several such projects, including Desert and Desertification (http://environment.negev.k12.il/desert/desert.htm), about deserts in the past, present, and future, and Earth's Crust and Plate Tectonics—or ECPT—(http://environment.negev.

k12.il/platline.htm), about "plate tectonics in everyday life." In David and Hannah's description of ECPT, the multidisciplinary, multilevel, multimodal, bilingual, and thematic nature of the project is evident:

> *During this project we will learn about the movement of the plates, and the ways in which this phenomenon effects everyday life in many parts of the Globe, how it affects the climate of the earth, the shape of the Earth and the formation and distribution of fauna and flora.*

> *We will follow the way in which this theory was developed, together with development in sciences and technology in the 17–18 centuries.*

> *We would like to see the participants in this project share with each other their personal experience from meeting land forms and events that result from the movement of the plates.*

> *We invite Netters, teachers, students and researchers, to join us in an adventure of learning about "The Earth's Crust and Plate Tectonics". This is a year long (September 1995 to May 1996) project, that has 5 Stages. The structure of this project will enable students (as well as classes) to join this project at any stage according to their timetable. In this project we will study Plate Tectonics, what the causes of this phenomenon are and how it affects the Globe and its people. The project will be a bi-lingual project—it will be conducted both in Hebrew and English.*

(http://environment.negev.k12.il/platline.htm)

Additional examples of global classroom projects are available for you to browse among at http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/.

Have you noticed that I have been using both "activity" and "project" to refer to what can be designed using activity structures? Have you wondered if there is a difference? Although the words are probably used interchangeably by educators, for our purposes, let's agree to use "activity" for something of shorter duration and "project" for something that takes longer to complete. Usually, "activities" combine to form a single "project." The activity structures we have seen thus far in this chapter probably would be considered by most to have been used to create "projects." The next structure, according to the difference I've just suggested, would probably help you to build an "activity."

Structure 3—Electronic Appearances

Interpersonal exchanges can also host a special guest, with whom students can communicate either in realtime or asynchronously. Such electronic appearances are usually made on a one-time basis by someone who is a subject matter expert. In some cases, electronic appearances are made by famous experts.

Although electronic appearances can be conducted using e-mail or asynchronous computer conferencing tools, most are done using realtime text chat or audio/videoconferencing, such as CU-SeeMe (http://www.indstate.edu/msattler/ sci-tech/comp/CU-SeeMe/index.html). This establishes telepresence for the session's participants and accommodates the short-term nature of this kind of activity.

NASA's Ask-the-Scientist videoconferences (http://space.rice.edu/hmns/dlt/ videosched.html), for example, allow students to communicate directly with scientists on several different prescheduled topics each month. The lineup displayed at the site when this chapter was being written in 1997, for example, included a session with Dr. Patricia Reiff, chairman of the Department of Space Physics and Astronomy at Rice University, talking with interested learners about the Hale-Bopp comet, and Truett Latimer, president of the Houston Museum of Natural Science, talking about the making of an IMAX film about the Alaskan wilderness.

KIDLINK's (http://www.kidlink.org/) Kidwriters Writing Studio (http://www. kidlink.org/KIDPROJ/Kidwriters) is a Web site that has a corresponding monthly meeting of children ages 15 and younger who use IRC to discuss writing. At some of these virtual meetings, famous authors come online to interact about their craft. These discussions are then summarized and archived at the Web site so that students who were not able to participate in realtime can experience the virtual appearance virtually <grin>. One particularly powerful session archived at the site was conducted with Zlata Filipovic, a young Bosnian writer living in Paris. The archived conversation is introduced as follows by one of the adults who participated in the four-hour experience:

> *Writers' Corner On-Line Chat With Zlata Filipovic*
>
> *She is perhaps the most famous Bosnian child living in exile. On June 2, 1995, Zlata Filipovic met with children around the world in the Kidlink chat area for a four hour on-line conversation. She was the first writer invited by Kidlink kids to the Writers' Corner.*
>
> *From a laptop computer in her Paris home, she discussed her book (Zlata's Diary), war and peace in Bosnia, and the Zlata fund— money she is raising for children displaced or orphaned by the war. Many of the children in the audience participated in reading circles with classmates and teachers before meeting with Zlata. Their preparation was evident in the questions they asked the author.*
>
> *In the more unstructured second half of the chat, Zlata allowed us to peek over her shoulder as she hung out with her new found international community of friends. Many adults watched silently in the background as the children's conversation slipped back and forth between discussions about life, death and MTV. After four hours, Zlata did not want to leave.*

> *Not only did Zlata connect with many new friends, she also discovered that other Bosnian children were attending schools linked to the Kidlink network. As a result of this chat, Kidlink members convinced several companies to donate a laptop, modem and software to Zlata permanently so that she could establish regular contact with other Bosnian children living in exile throughout the world.*
>
> *Everyone was captivated by her warmth, her message and her intelligence. But most of all, we all hope that the on-line session helped Zlata recapture a tiny strand of her lost childhood.*
>
> (http://www.mv.com/Writers-Corner/EVENTS/zlata.html)

Some electronic appearances originate as asynchronous, rather than synchronous, events. Such is the case with an interview with Dr. Francis Crick (http://www.gene.com/ae/AE/AEC/CC/crick.html), the 1962 Nobel Laureate who co-discovered the structure of DNA.

One of the most well-developed electronic appearance haunts on the World Wide Web is the Women of NASA site (http://quest.arc.nasa.gov/women/intro.html), designed to acquaint its visitors with the specializations, histories, and daily lives of more than 50 female scientists, mathematicians, engineers, and administrators who work for NASA. Each woman featured has self-authored profile and "day in the life" documents available at the site. Several monitored Web conversations with individual participating scientists are scheduled each month, during which participants discuss "math, science, space, technology, and gender equity," according to their interests and preferences.
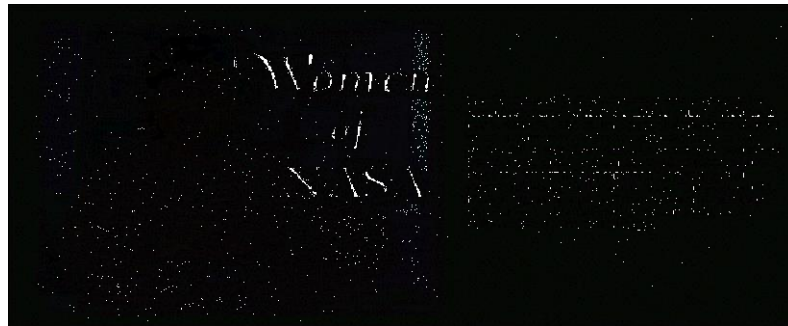
Women of NASA is part of a series of projects collectively called Sharing NASA (http://quest.arc.nasa.gov/). This series connects classrooms to NASA experts.

More examples of electronic appearances are available for your reference at http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/.

The fact that the Internet can connect subject matter experts directly with students so that they can engage in inquiry-based dialogue either synchronously or asynchronously is an exciting but as yet underutilized aspect of global telecommunications. Electronic appearance activities usually allow students to communicate with locally, nationally, or internationally known people for

relatively short periods of time. When exchanges with subject matter experts become more extended and a teleapprenticeship (Levin, Riel, Miyake, & Cohen, 1987) forms, the activity structure can be called *telementoring.*

Structure 4—Telementoring

Internet-connected subject matter specialists from universities, business, government, or other schools can serve as electronic mentors to students wanting to explore specific topics of study in an interactive format. For example, Hewlett-Packard's Email Mentor Program (http://mentor.external.hp.com/) helps individual students in grades 5–12 who are interested in math or science find mentors who work at any of Hewlett-Packard's international centers.

Professionals at the Museum of Science in Boston create science-related collaborative activity packets for classes participating in the Science-By-Mail® program (http://www.mos.org/mos/sbm/works.html) and then communicate with students as they perform the experiments included in the packets, "answering questions, comparing results to activities, and responding to the kids' work." Students supported and encouraged by these scientists also ask their adult mentors about their work, education, and science-related experiences.

A service called the Electronic Emissary (http://www.tapr.org/emissary/), directed by your humble author, helps match volunteer subject matter experts (SMEs) from all over the world with teachers and their classes.
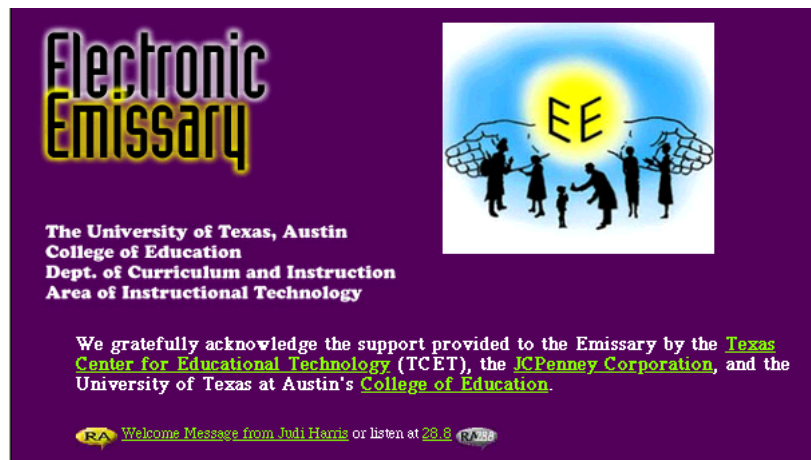
A database of information on the Emissary's volunteer experts is searched by teachers and students according to curriculum topics planned for study. The service helps the newly formed teams composed of SME, teacher, and students structure a mentoring project that focuses upon curriculum-related inquiry in the SME's field(s) of expertise. Students and teachers then communicate, often using e-mail, with the SMEs. All communications are monitored and guided by Emissary staff members who are experienced both as educators and online project facilitators. After the project has ended, team members share what they learned together with others who visit the Emissary's site by creating searchable documents for other Internet-connected students and teachers to use in their

project planning. A sample exchange (http://www.rice.edu/armadillo/Schools/Lanier/EEP/) focusing upon journalism and involving students from Lanier Middle School in Houston, Texas, and James Derk, computer columnist for the Evansville, Indiana, *Courier*, is available online.

Telementorships don't have to be arranged by services such as the ones just described or by others indexed on the World Wide Web (http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/). Mentors are often located by "virtual word-of-mouth," as happened with Martha Kate King's fourth-grade class's Spanish Texas project, which involved two avocational historians plus a senior historical author and his wife. Highlights of this e-mail exchange are available at the project's archive (http://riceinfo.rice.edu/armadillo/Projects/letters.html). The incredible power of telementoring is evident in this excerpt of a message from historian David LaRo to Emily, a nine-year-old who asked about Cortez:

> *You are doing a report on Cortez? Well, great! I hope you learn a lot and that you will develop an appreciation for what the early Spanish did to this "new world" which they found here.*
>
> *One thing we should understand first is that always, throughout your life, there will be more than one way to look at anything. If some people see a problem, there will always be people who will find something GOOD in the situation (which means it is NOT a problem for them.)*
>
> *It is usually a good thing to look at all sides of a question or problem before we make up our minds about it. The more we know, the better we can understand and make decisions, right?*
>
> *The story of Cortez in Mexico is a story of many sides.*
>
> *Cortez is famous in the history of Texas because he was important to the history of Mexico, and Texas was settled by Spanish people who came through Mexico. You see, if Cortez had not come to what we now know as Mexico, if he had not conquered the Aztec Indians, Texas history might have been very different.*
>
> *He is called the "conqueror of Mexico" because in the year 1519 (that was about 27 years after Christopher Columbus first sighted the land of the "new world") this man Cortez brought some soldiers and a few horses ashore in Mexico, marched inland to the city where the Aztec Indian empire was found. Along the way, he encountered many representatives of the Aztec King, Moctezuma (or Montezuma, depending on how you want to spell it. He died a long time ago, so he can't really know how we try to spell his name.)*
>
> *We read in history books that Hernan Cortez was an explorer, a Spanish conquistador, and it was his goal to conquer the natives of Mexico (or, what we now call Mexico) and to make those natives*

(Indians) work in the service of the Spanish king. He may have had some ideas that he would personally benefit, too!

We know that the Aztec Indians who inhabited that area of Mexico were fierce warriors; that they were feared over most of their world. There were many more Aztec warriors than there were Spanish under the command of Hernan Cortez! Yet, Cortez conquered the entire Aztec Empire with all its mighty warriors!

How did he do that?

Well, he had a few things on his side that the Aztecs did not. First, he had weapons made of Toledo steel, armor (suits made of metal,) and some of his men—but not all—rode on horses! The Aztecs had never seen such things before and may have believed that the soldiers on horseback were ONE large war monster! The thought that they had to fight this huge monster with four legs, a shiny metal head and a metal jacket over much of its body—well, that was very scary. But the army of Cortez had another secret advantage. So secret that even the Spanish did not know about it.

But first, I need to tell you that what I've told you so far comes from me. It's what I believe about this part of history, and it is based on things I have read. It may or may not be accurate and you can believe me or not! If you are interested, you may want to ask more questions of your teachers, or go visit your librarian and ask them for some suggestions for further reading. You see, your opinions are just as good as mine, and the more you read about something, the better chance you have to form good opinions!

Using another activity structure that has more recently emerged, students' contacts with SMEs are brief: only as long as is necessary to have their specific questions answered.

Structure 5—Question-and-Answer Activities

As the amount and varieties of information available online grow exponentially, so can our difficulties with finding answers to questions that specifically meet our needs as learners. For students who either can't find the information they need to fully answer a question they have or who don't fully understand the information they have found online, a *question-and-answer* activity might be appropriate. Of all the activity structures that have emerged as the Internet has been appropriated for educational use, question-and-answer activities are the briefest in duration.

Question-and-answer activities are often incorporated into larger projects. For example, Dr. Larry McKee, the director of the archaeology program at Andrew Jackson's Hermitage (http://www.earthwatch.org/ed/mckee/mckee.html), is working with others to excavate the former U.S. president's slaves' quarters to learn about this community of 130 African Americans. In Dr. McKee's words,

> *The Hermitage Archaeology Program is a multi-year study of slave life at the plantation home of Andrew Jackson. Recent archaeological studies of slave life in the ante-bellum U.S. are showing that slaves did not lead passive lives in complete acceptance of their social condition. Research has shown that slave communities worked toward actively transforming and successfully altering their circumstances by participating in the local and regional economies of both white and other slave communities. Excavations will reveal how slaves of the Hermitage altered and re-designed their allotted space and buildings on the plantation. Artifacts will indicate comparative lifestyles of Hermitage slaves vs. those of the well-documented white population, degree of contact with other communities, and extra-community participation in trade and economic networks.*

<div align="right">

(http://www.earthwatch.org/x/Xmckee.html)

</div>

One part of this Earthwatch-sponsored (http://www.earthwatch.org/ed/home.html) project offers the opportunity for students to send questions to Dr. McKee by using a specially created Interview the Scientist Web page (http://www.earthwatch.org/ed/mckee/interview.html).
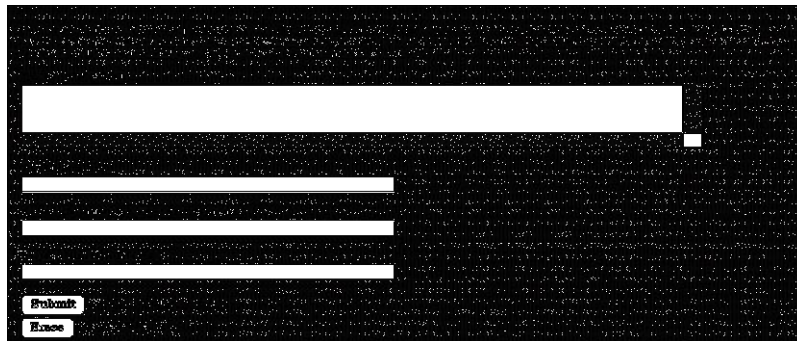
Earthwatch provides similar opportunities in its other projects, such as an exploration of katydids, led by entomologist David Nickle (http://www.earthwatch.org/ed/pm/interview.html) of the Smithsonian Institution's U.S. National Museum of Natural History.

By far the most common representation of question-and-answer activity possibilities on the Web, though, is the availability of "ask-the-expert" services. Pitsco, Inc., has organized more than 300 such services into an index (http://www.askanexpert.com/askanexpert/), making it much easier and more efficient for learners to find places to get their questions answered. The Ask an Expert site

categorizes the services it indexes into 12 subgroups (e.g., science/technology, health, arts, law). It also provides a search engine to help visitors locate the service best suited to provide an expert's answer to a particular question, whether it is Ask a Volcanologist, Ask a Venture Capital Expert, Ask a Veteran, Ask a Veterinarian, or other service on the site's ever-expanding list.

While many question-and-answer services serve both formal and informal educational purposes, some are designed specifically with primary through secondary learners in mind. Sponsored by Washington University's Medical School in St. Louis, the Mad Scientist Network (http://madsci.wustl.edu), a "collective crania of scientists answering questions in many areas of science," offers a very well-conceived, well-structured set of science education resources, including an Edible/Inedible Experiments Archive, a guided tour of the Visible Human, and a Random Knowledge Generator. I mention this site here because it also hosts an Ask-a-Scientist service with a database of more than 4,000 already-posed-and-answered questions that visitors are encouraged to search before sending in their queries. An example of a question and its response follows. In keeping with the kitchen theme of this chapter, I selected a question about a refrigerator. It was answered by a chemist with a specialization in pharmaceuticals working in Philadelphia:

> *Q. Why is my refrigerator door harder to open the second time—i.e., after I open it and close it, and then immediately try to open it again?*
>
> *A. It is your conscience telling you not to eat that double-fudge ice cream.*
>
> *Either that, or it is because opening the refrigerator door the first time allows relatively warm air from your kitchen inside. When you close it, the air quickly begins to cool, and as it does so it contracts, forming a partial vacuum.*
>
> *If this ever stops happening, you should have the gasket on the door replaced.*
>
> (http://128.252.223.239/~ysp/MSN/
> posts/archives/may97/861723829.Ph.r.html)

In all of the interpersonal exchange activity structures we've examined so far, participants have shared information that directly pertains to them: their work, their lives, and their learning. In the next structure, at least one participant in an online group communicates not as himself, but in character. These virtual performances, quite popular for both the actors and the other interactants, are called *impersonations*.

Structure 6—Impersonations

Impersonation projects are those in which any (or all) of the participants communicate with each other in character. For example, April Vega and Bonnie

Hopkinson-Johnson, teachers at U.S. Department of Defense Schools, worked with fourth- and fifth-grade classes reading historical fiction (*Conrad, Pedro's Journal, A Voyage with Christopher Columbus; Speare, The Sign of the Beaver; Fritz, What's the Big Idea, Ben Franklin; and Lenski, Indian Captive, The Story of Mary Lemison*), helping them communicate via e-mail with the books' protagonists (http://www.tmn.com/dodea/imperson.htm). Characterizations were provided by adult members of the administrative and teaching staff.

In an ongoing impersonation project for students in Virginia, Robin Gabriel, the Director of Education at Monticello, Thomas Jefferson's home, answers students' questions in character by e-mail as the former president. A wonderful archive of sample questions and responses from this project is available online (gopher://pen.k12.va.us:5000/11/Pav/SocStudies/Jefferson/Letters). A typical example of this correspondence is shown below. Please note that the contents of this archive change periodically.

Dear Mr. Jefferson,

We are from Hollymead School. We would like to know two things. Why did you build U.V.A?

We also went to your house on November 11, 1994 and we found out that you did not like to waste space and we would like to know why.

From,
[names deleted for confidentiality]

Dear Master M. and Mistresses G., M., and B.,

Please excuse my delay in answering your letter, I have been away from Monticello and just recently returned. Before I answer your questions, I would like to ask one of my own of Mr. Meriwether. Are you per chance related to the Meriwethers of Albemarle of my day?

You ask me why I built the University. This is in essence a simple question. I wish to expose the citizens of Virginia to a good education. It is also a difficult question to answer in that there were many political and physical decisions that played a role in the founding of the University. They are too numerous and complicated to go into at this time.

Your second question about wasted space is an interesting one. Although I wish everything good of its kind and handsome in stile, I am a great enemy to waste and useless extravagance and see them with real pain. Small, private staircases are preferable to great staircases, which are expensive and occupy a space which would make a good room.

I am with great esteem, Your most obedt. humble servt,

Th. Jefferson

This kind of activity can also involve students as online characters. Harold House, a social studies teacher at North High School in Wisconsin, has devised a rich role-playing project (http://www.ecnhs.org/dept/socstudies/wurtz/Wurtz. html) in which he and his students interact in character. The scenario occurs in medieval times (1210 A.D.), in the County of Wurtz, ruled by King Harold Ragnar One-Thumb, with Mr. House playing the role of the king's scribe and his students becoming inhabitants of the village of Melzar or the town of Draakmar, both within the county.

The king introduces himself like this:
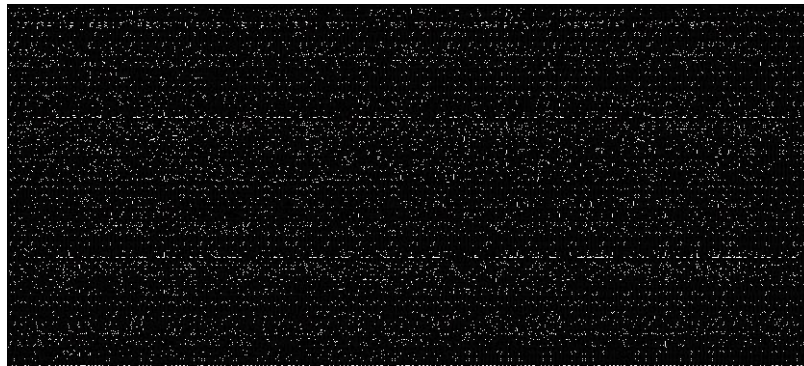
One-Thumb then makes a series of decrees, one of which says, in part:

> *A traveler has visited my castle and told me of a sickness that knows no cure. It is a dark sickness and lies to the East of our land. It is said that this sickness strikes down all with no simpathy to age or degree of health. Seek out those who may know something of this sickness, be he doctor, witch, or gypsy. We may need help from all quarters. We must quickly complete our Cathedral in Draakmar so that God will drive away this new illness.*
>
> *I also need many volunteers to enter the Great Forest to improve and clear the road that connects the village of Melzar and the city*

of Draakmar. I know that this is not a pleasant request for the forest hold many creatures, both known and unknown, but it is nonetheless an important project and those volunteering will be taken off of next month's tithe rolls.

Mr. House then asks each participating student to react to the decrees, using a persona the student has created as part of the role-playing activity. One student, for example, says, in part:

My name is Sir Christoph Segensburg. I come from Germany. I came here to escape the constant warring between the Germanic nobles. I came here because I heard that this was a peaceful country. Well, anything is better than where I came from. My full armor was made by my old lord's master armorer, and my long sword was made my lord's master swordsmaker. Both owed me a favor during a siege.

I hope that I can get a job with the local army, as a military advisor, or in the local law enforcement. I'm staying at the inn in Draakmar, until I can get a room at the castle. And to show good faith, I'll join the expedition to clear the paths to Melzar. I'll either work or patrol the working area, to keep the beasts and thieves away.

Clearly, this is a rich and motivating way for students to use telecomputing tools to help them explore many curriculum-related topics in dynamic, interactive contexts.

Information Collection and Analysis

Some of the most successful educational telecomputing activities involve students collecting, compiling, and comparing different types of interesting information. With the advent of the World Wide Web and its wealth of available resources, this use of educational telecomputing has become quite popular. Please note, though, that the five activity structures described in this section are essentially *telecollaborative* in nature, with teleresearch used only to *support* the learning done jointly among students and teachers. (More on teleresearch will be presented in Chapter 3.)

Structure 7—Information Exchanges

There are many examples of thematically conceptualized information exchange that have been employed as curriculum-based telecomputing activities. For example, students and their teachers from around the globe have collected, shared, compared, and discussed these topics:

- ◆ indigenous insect species
  http://www.minnetonka.k12.mn.us/groveland/insect.proj/insects.html

- ◆ boiling points of water at different locations and elevations
  http://k12science.ati.stevens-tech.edu/curriculum/bp/

- slang words from different countries
  http://www.interlink.org.nz/projects/chewfat/chewfat2.html

- proportions of edible and inedible material in different varieties of oranges
  http://archives.gsn.org/apr97/0060.html

- home remedies for illnesses
  http://www.otan.dni.us/webfarm/emailproject/rem.htm

- medicinal plants
  http://www.kidlink.org/KIDPROJ/Plants/

- different types of currency and monetary exchange rates
  http://www.kidlink.org/KIDPROJ/Money/

- newspaper headlines
  http://www.kidlink.org/KIDPROJ/Journalism/

- meteorological observations, e.g., relative humidity
  http://www-kgs.colorado.edu/rt_clouds.html

- television advertisements
  http://www.eduplace.com/projects/tv.html

- characteristics of wetland environments
  http://www.kidlink.org/KIDPROJ/Wetlands/

- historic trees
  http://www.nyu.edu/projects/julian/toc.html

Additional examples of information exchange activities can be seen online at http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/.

Sharing information that is intrinsically interesting to young people on an international scale is an excellent way to engage students in authentic cultural interchange. One of the best examples of curriculum-related information exchange is David Warlick's yearly Global Grocery List project (http://www.landmark-project.com/ggl.html), in which students from all over the world collect the prices for each item on a common but virtual shopping list.

Participating classes use the price lists contributed by their peers to discover which items are more expensive in which places. Once these patterns are identified, students can begin to research and discuss why these differences in cost are observed.

Information exchanges can involve many classes without becoming an overwhelming managerial task for teachers. Projects such as these are particularly appropriate uses for telecomputing tools because participating students become creators, consumers, and critics of the information they share.

Structure 8—Database Creation

Some information collection and analysis projects involve not only collecting but also organizing information into databases that project participants and others can use for study. Successful information exchange activities can "grow" into database creation activities.

Wild bird observations, for example, are popular topics for information exchange activities. The Wild Ones (http://www.columbia.edu/cu/cerc/WildOnes/), a collection of projects sponsored by the Wildlife Preservation Trust International and hosted by Columbia University, offers a Bird Migration Project (http://www. columbia.edu/cu/cerc/WildOnes/migration.html) in which students are encouraged to contribute weekly bird observations by submitting information to an online database. Participants are asked to report species observed and number of each seen, latitude, longitude, method of attraction, observation time, school name and teacher information, plus any other comments they wish to add. Data from all over the world are then combined and separated by locations and species to yield migratory patterns.

Michelle Childress, a teacher at an elementary school in Virginia, has organized a well-conceived, well-supported database creation project for young children that helps them explore animal species and the alphabet. In Amazing to Zany: An Electronic Dictionary of Animal Art (http://kpt1.tricon.net/Personal/mchildre/dict.html), children in kindergarten through third grade all over the world create and contribute artwork and texts describing different types of animals. Their works are then displayed at the project's Web site. Here, for example, are two entries for the letter M:
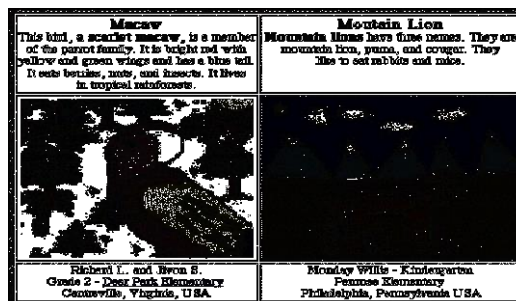
Artwork for this project can be done either with hand-held drawing tools and then scanned to create a data file or with computer-based paint tools. Michelle asks teachers to register their classes before submitting contributions so that she can suggest three letters of the alphabet with which each class can work. She also provides a rich collection of ideas for classroom activities related to project participation, an in-depth assessment rubric, and a page of links to Internet resources through which students can locate animal information.

One of the longest-running database creation projects is KIDLINK's (http://www. kidlink.org/english/index.html) Multi-Cultural Calendar (http://www.kidlink.org: 80/KIDPROJ/MCC/). Since 1994, students from many different countries have been contributing database entries on holidays celebrated where they live. These records are searchable by month, holiday, country, user-supplied keywords, and author. Entries for the month of October, for example, include Japan's Health/Sports Day, New Zealand's Labour Day, Egypt's Armed Forces Day, Canada's Thanksgiving, Argentina's Mother's Day, Turkey's Republic Day, and the United States' Hallowe'en. This is indeed a rich and well-organized collection of interesting, student-produced information that has many possible uses in the classroom.

Information collection results can be analyzed in other ways, also. One of the most popular is through electronic publishing activities, which usually result in electronic periodicals (e-zines), report repositories, or online galleries.

Structure 9—Electronic Publishing

Increasing numbers of schools with high-speed access to the Internet, along with the proliferation of HTML authoring tools, have made it quite easy for primary through secondary electronic publishing projects to take place. The appeal of an international audience for students' work is powerful, and many examples of electronic publishing projects are viewable online. A selection of links to these projects is available at http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/.

One of the most well-known examples of electronic publishing is MidLink Magazine (http://longwood.cs.ucf.edu/~MidLink/), a quarterly e-zine created by and for students ages 10–15. Each issue contains pupils' graphic creations, poems, essays, and short stories organized around several themes. For example, in February and March, 1997, contributors encouraged readers to think about dreams for peace in honor of Dr. Martin Luther King. Other sections in the publication included an egg hunt, a haiku exchange with students in Japan, and a virtual quilt project, under which site visitors were invited to "curl up by the fire … and drink a cup of hot chocolate with your cyber-friends." The quilt was virtually created with student-contributed squares and stories that represented the countries, states, and territories in which they lived.

NewsOntario, a collaborative electronic publishing project involving approximately 30 schools in Ontario, Canada, invites students of any age to write news stories of local, provincial, or national scope and share them with other

student journalists online, using the NewsOntario Web site (http://www.lbe.edu. on.ca/bonavent/newsontario/index.htm). Participating classes or schools produce their own newspapers locally, sending paper versions to NewsOntario's five coordinators, who then distribute copies to schools whose students' stories were included. This project is structured similarly to Newsday (http://www.gsn. org/project/newsday/), an older, ongoing project in the United States sponsored by the Global SchoolNet Foundation (http://www.gsn.org/). A related, larger-scale student journalism project is sponsored by Canada's SchoolNet. Likened to CNN, it is called SchoolNet News Network (http://www.stemnet.nf.ca/snn/) and features monthly electronic publications comprising Canadian students' news stories, photos, and clips of videotaped interviews and reports.

The e-me, or Electronic Self-Portraiture project (http://www.inform.umd.edu/ EdRes/Colleges/ARHU/Depts/ArtGal/.WWW/digvil/eme/eme.htm), takes virtual form as an international online gallery of students' graphic representations of themselves. Based at the University of Maryland, the project's organizers describe the intent of their venture as follows:

> *The Art Gallery invites students K–12 to participate as exhibiting artists in The Digital Village. As computer technology shapes our world, expanding possibilities for human interaction and artistic creation, it is crucial to engage students in projects which demonstrate the potential for global collaboration using technology and the arts. It is the goal of the e-me: Electronic Self-Portraiture educational outreach program to create a collective portrait of the emerging cyberspace student community.*

The range of styles and expressions shared in this collection is impressive, as is the rapidly expanding potential of electronic publishing efforts in general.

Although the activity structures helping students to collect and analyze information presented thus far in this chapter emphasize comparison and contrast (information exchanges) or collaboration to create a common product (database creation and electronic publishing), information collection and analysis activities can also help students to experience *telepresence,* as is the case with what Al Rogers (http://www.gsn.org/who/team/ar.bio.html) has dubbed *telefieldtrips.*

Structure 10—Telefieldtrips

Local fieldtrips can be engaging, beneficial educational experiences for students. However, funding constraints and geographical location may limit frequent and productive curriculum-based traditional fieldtrip options for many schools. A very popular type of online project, the telefieldtrip, can open virtual doors to fieldtrip experiences that students from even the wealthiest and most centrally located regions would not be able to sustain.

This rapidly multiplying type of online project has two variations. The first, and simplest to organize, involves students in one location taking a fieldtrip locally

and then sharing their experiences online with other students interested in similar curriculum-related experiences. This can involve remotely located classes sending fieldtrip partakers questions to which they must attempt to find answers while experiencing the excursion. An excellent example of this practice is illustrated in the Hong Kong International School's Virtual China week-long virtual fieldtrips, during which two groups of seventh-grade students visited either southern China by bicycle or the ancient Chinese capital of Xi'an. The travelers kept in touch with preregistered classes using both e-mail and a question form at the Virtual China site (http://www.kidlink.org/KIDPROJ/VChina97/). The travelers were grouped into study teams, each specializing with a different focus upon the Chinese people and Chinese culture. Photos from their trips, their itineraries, and copies of messages sent and received were shared with virtual participants.

The second, and by far the most popular, type of telefieldtrip is essentially a virtual expedition, in which students share in a real-world fieldtrip taken by adults who are researching scientific relationships or historical sites. Online participants are invited to experience the expedition, usually in multimedia form via the World Wide Web, and, in some cases, remotely participate in the inquiry. One of the most well-known and well-developed examples of virtual expeditions is MayaQuest (http://www.mecc.com/ies/maya/maya.html), which follows archaeologists and videographers as they travel by bicycle through Mesoamerica, exploring sites of Mayan ruins and the rainforests in which they are located. Classes having a subscription to this project can interact with the explorer team, helping team members to solve problems encountered in their on-site work. Rich information about the current-day Mayan people, especially children, and their towns, lives, and experiences, is also shared at the MayaQuest Web site.

NASA has sponsored many educationally rich telefieldtrips that address topics in space science and include active interaction with NASA scientists. Live from Mars (http://quest.arc.nasa.gov/mars/index.html), Online from Jupiter (http://quest.arc.nasa.gov/galileo/index.html), and the Shuttle/Mir Online Research Experience (http://quest.arc.nasa.gov/smore/index.html) are three noteworthy examples.

There are also several virtual expeditions that track explorers as they climb mountains. Sandy Hill Pittman's progress up Mount Everest in 1996 was tracked and discussed through a project sponsored by the Global SchoolNet Foundation (http://www.gsn.org/past/kidspeak/), and Phil Buck's climbing of the tallest mountains in each nation in North, South, and Central America is chronicled at http://www.23peaks.com/.

The range of telefieldtrips available online is awe inspiring. The National Audubon Society helps students track the flights of snow geese (http://north.audubon.org/), the Global SchoolNet Foundation has helped participants follow the path of the Olympic torch before the 1996 games in Atlanta (http://www.gsn.org/past/torch/index.html), an organization called TerraQuest has helped learners to virtually experience the Galápagos Islands (http://www.terraquest.com/galapagos/), the Yukon Educational Student Network (YESnet) helps pupils

follow the annual Yukon Quest dogsled races in Canada (http://www.yesnet.yk. ca/schools/projects/quest/), and MCI and the Global SchoolNet Foundation help onlookers follow Roger Williams, a retired U.S. Marine Corps pilot, as he drives around the world for the Where On the Globe Is Roger? project (http://www.gsn. org/roger/). These are but a few of the virtual adventures vicariously available to teachers and students on the Web. Links to additional examples are available at the site supporting this book (http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/).

As you can see, the possibilities for these rich, multidisciplinary, multimedia virtual experiences are numerous and most exciting. Yet in all of the information collection and analysis structures discussed thus far, students either vicariously partake of an activity or they amass, compare, and contrast information in different forms. The final activity structure in this category encourages learners to pool similar data from different locations and then analyze the patterns that emerge as a result of the combination of samples.

Structure 11—Pooled Data Analysis

Information exchanges are particularly powerful when data are collected at multiple sites and then combined for pattern analysis. The simplest of these types of activities involve students electronically issuing a survey, collecting the responses, analyzing the results, and reporting their findings to all participants. Many of the electronic publications at the National Student Research Center (http://members.aol.com/nsrcmms/NSRC.html) at Mandeville Middle School in Louisiana are articles reporting the results of such surveys.

Younger children have used mathematical explorations of probability within this activity structure. For example, elementary-level students have explored the proportions of candy colors in packages of M & M's in the Marvelous M & M Project (http://teams.lacoe.edu/documentation/projects/math/mm.html), and sixth-grade students at the Ralph Bunche School in Harlem, New York, use a Web page form to request that young people worldwide help them with a math experiment (http://www.rbs.edu/RBS_Forms/RBS.html). Participants are asked to put 10 pennies into a cup, shake them, empty the cup, and count how many pennies land with their heads up, repeating the procedure four more times. The data are submitted to the Web site, and interested distant collaborators are contacted by e-mail and given total counts for heads and tails.

Pooled data activities have also included projects in which students collect environmental data at numerous and varied sites and then pool and analyze it to reveal patterns that help to address current scientific challenges. Although many such projects are offered on the Web (links to which are accessible at http:// ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/), among the best-designed and best-supported are the projects sponsored by EnviroNet (http://earth. simmons.edu/), based at Simmons College in Boston. One of the most popular of these is the U.S. national RoadKill project (http://earth.simmons.edu/roadkill/ roadkill.html), which asks students to record and report the numbers, types, and

locations of creatures killed in the streets between their homes and their schools. Dr. Splatt, the fanciful RoadKill project facilitator, helps participants observe, explain, and predict seasonal and incidental patterns of roadkill. EnviroNet also sponsors pooled data analysis projects that help students track ozone emissions, wild bird species, patterns of coyote howls, and different types of chemicals used in different parts of the country to clear wintry roads.

Other notable pooled data analysis projects have included re-creations of Eratosthenes' shadow measurement experiment, which was done to estimate the circumference of the earth, and is explained most compellingly by Karen Nishimoto of the Punahou School in Honolulu (http://www.wested.org/tales/03tall01.html); the University of Kansas' multinational Monarch Watch migration-monitoring project (http://www.MonarchWatch.org/); and the very popular Kidlympics (http://www.kidlink.org/KIDPROJ/Kidlympics/) international schoolyard Olympics simulation, first conceived and coordinated by Linda Delzeit of the National Public Telecomputing Network and now facilitated by KIDLINK.

Clearly, this type of project holds much promise for involving students in large-scale research efforts that use mathematics and scientific methods to answer complex and interesting questions.

Problem Solving

Problem solving is one of the most beneficial educational opportunities we can offer students of any age. The Internet can be used to support problem-based learning around the world. Problem-solving projects are, as yet, the least common type of educational telecollaborative activity, but they are among the best examples of how connectivity can be used to support and enrich K–12 curricula. Examples of each of the following seven activity structures can be accessed through the index offered at http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/.

Structure 12—Information Searches

Problem solving online can be either competitive or collaborative. In the simplest form of problem-solving activity, students are provided with clues and must use reference sources, found either online or offline, to answer questions. Information searches are usually structured as competitive activities, with the winning individuals or teams being those who correctly answer the most questions by a shared, short-term deadline.

The Landmark Game (http://www.kidlink.org/KIDPROJ/Landmark97/landmark.html), for example, organized for KIDLINK by students and teachers at the Germantown Academy in Philadelphia, Pennsylvania, was described by its creators as follows:

> *Choose a Landmark any where in the world. Have your students research facts concerning the landmark and compose nine*

interesting clues. Three clues per week will be posted by the landmark moderator to the Kidproject board over a three week period. All registered schools can ask one question per week which requires a yes or no answer to each clue posting school. At the end of the three weeks the school which guessed the most landmarks will be declared the winner!

(http://www.kidlink.org/KIDPROJ/
Landmark97/landmark_announcement.html)

Here's an example of a set of clues about a particular landmark. The clues were contributed by students at the Grady A. Brown Elementary School:

1. *People first learned about me around the world in 1843.*

2. *My greatest value to the world today is that I am a living laboratory.*

3. *If I huff and I puff, I will blow your house down.*

4. *I am similar to a dragon.*

5. *I live on an island somewhere in the world.*

6. *I'm about half the size of the island I'm on.*

7. *I am one of an elite 15.*

8. *13,680 ft. high.*

9. *I'm the largest explosive object on the face of the earth.*

(http://www.kidlink.org/
KIDPROJ/Landmark97/clues.html#clues96)

Do you know what the landmark is? If not, would it help if I told you that it is in Hawaii? Yes, that's correct; these clues describe Mauna Loa.

Coordinators of the Math Forum (http://forum.swarthmore.edu/) at Swarthmore College sponsor a monthly Internet Geometry Hunt (http://forum.swarthmore.edu/hunt/), which is a math-related trivia game. Each month, several questions are posted, including ones like these:

1. *Which mathematician, born on May 11, was awarded the Nobel Prize in 1965?*

2. *What is CLIME?*

3. *Who's the current President of the MAA? (What's the MAA?)*

4. *Who wrote the book "Writing to Learn Mathematics"?*

5. *Last year Ryan Morgan discovered a theorem using Sketchpad. What was the theorem?*

6. *The soccer ball is really an Archimedean Solid. What's the name of that solid?*

(http://forum.swarthmore.edu/hunt/current.hunt.html)

Site visitors are encouraged to find answers to the questions on the Internet, keeping track of their problem-solving paths. Individuals or teams are invited to submit their solutions by the end of the month, explaining the answer found, the URL at which it resides, and, most importantly, the path taken to locate that answer. Correct solutions are entered into a random drawing for a Math Forum T-shirt. Winners are announced at the Web site.

Probably the longest-running, most well-received information search activity on the Internet is the Global SchoolNet's GeoGame (http://www.gsn.org/project/gg/index.html), originally developed by Tom Clauset of North Carolina.
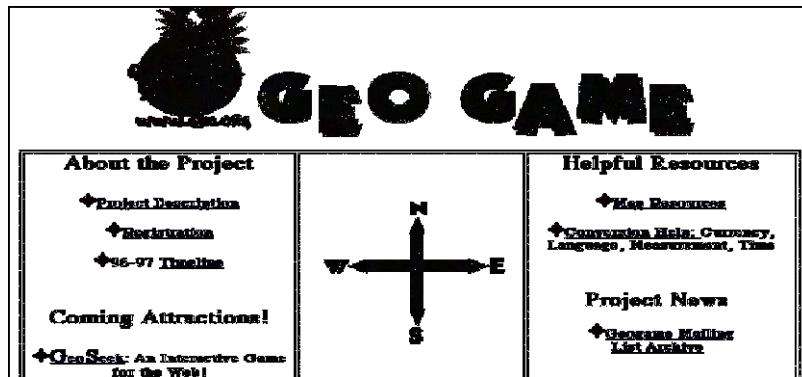
Classes participating in this geography game are asked to send in 10 pieces of information about their school's location, including the categories shown here:

The project's organizer (Lorna Pasos, in 1997) then scrambles the information submitted, keeping the clue sets intact but separating them from the names of the locations they describe. The resulting two information lists (one of all of the clue sets and the other of all of the locations) are then sent to all participating classrooms. Students have approximately two weeks to use online and offline information resources to match clues with communities before the winners are announced by e-mail.

Information search activities can also be of longer duration and embody rather extensive and sophisticated research, analysis, and communication activities for participating students. Typically, though, educational endeavors supported with

this structure are deductive and convergent reasoning activities. The next structure shows how multiple viewpoints can be explored in frameworks designed to display divergence of thought and perception.

Structure 13—Peer Feedback Activities

Peer feedback activities encourage participants to offer constructive responses both to others' ideas and to the forms in which those ideas are expressed. The Writers in Electronic Residence project (http://www.edu.yorku.ca/WIERHome. html), for example, uses a national computer conferencing system to assist young writers in Canada in responding to each other's poems, essays, and short stories. What is especially exciting about this collection of activities, though, is that many professional Canadian authors work directly with participating classes, adding telementoring to peer feedback.

Peer feedback activities can also be set up as electronic debates, as in the How Far Does Light Go? project (http://www.kie.berkeley.edu/KIE/web/hf-description. html), sponsored by the University of California at Berkeley. Project organizers suggest that middle or high school students prepare position papers about the scientific properties of light, using relevant information located on the Web to support their assertions. They also critique other students' statements according to what they understand about light's properties.

A different creative form of electronic debate is suggested by Access Excellence's (http://www.gene.com/ae/) Classroom Anatomy Online (http://www.gene.com/ ae/LC/aeLCOCclassanat.html). In this activity, students are asked to create and post "patient cards," or descriptions of ailments that fictitious patients are suffering. The cards are prepared as students use online and offline resources to explore the nature and symptoms of different diseases. Here is one example:

> *Joe Bob*
>
> *Joe Bob is a 14 year old boy who is in boy scouts. One day he went with his group on a hiking trip. They spent the weekend out in nature.*
>
> *About a month later he noticed a rash on his arm. He had severe headaches, fatigue, chills, and fever. Within the next few months he went to the doctor and the doctor said that Joe Bob also had inflammation of the heart muscle and nervous system.*
>
> *His disease has caused Meningitis. The doctor treated him for the Meningitis and gave him antibiotics as an effective treatment.*

Once the patient cards are available for other students to see online, readers are encouraged to post their diagnoses. The students who posted the patient cards then respond to the diagnoses offered, engaging in a medically based debate, if necessary.

There were four responses posted to the patient card in the example given here. Two suggested that Joe had been using steroids, one thought that he had rabies, and one said, "It sounds like Lyme disease to me."

Students who originally post the patient cards in this project are responsible for replying to the diagnoses with feedback on the accuracy of the other students' assertions.

Peer feedback activities can also be very successful with young children. In the Mind's Eye Monster Exchange Project (http://www.csnet.net/minds-eye/), for example, participating children draw original monsters and then describe their fiends using words. The descriptions are sent by e-mail to students in other schools. Those students then read the descriptions and draw what they think the original monster looks like. Both pictures are then displayed, along with the description, in the project's Monster Gallery (http://www.csnet.net/minds-eye/gallery.html), and students are given opportunities to communicate with each other about the similarities and differences they see between original and redrawn images.

Peer feedback activities encourage students to comment upon their colleagues' ideas and/or the forms used to express those ideas. With the next activity structure, students have opportunities to discuss each other's problem-solving processes.

Structure 14—Parallel Problem Solving

In this popular activity structure, a similar problem is presented to students in several locations. They explore the problem separately at each site and then come together online to compare, contrast, and discuss their varying problem-solving methods.

In the Crater Project, sponsored by Smithsburg High School in Maryland, for example, participating classes are asked to drop 1-inch spheres made of differing materials from a height of 1.5 meters into a bucket of sand multiple times. In each instance, students measure the diameter of the "crater" formed by the sphere. These data sets are then compared across sites to discover patterns. A sample data set displayed at the project's Web site (http://www.smithsburg.wa.k12.md.us/crater.html) shows the results from spheres made of aluminum, brass, cork, steel, and wood, each of which was weighed and then dropped 10 times.

In the yearly Mouse Trap Powered Vehicle Challenge (http://www.leeca.esu.k12.oh.us/ofcs/ms/MTPV_Files/mtpv.html), students all over the world are invited by a class of eighth graders to design a vehicle powered by a single Victor brand mousetrap without altering or appending anything to the trap's mechanism. Winners are determined by how far the vehicles travel, and the vehicles are displayed at the project's Web site. Similar competitions are offered in the Great Go-Car Challenge (http://prism.prs.k12.nj.us/WWW/OII/gocars.html), the Great Paper Airplane Fly-Off (http://www.uwm.edu:80/People/ekwalsh/), and the Great

Paper Airplane Challenge (http://teams.lacoe.edu/documentation/projects/math/airplane.html).

Elissa Gerzog's Monsters, Monsters, Monsters project (http://www.2cyberlinks.com/monster.html) gives classes of young children opportunities to collaboratively create and compare fanciful monsters according to different body part descriptions that the classes contribute. Each class in a participating group creates a text description for an assigned body part. The description is e-mailed to the project coordinator, who compiles all body part descriptions into an electronic mailing that then goes out to all classes. Each class then uses a variety of materials, such as construction paper, magic markers, and paint, to create a large representation of the monster. When the monsters are complete, many classes opt to take pictures of their creations and send copies to the other participants and Ms. Gerzog, who then posts the pictures at the project's Web site. Students can thus see how the same description can be interpreted differently by different groups.

One of the most creative and well-developed parallel problem-solving projects is the Electronic Schoolhouse's International Egg-a-Thon (http://www.eggathon.com/97/eggathon_home.html). In this collection of related challenges, students are invited to use eggs to solve a number of problems. In the Bundled Egg Drop, they are asked to create a crate for a raw egg in 30 minutes, using a collection of predetermined materials. The crate is supposed to protect the egg from breaking when the package is dropped from a standard height. In the Naked Egg Drop, students are invited to create a landing structure to protect a raw egg from breaking when dropped from a standard height. In the International Egg Toss, teams of students create packages to protect raw eggs when they are surface-mailed to other classes participating in the activity. In the Art Egg Exchange, classes empty raw eggs of their contents, then make them into works of art using whatever designs and materials they choose. The egg-based works of art are then mailed to partner classes. Finally, in the Bungee Egg Drop, a raw egg is dropped from the height of 1 meter into a bowl of water. Ten centimeters of masking tape and an unlimited number of same-size rubber bands are the only materials that can be used in attempting to drop the egg without cracking or breaking it.

Such rich and varied problem-based learning, accompanied by discussion of multiple problem-solving methods, is becoming quite popular among telecollaborating classes. Students can also interact by collaboratively creating a common work, as happens with a recent, and as yet little-known, activity structure called *sequential creations.*

Structure 15—Sequential Creations

An intriguing kind of artistic problem solving has emerged on the Internet, in which participants progressively create either a common written text or a shared visual image.

Mary Ann Campbell's students at Rock Falls Middle School, for example, invited young people from all over the world to join them in honoring Dr. Martin Luther King, Jr., by creating a stanza for a poem they titled "I Have a Dream." Each 4– to 10-line stanza, many of which are displayed at the project's Web site (http://www.kidlink.org/KIDPROJ/Dream/), begins with the words "I have a dream."

KIDLINK's MIDI Music Relay (http://www.kidlink.org/KIDPROJ/Midi/), coordinated by Stefan Gustafson in Stockholm, invites students to write songs progressively by adding 30-second MIDI segments to files as the songs travel globally from person to person on the Internet. Illustrated, 23-page stories for children are created sequentially, a page at a time, among classes coordinated by Deborah Falk of Duck Bay, Manitoba, in her Write and Illustrate a Children's Story (http://www.mbnet.mb.ca/~dfalk/Writing.html) effort.

Rosa Gunnarsdottir's heart-warming Benni the Bear project (http://www.kidlink.org/KIDPROJ/Benni/) follows a stuffed bear named Benni, packed in a box originating with Rosa's class in Iceland, as he physically travels from classroom to classroom around the world. As each class receives Benni, the students explore the local artifacts that previous hosts have placed in Benni's box. They also take photos and write reflections, which are then displayed on their class's page at Benni's Web site.

The sequential creation activity structure seems to be applied using a variety of expressive media to support intriguing collaborative creative efforts.

Structure 16—Telepresent Problem Solving

Telepresent problem-solving activities bring together participants from different geographic locations and time zones asynchronously or in realtime to virtually participate in a computer-mediated meeting, use remotely located robotic tools, or simultaneously engage, without direct electronic contact, in similar activities at different project sites.

KidCast for Peace (http://creativity.net/kidcast2.html), for example, is a Web site that hosts students' artwork and sponsors periodic CU-SeeMe audio/videoconferences, helping young people from all over the world create and share ways to "make this a happier, healthier, safer and peaceful world." The UNICEF-sponsored Voices of Youth project (http://www.unicef.org/voy/past/voyI/youth.html) helped students from 80 countries communicate with world

leaders attending the Summit for Social Development in Copenhagen in early 1995. Samples of the messages sent are posted at the project's Web site. Each Saturday at 18:00 hours GMT, members of the international KIDCLUB (http://www.kidlink.org/KIDCLUB/) meet using IRC text chat to discuss topics that often involve awareness of and problem solving related to global challenges, such as endangered species, hunger, and poverty. As you can see, telepresent problem solving can take many forms and use widely varied types of multimedia to connect students with each other.

NASA has held a series of realtime "virtual conferences" (http://quest.arc.nasa.gov/top/bwidth.html) that help students and teachers participate in historically significant science and technology events. For example, students were able to study space science by participating in a virtual event on March 3, 1997. The event was described by NASA coordinators as follows:

> On March 3, 1997, we celebrated the 25th anniversary of the launching of Pioneer 10. This spacecraft survived the asteroid belt and was the first to encounter Jupiter. Pioneer 10 continues to travel through space sending back data from the edge of the solar system.

> Attendees were able to listen to the presentations given in NASA's HQ auditorium using RealAudio, view graphics from the Web and ask questions using WebChat or email. Over 1,300 remote attendees visited the conference from 32 countries. Questions came in from school students learning about Pioneer 10 for the first time, and from scientists and researchers who have followed the spacecraft from the beginning. A good time was had by all!

The Global Schoolhouse's Microsoft-sponsored Read-In! virtually hosted more than 140,000 elementary through secondary students in several countries for a day-long series of activities that helped them share with each other, via the Internet, what they had been reading for approximately six weeks. Teacher Jane Johnston of Oakridge Middle School in Naples, Florida, organized teams of students in different locations throughout the United States. The students, who were studying the inventions of Thomas Edison, participated in a CU-SeeMe meeting to decide what Edison's "greatest invention" was (http://www.eduplace.com/projects/edison.html). After participating in the virtual discussions, the teams prepared drawings of the chosen inventions to be displayed at the project's Web site, followed two weeks later by the exchange of five-paragraph persuasive essays explaining why the featured inventions were selected as Edison's greatest.

In recent, forward-looking types of telepresent problem-solving activities, students have used robotically controlled devices remotely via the Internet to generate data, move remotely located objects, and cooperatively solve problems. The University of Southern California's Telegarden (http://www.usc.edu/dept/garden/), for example, allows students in different locations to "plant, water, and

monitor the progress of seedlings via the tender movements of an industrial robot arm."

Details on the use of other telerobotic tools for educational purposes (http://www.iearn.org/iearn/webtour/2/future1.html), including a telescope that can be aimed, a model house whose lights and heating/cooling systems can be controlled, and a robot in Australia that can be commanded to build with blocks, are shared by Margaret Riel as part of her excellent WebTour (http://www.iearn.org/iearn/webtour/).

Telepresent collaboration helps participants solve real-world problems in real contexts. The next activity structure creates situations in which students can solve problems in simulated contexts.

Structure 17—Simulations

Online simulations require the most coordination and maintenance of all activity structures, but the depth of learning possible and the task engagement displayed by participants can convince project organizers to spend the additional time and effort necessary to make simulations work well.

Presented in installments by its two talented creators, Leni Donlan and Kathleen Ferenz, Westward HO! (http://www.town.pvt.k12.ca.us/Collaborations/WWHO/wwho.html), a simulated 19th-century wagon train journey from Independence, Missouri, westward, is a perfect example of a motivating historical simulation. Leni and Kathleen describe, in part, how the simulation works:

> *Classes are divided into cooperative groups. Each group assumes a "Wagon Identity" based on a real pioneer woman and her family. Together, all the wagons from all the classes form the Westward HO! Wagon Train which (virtually) leaves Independence, Missouri on May 1, 1852 and follows the authentic Oregon trail out West.*
>
> *Along the way, critical decisions are made which determine the survival of wagon families and the success of the wagon train. Wagons join weekly, online, to make major decisions about route, and procedure. Wagons make daily decisions, in their classrooms,*

that involve life or death situations and determine their eventual safe arrival, or their failure to reach either Oregon or California.

The journey lasts five weeks, and concludes with a celebration of arrival at destination and the good fortune of being alive! Along the way, integrated, curricular opportunities abound. Wonderful student diaries and journals are written. Cooking, quilting, singing, square dancing, wagon constructing and outfitting, drama, research, parties and critical thinking occur in classrooms across America. In past journeys, one classroom wagon was the collaborative effort of a Southern CA 4/5 class and a PA Homeschool. This "wagon family" sent daily e-mail with suggestions, queries, and love. Other classes have engaged in campouts, line dancing, campfires, exchange of multimedia stacks, newspaper publications, video production and more! On an Electronic Bulletin Board notices of births, searches for beaus, student "Hands for hire" and advertised jobs, lost children and animals, poisoned springs, buffalo stampedes survived, rivers to be forged, and life changes are all posted.

(http://town.pvt.k12.ca.us/Collaborations/WWHO/howto.html)

First Landing on Mars (http://cotf.edu/ETE/scen/activities/mars.html), a space science simulation, challenges students to use actual digital images in landing a spacecraft on the surface of Mars. The simulation is written in an entertaining way, as can be seen in this excerpt:

YOUR SITUATION

This is it! You are aboard the good ship "Low Bid," the first manned spacecraft to orbit Mars. The trip has been long (18 months in a minimum energy orbit, naturally), and tedious, with only you (the Captain), the pilot, and your know-it-all computer, the SAL 9,000,000,000 (Sarcastic, Arrogant, and Loquacious: "I'm 32 billion times smarter than you humans!") aboard to talk to. Finally, it is time to choose a landing site and get off this flying tin can. This is a really cost-effective flight, so you have no big windows or high powered telescopes aboard, only an internal guidance system controlled by SAL ("Don't worry about it. I can land you anywhere you choose to an accuracy of a few millimeters!"). Instead, you are relying on old Viking Orbiter images taken 'way back in the 70's to find a good spot to settle down.

YOUR MISSION

You have been directed to find a safe landing site somewhere around latitude 42N, longitude 10W in the region called Cydonia Mensae, west of the crater Bamberg. This site is along the boundary

between the Martian highlands and the northern lowlands which cover the northern third of Mars.

(http://cotf.edu/ETE/scen/activities/mars.html)

Comprehensive directions on how to use public domain image-viewing software are provided, with helpful "interruptions" by SAL included.

Brian McGee's Electronic United Nations project (http://www.simulations.com/eun/index.htm) invites classrooms to become countries and interact with other participating classes. Students discuss issues, create and complete surveys, and craft and vote on proposals in a simulated United Nations. Along the way, students and teachers can learn much about global issues, politics, debate, and social ideas. In another arena, classes can develop and monitor the progress of stock portfolios in Leni Donlan, Jory Post, and Leslie Christman's Taking Stock (http://www.santacruz.k12.ca.us/~jpost/projects/TS/TS.html) simulation.

Simulations can also be organized around the use of software that helps students create and explore virtual models. The Outreach Group for the National Center for Supercomputing Applications (NCSA), for example, permits classes of students to use supercomputing facilities at the Lawrence Livermore National Laboratory remotely to create models of solutions to proposed problems in biology, chemistry, computer science, earth science, physics, and mathematics. Sophisticated simulation software, which allows students to explore, for example, climate modeling, ray tracing, molecular configuration, or plant growth modeling, is made available for downloading to students and teachers at the Outreach Group's Web site (http://www.ncsa.uiuc.edu/Edu/RSE/RSEindigo/modelhomepage.html). Teacher education materials and curricular integration suggestions are also available.

We move now from projects and software that help students simulate problem-solving situations to endeavors that help learners understand, and take action to solve, global challenges.

Structure 18—Social Action Projects

It should be no surprise to global citizens living near the end of the second millennium that the Internet can serve as a context for "humanitarian, multicultural, action-oriented telecommunications projects" (Ed Gragert, I*EARN, http://www.iearn.org/iearn/) that involve the future leaders of our planet: our children. These undertakings are called *social action projects* because of their focus upon real and immediate problems and their orientation toward taking action toward resolution rather than stopping with understanding.

There are many good examples of online projects in this structural classification. Many are sponsored by I*EARN (http://www.iearn.org/iearn/), such as the multi-national Holocaust/Genocide Project (http://www.igc.apc.org/iearn/hgp/), which explores genocide, including the Holocaust in Europe during World War II. Guided by mentors in the study of genocide, students of ages 12–17 participate in

teleconferences and, through these conferences, annually publish a magazine called *An End to Intolerance* (http://www.igc.apc.org/iearn/hgp/aeti/student-magazine.html). Students have the option to go to Poland, the Czech Republic, and Israel on a two-week study trip that takes place each spring near the Passover holiday. I*EARN also sponsors the long-running, well-known Rope Pump Project (http://www.iearn.org/iearn/projects/pump.html), which provides rope-operated water pumps to villages in Nicaragua, using money ($200 U.S.) that classes earn during fundraising events. After the pump is installed, children from the village communicate with the students who provided the funds for the pump, telling them of the changes that had resulted after the pump was installed in the village.

Many social action projects focus upon environmental issues. For example, the annual Earth Day Groceries Project (http://www.halcyon.com/arborhts/earthday.html) coordinates the efforts of thousands of elementary-level students throughout the United States to decorate grocery bags with images and text that can increase environmental awareness. These bags are filled with groceries and distributed in the children's communities each year on Earth Day (April 22). Nina Hansen's annual international Save the Beaches Project (http://ednhp.hartford.edu/WWW/Nina/Beaches2.html), supported by the University of Hartford in Connecticut, helps students living near beachfront areas clean their local beaches and collect data on the quantities and types of litter found. These data are shared among all project participants so that overall patterns can be detected. The students study the patterns and share suggestions about how excess amounts of a particular type of litter could be reduced in the future.

The Giraffe Project (http://www.giraffe.org/giraffe/), an effort to encourage others to follow the examples of people worldwide who "stick their necks our for the common good," has a special K–12 curriculum (http://www.giraffe.org/giraffe/tall.html) that has been implemented throughout most of the United States. The project's storybanks help students come to know "giraffes" and then helps them "become the story" themselves, as the coordinators explain in the following description:

> *Then it's time to stand tall themselves, putting what they've learned about heroes' courage, compassion, and responsibility into action. The kids look around themselves, decide what they want to change for the better, then design and carry out service projects to make it happen. The Giraffe Program leads them through a seven-step process that takes them from deciding to succeeding.*
>
> *Making their own observations and creating a response—rather than just signing up with an existing service program—is critical to their sense of taking responsibility for something beyond their own lives. It also requires them to get up and over their fears and their sense of personal limitation.*
>
> *When kids hear stories of heroes, tell their own heroes' stories, and exercise their own heroic qualities, the elements of character*
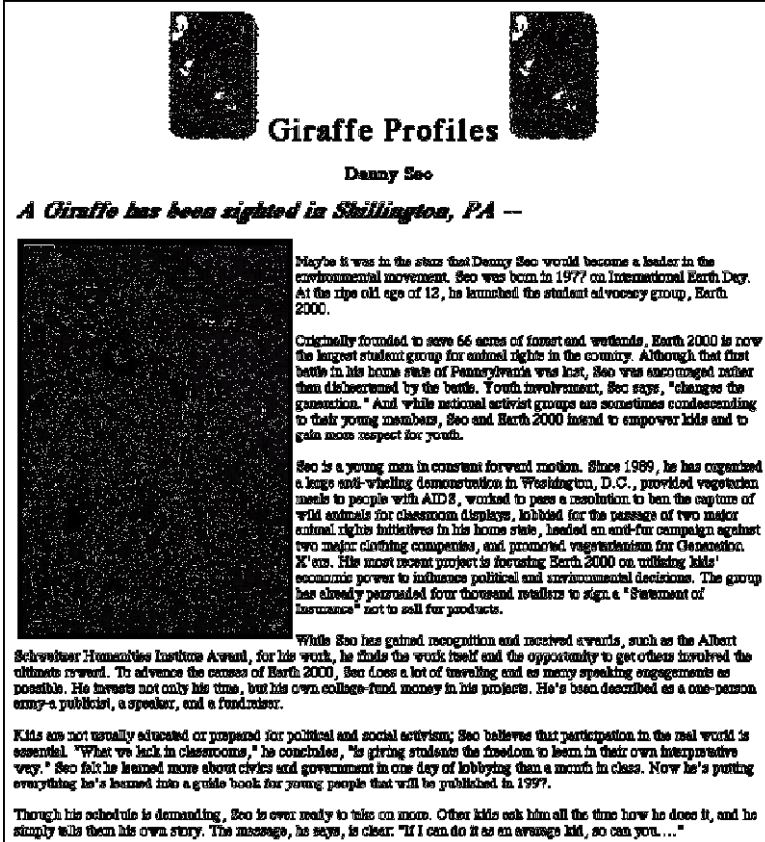
emerge in their thoughts, feelings and actions—out of their own experience. Most kids start The Giraffe Program with some uneasiness and end with a sense of responsibility and self-respect that spills out all over their lives. They've come upon their own compassion, experiencing their connection to other individuals and to their community. And it happens without the intellectualizing involved in lectures, rules, or debates—it happens by using stories to reach straight into the heart.

(http://www.giraffe.org/giraffe/tall.html)

A sample "giraffe sighting" entry in the storybank tells of the actions of Danny Seo of Shillington, Pennsylvania:

Some social action projects are symbolic in nature, but this does not reduce the potency of the action that participating students take. The Cranes for Peace Project (http://www.he.net/~sparker/cranes.html) is a good example. Its creators describe its impetus as follows:

Cranes for Peace began as a project to collect paper cranes to be sent to Hiroshima for the 50th anniversary of the bombing. Ever since the story of Sadako Sasaki, a young girl who was 2 at the time of the bombing and 10 years later died of leukemia, became widely known, people from around the world have sent origami cranes to

the Children of the A-Bomb statue in the Hiroshima Peace Park as a symbol and wish for peace. Sadako attempted to fold 1000 cranes believing she would get well by doing so. It is Japanese legend that folding 1000 cranes (senbazuru) so pleases the gods that the folder is granted a wish. Sadako wished to get well. Her story, as presented in several books, has become an inspiration for school children world-wide to fold cranes in a wish for peace.

Students are invited to make cranes from folded paper and deliver them before August of each year to Peace Park in Seattle, Washington, or another of the international locations listed at the Web site. Project coordinators place the cranes at the statue and take photographs of the scene created. These photos, along with other pictures that participants want to share, are then placed on the project's Web page.

The potential for the multidisciplinary, forward-thinking, truly collaborative learning that can take place in projects such as these is awesome. It also is interesting to note that many of the more sophisticated, interdisciplinary, authentic, online problem-solving projects focus their participants' attention upon solving problems rather than upon using telecommunications technologies that help participants share information with distant collaborators. This clear emphasis upon curriculum-integrated learning rather than upon the technologies that can facilitate that learning is one of the characteristics that makes Internet-based problem-solving projects so potentially powerful.

What Makes Them Work?

As you may have noticed while exploring these activity and project examples, the ideas behind them are simple, yet powerful. Their power rests in the interconnectedness that participants experience while they communicate across what were once geographic and temporal boundaries to collaboratively realize a shared goal. This, along with the vision, energy, enthusiasm, commitment, and patience of the teachers and students who help bring these plans to life, is probably the key to their inspiring telecollaborative success. Want more specific suggestions on how to organize and direct a successful telecollaborative project? These will be provided in Chapter 4. First, though, let's look more in depth at *teleresearch* in Chapter 3.

3

As you explored the sample projects in the previous chapter, did you notice that they not only were essentially telecollaborative in nature but also frequently incorporated teleresearch in their designs? As was suggested in Chapter 2, teleresearch often supports curriculum-based telecollaborative endeavors. That's why we really can't identify educational teleresearch *activities;* there are no teleresearch structures that parallel telecollaborative activity frameworks. Instead, there are *purposes* for teleresearch that are interwoven through many telecollaborative projects.

I'll bet some of you are furrowing your brows in disagreement here. "What? Teleresearch isn't an educational activity?" you may be asking yourself. No, it really isn't. As an activity unto itself, teleresearch builds an important set of skills, but these prerequisites to successful information location are really only a small part of what we teachers must consider when we ask our students to use teleresearch educationally. If the reasons for this are not apparent to you right away, please consider the metaphoric location I've chosen for this chapter in our virtual house. In a well-stocked study, learning can happen, for sure. Yet it isn't *finding* the book, videotape, photograph, or CD soundtrack that constitutes the educational occurrence. It's what the study's visitor then *does* with the located information that determines whether learning takes place. Do you remember the discussion in Chapter 1 about the importance of deciding whether each proposed educational use of Internetworked tools and resources is "worth it"? Beyond building prerequisite information-searching and information-sifting skills, doing teleresearch for its own sake really isn't "worth it." Despite the enthusiasm many decision makers have for giving students access to information online, there is no reason for students to do teleresearch if they can't *use* these resources to do something worth their time and effort that they either couldn't do, or couldn't do as well, before.

The Importance (?) of Information Access

There appears to be a common assumption that giving students (and teachers) access to the vast number and variety of resources available on the Internet is both important and impending. As Gallo (1994) observed,

> Although the educational benefits of computer networks are still relatively unknown, the prevailing wisdom in some educational technology circles throughout the country is that the K–12 community needs to be connected to a global network and that once connectivity is achieved, K–12 educators will use the resources not currently available within their classroom walls to enhance their institutional programs and achieve specific educational goals. The underlying premise is that if a network is built that will support educational activities, then every school will want to establish a connection to this network, and teachers in these schools will use the activities to meet the current challenges of education: "If you build it, they will come." (p. 18)

Although we want our students and ourselves to be able to access Internetworked information, we are not often sure how this access will serve teaching and learning needs and preferences now or in the future.

Baltasar Gracian's 17th-century assertion—"We live by information, not by sight" (Tripp, 1970, p. 338)—rings true, particularly in this Information Age. If students and teachers are given access to global networks, information can be brought into the classroom. Will access to information and the use of computers to organize it change our schools, or our thought processes, for that matter? Some observers, like historian Eugene Provenzo (1986), believe it will:

> The widespread use of the computer as a means by which to organize and control knowledge—to maximize human intelligence—is as important a revolution in the history of thought and thinking as the invention of writing or the Gutenberg revolution with its invention of movable type. (p. 94)

Can the Internet bring knowledge to students and teachers in our schools? Interestingly, the answer is probably "no." Surprised? If so, please consider the differences between information and knowledge.

Information Versus Knowledge

Clearly, there is an enormous amount and variety of information available on the Internet. It comes to account holders in many different forms—as text, pictures, video clips, sound files, multimedia documents, and software—and via several different methods of information exchange—the World Wide Web, electronic mail, computer conferencing, and direct file transfer, for example. But is this knowledge? Many scholars, like Taylor and Swartz (1991), would say "no." To them, knowledge is a result of the process of knowing, which can only occur as

the learner uses information in the process of actively *constructing* what he or she knows. Larsen (cited in Fox, 1991) declares that the confusion between knowledge and information

> is perhaps one of the most serious and widespread mistakes in the current use of information technology, and it leads to the attitude that giving students information is identical to giving them knowledge. (p. 224)

Larsen says that knowledge results when an individual personally transforms information. Knowledge is private, while information is public. Knowledge, therefore, cannot be communicated; only information can be shared. Whenever an attempt to communicate knowledge is made, it is automatically translated into information, which other learners can choose to absorb, act upon, and transform into their own knowledge, if they so desire. Citizens in the Information Age must therefore learn not only how to access information but also—and more importantly—how to manage, analyze, critique, cross-reference, and transform it into usable knowledge.

Managing Miscellany

Why is the development of the skills necessary to transform information into knowledge so essential? Let us begin a response to this question with a seemingly simple example. Assume that a student is doing research on wild ferrets. (Some of you may remember my first book, *Way of the Ferret: Finding and Using Educational Resources on the Internet* [Harris, 1995]. It is only for this somewhat sentimental reason that I have chosen this topic to illustrate my point.) What resources are presently available on the Internet that would help to inform our student's study? Her first step might be to use a meta-searching tool, such as Dogpile (http://www.dogpile.com/), which issues search commands to several different search engines at once. If, in mid-1997, she had asked Dogpile to search on the term *ferret** (the asterisk is used so that any endings for the word "ferret" would also be included), the meta-tool would have returned many types of links after contacting 13 different search engines.

Yahoo!	found 131 matches, 4 of which were categories
Excite	found 26 documents
WWW Yellow Pages	found 10 documents
World Wide Web Worm	found 10 documents
Lycos	found 4 documents
WebCrawler	found 1,025 documents
AltaVista	found 20,000 documents
PlanetSearch	found 1,938 documents

InfoSeek	found 12,442 documents
Excite Web Search	found 7,957 documents.
HotBot	found 0 documents
OpenText and What U Seek	returned nothing after a 20-second wait, so Dogpile abandoned those searches

Obviously, the next step that this student's teacher might take is to suggest that she employ one or more of a number of different search-narrowing strategies, such as using Boolean operators (e.g., *and, or, not, near*) with specific search engines that can accept them or stipulating a higher level of specification in the search terms. For example, if she changed the search phrase to a particular type of ferret, the *black-footed ferret*, which is an endangered species, Dogpile would find only seven engines that returned links containing this string, with far fewer documents located than were found in the previous, more general search.

Types of Information

As important as it is for our student to learn to narrow a Web search to generate a more manageable list of ferret-related online resources, she must still wade through what she has found, making important evaluative choices about possible *use(s)* of each information set. Helping students know how and when to do this kind of assessment and application is far more complex than teaching them to use any number of different search tools or strategies. To illustrate, let's consider the nature of some of the links that the search string *ferret* +wild* -pet* would yield.

The very first link that would have appeared in our results in mid-1997 would have looked like this:

```
Business and Economy: Companies: Animals: Ferrets

•   Ferret Reflections—offers a complete line of unique gifts for
ferret lovers. T-shirts, mousepads, jewelry and more.
•   Ferret Calendar, The—dedicated to the California Veterinary
Medical Association and it's director, Dr. Dick Shumacher.
•   Ferret Outfitters—quality products for you and your ferrets.
```

Our student needs to know just from reading these descriptions that her quest for information about the ferret as a wild animal in its natural habitat will probably not be satisfied at any of these sites. This shouldn't be too difficult to teach her to do independently if she doesn't already know to ignore such resources, along with any information on domesticated ferrets that made it into the link pool.

What about a link that says "Wild Ferret Software"? Our young researcher might excitedly think this will bring her to a downloadable program that will help her observe and analyze the behavior of wild ferrets. Unfortunately, the site to which

this link leads describes a number of different software tools for use on the Internet, many of which, if utilized, might anger Internet account holders because of their potential to support spamming, or electronic bulk mailings.
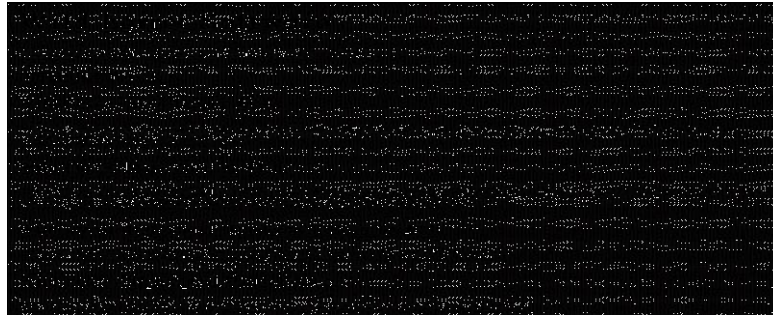
Our young researcher could even find an online game called Ferret Frenzy (http://www.delphi.co.uk/delphi/interactive/ferrets/intro.html), which was authored in the United Kingdom and allows users to make fictitious wagers (in pounds, of course) on six different racing ferrets, each complete with a photo, profile, past racing behavior, and betting odds.
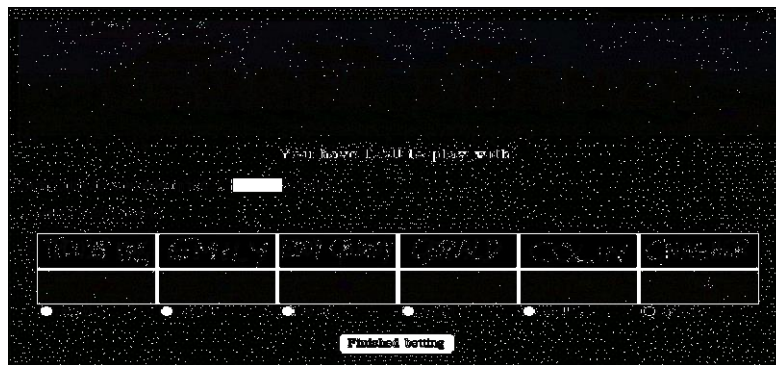
Hopefully, our student will not be distracted from her information quest to play the game. Then again, how many of *us* would be able to use our willpower in such a way? (OK, OK, I'll admit it. I bet 25 pounds on Emily while I was writing this chapter. <grin>)

Is the easy accessibility of resources like those just mentioned reason to bemoan the lack of quality control of publicly available, rapidly multiplying information on a globally distributed network of networks, sometimes jokingly labeled "the most successful anarchy in history"? Certainly not. Instead, it is cause to recognize the importance of developing and using higher-order information-processing skills. It is probable that these capabilities will be among the keys to successful learning and teaching in the future, when the sheer volume and varied nature of easily located information will demand (at least in theory) the transformation of knowledge from that which was transmitted to that which learners will actively, collaboratively, and critically build.

When It Isn't an Issue of Quality

Of course, there *is* information that the ferret search yielded that will probably be of interest and assistance to our young researcher. For example, Texas Parks and Wildlife put an easily read "fact sheet" about the black-footed ferret online (http://www.tpwd.state.tx.us/nature/endang/bfferret.htm), complete with a beautiful photo and interesting informational tidbits about the mammal. Did you know, for example, that prairie dogs make up 90% of the diet of ferrets and that these relatives of weasels "are susceptible to canine distemper, to which they have no natural immunity"?

The U.S. Fish and Wildlife Service has also posted a page of text about the black-footed ferret (http://www.fws.gov/~r9extaff/biologues/bio_ferr.html). It includes biological information, recovery efforts, reintroduction sites, and references. Andy Abate and Carolyn Kinsey, of the Society for the Protection and Conservation of the Black-Footed Ferret, have provided a richly detailed, engaging piece (http://www.acmeferret.com/saveBFFs/bffhist.htm) on their attempt to breed black-footed ferrets in captivity, with the goal of preparing them for life and procreation in the wild. Canada's World Wildlife Fund (WWF) has posted a beautifully illustrated page of information about the black-footed ferret (http://www.wwfcanada.org/facts/ferret.html), including a detailed physical description, threats to the species, facts about WWF programs to help the ferret, and steps that folks in Canada can take to assist these creatures. The text of the State of Michigan's Public Act #358 (http://loki.stuaffrs.wayne.edu/ferretlaw.html), which was signed into law on December 22, 1994, and regulates the possession of ferrets, was located in our student's search. Also, links to many collections of pictures of domesticated and wild ferrets surfaced. Our young researcher should certainly be able to find the information she needs for her study of wild ferrets.

But what about this promising-looking link located with Lycos?

```
9) Saving the Black-Footed Ferret
     Saving the Black-Footed Ferret Policy Reforms and Private
     Sector Incentives by Karl Hess, Jr. …
     http://www.selectron.com/~rot/bffhess.html
```

The text of this well-organized article, subtitled "Research Paper 32" and authored by Dr. Hess at the Thoreau Institute, begins with information about the black-footed ferret:

```
Executive Summary
One hundred years ago, between one million and six million black-
footed ferrets thrived in the prairies of the Great Plains
and the Intermountain West. But at the end of 1985, only eighteen
were left, making it North America's rarest mammal.
Since then, federal and state agencies have spent at least $12
million trying to save this member of the weasel family. From
the ten survivors they have successfully bred hundreds of ferrets
in zoos and captive breeding facilities. But attempts to
```

```
reestablish the animal in the wild have, for the most part,
failed.

The black-footed ferret, prairie dog, and North American bison
formed three important components of prairie ecosystems.

The bison ate densely growing grasses, opening up the prairie to
prairie dog colonization. The prairie dogs burrowed and
churned the soil, promoting a diversity of grasses. The ferret
hunted the prairie dogs, keeping their numbers from
overpopulating the plains.

Today, the plains bison have been exterminated—the only surviving
bison are probably a mountain variety. The prairie dog has been
reduced to 2 percent of its original range. And the ferret is on
the verge of extinction.
```

Our student might now assume that the rest of the article will include additional information about this rare mammal and perhaps suggestions for ways it could be saved from extinction. These expectations *are* fulfilled, but the paragraph following the four just quoted will reveal the political context within which the suggestions will be made:

```
At first glance, this seems to be just another story of greedy and
selfish people working in a free market and conflicting with the
natural world. But close scrutiny reveals that nearly all of the
factors leading to the ferrets troubles are due to poorly designed
government laws and policies.

A History of Government Failure
```

The document is actually a fascinating one, tracing in a clear and well-supported way how misguided and ill-informed governmental policies and regulations, even those implemented as late as the mid-1980s, did much to further the species' decline toward extinction. But our student must make a difficult decision in reading this report. Does this document address her research focus?

In asking our student to form answers to questions like these, we are not asking her only to differentiate "good" from "bad" information by questioning its source, the motivation of its author, its comprehensiveness, or its currency. In addition to wanting our student to consider these quality indicators, we are requiring her to determine whether even a high-quality document like this is appropriate for the research purpose previously determined (i.e., relevant), or whether what has been uncovered is important enough to support a reconceptualization of the nature of the inquiry. This is far more challenging to do when using resources on the Web, with its wealth of diverse information types brought to the seeker in minutes.

Information-to-Knowledge Processes

How might we go about teaching our young researcher to effectively forage her way through such a morass of data offered in so many forms? Fortunately,

librarians and information specialists have suggested well-conceived "information processing" methods for many years. For example, the Maine Educational Media Association Ad Hoc Committee on Information Skills has created a helpful scope and sequence of information skills for K–12 students in their state (Conant, A., Carr, B., Garthwaite, A., Gregory, D., Lord, L., & Allison, S., 1990). They describe the research process in 13 steps:

Pre-Search

1. Formulate the central question.

2. Relate question to prior knowledge.

3. Identify key words and names.

4. Integrate concepts and state in own words.

5. Develop questions to organize search.

6. (When needed) re-explore general resources.

The Search

7. Locate resources of information.

8. Search for relevant information.

Interpretation

9. Select and evaluate information.

10. Interpret, infer, analyze, and paraphrase.

Application

11. Organize information for applications.

12. Apply information for intended purpose.

Appreciation (ongoing)

13. Value and enjoy information in various formats. (pp. 20–27)

Although all these steps are important, I would suggest that items 10 and 12, interpretation and application, are particularly crucial to success in knowledge-making if a learner is using information located on the Internet. The authors of the guide suggest that minimal skill levels in resource selection and evaluation be set to help students:

A. Evaluate for currency of information.

B. Identify the contributor/producer of the sources being used.

C. Evaluate the contributor's/producer's work for motive, point of view, bias authority, intended audience, etc.

     D. Distinguish among fact, nonfact, opinion and propaganda.

     E. Select information that is most useful in meeting the needs of the central question. Eliminate irrelevant information. (pp. 39–40)

How does one develop these skills? Progressively, over time, through experience, and probably as a result of good modeling by more adept researchers.

The guide's authors go on to explain that it is critically important for learners to develop strong information interpretation, inference, and analysis skills:

> Interpretation skills start, but do not end, with reading. A good reader makes use of context clues, discerns the structure of a piece of writing, draws inferences, and perceives relationships. Such skills are also essential to such diverse activities as reading maps, interpreting tables of statistical data, reading schematics, and studying still photographs. During any information quest, the searcher must have the interpretation skills required by each format for the useful pieces of information or else the whole process becomes meaningless in the purest sense of the word. As our students encounter information they cannot interpret, we have two choices: to teach them how to interpret it or interpret it for them. Which is appropriate depends on the purpose of the instructional activity and the time available.

> One reliable test of a person's understanding of a piece of information is his/her ability to paraphrase it accurately. Therefore the admonition to students not to copy from their sources except for direct quotation has to do as much with interpretation as it does the ethics of plagiarism. (p. 41)

It is also important to note that the skills recommended by these authors should be used to locate and process information found in any medium and by any method. Although more critical evaluation and higher-level synthesis may become increasingly necessary for our students as they encounter more information in ever more variable formats online, general recommendations for well-informed, intelligent research will probably remain much the same. The difference in the coming Internetworked society may rest in the necessity for us to finally and regularly *follow* our information specialists' advice so that retrieved information can be used to consciously and conscientiously construct knowledge.

Telehunting, Telegathering, and Then What?

How can teachers assist students' knowledge-making? As I suggested in the first part of this chapter, merely accessing information should not be confused with constructing knowledge. The making of knowledge is an active, holistic, idiosyncratic process for each learner and can be greatly enhanced with a teacher's guidance. Information accessed using the Internet can become some of

the elemental substances learners use to create knowledge, much in the same way a plant uses air, water, and light in the process of photosynthesis. Unlike the production of carbohydrates, though, the production of knowledge often benefits from direct, interpersonal assistance. As teachers, we know it is our responsibility to provide this guidance to our students. Yet, with the overwhelming amount and variety of information available online, how can we know how to do this?

Information Seeking

The usual answer to this question is technological—and insufficient. Information-searching programs, such as the variety of Web search engines and Internet bots, are certainly powerful, useful tools that can help our students to locate large numbers of diverse and timely documents. In schools where the luxuries of easy access and flexible class schedules exist, students (and teachers) happily "surf," often impressed with the range, amount, and appearance of all that can be found that is related to a particular area of inquiry. In a sense, we become Information Age hunters and gatherers in cyberspace, sharing news of the richest locations by exchanging URLs with members of our virtual clans. Yet it is here, at the point of information access, that many current efforts at creating knowledge falter. We find ourselves confronting a much more important educational issue: what students *do* with the information once they locate, evaluate, and comprehend it. This is the step at which mechanical assistance cannot replace human interaction.

In prehistoric terms, how can the fruits of the hunt be turned to food for the clan? Part of the answer to this question lies in the plan for information-seeking itself. If students know clearly how they will use the information they eventually locate, their chances for purposeful searching, rather than aimless surfing, increase. As teachers, we can help our students formulate and enact these plans. My travels on the Internet have revealed six purposes that students seem to have (often at the apparent suggestion of their teachers) when engaged in such "virtual foraging." I share them with you now with hopes that these categories will assist your online activity planning. The Web pages from which I have drawn these examples and additional ones in each teleresearch purpose category are online for your perusal at http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/.

Purpose 1. To practice information-seeking skills

Hazel Jobe's Earth Day Challenge (http://www.marshall-es.marshall.k12.tn.us/jobe/earthday97/main.html) helps elementary-level students to practice information location while they learn a bit more about life on our planet and efforts to preserve it.

A series of 20 questions, each revealed by clicking one of the 20 letters in the activity's title, is offered to the site's young visitors. Each question has an environmental education Web site suggested for exploration, both in search of the query's correct response and with hopes that students will stay longer and learn more about the Earth. For example, clicking on the letter g in the project title reveals this question:
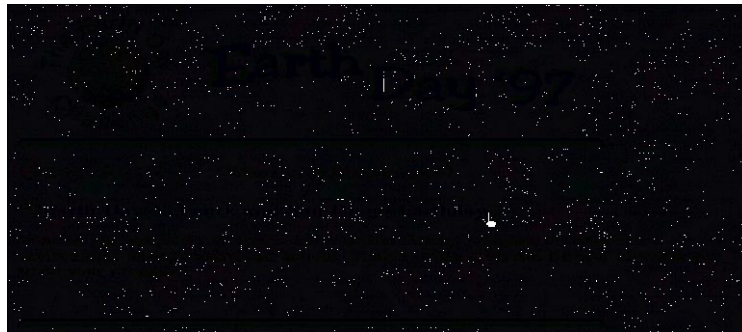
Folks working for the Earth Day Network have created the notion of the *humanitree*, which is displayed at the Virtual Humanitree Web site (http://www.202.org/earthday/) and is explained like this:

> *Humanitrees (like 'humanity' get it?) are tree-like structures built by people to express their individual promises to do something to improve the environment. The promises are written, signed and placed as the "leaves" of the Humanitrees. Trees can be painted on posters, built for desktops or made lifesize. Thousands of promises have been made from the easy to the hard, from common sense to visionary.*

> (http://www.202.org/earthday/)
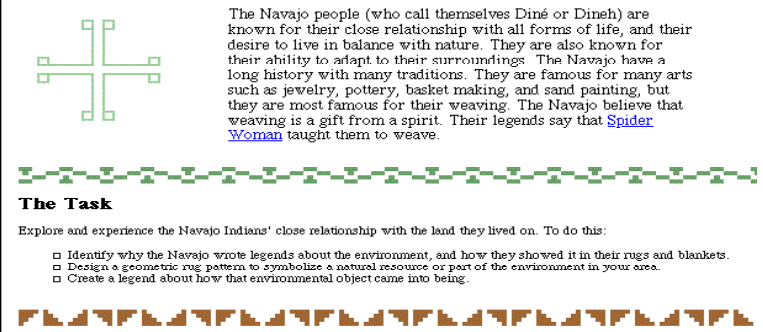
As you can see, the purpose for participating in this activity is for young students to practice information-seeking strategies within a particular Web site. More complex activities, such as the Math Forum's monthly Internet Geometry Hunt (http://forum.swarthmore.edu/) described in Chapter 2, require participants to use searching tools and strategies to review many different sites to find answers to specific questions.

Information Synthesis

Honing information-seeking skills is an important prerequisite to successful use of Internetworked resources for curriculum-based learning. It should not be forgotten, though, that developing these skills is but a means to an end. The synthesis and evaluation of multiple types, formats, and sources of information are truly at the heart of knowledge construction. Why might a student apply information-seeking skills? Four possible answers to this question comprise the next four purposes of teleresearch.

Purpose 2. To become informed about a topic of inquiry and/or answer a question

Much online information-seeking serves this purpose. Although there are many excellent examples of Web sites set up to guide learners through rich, inquiry-based teleresearch, those developed with Bernie Dodge's (http://edweb.sdsu.edu/people/bdodge/bdodge.html) WebQuest (http://edweb.sdsu.edu/webquest/webquest.html) concepts provide exceptional depth in engaging, intellectually nourishing formats. For example, Joan Schatz' WebQuest, In the Time of the Old Ones (http://www.itdc.sbcss.k12.ca.us/curriculum/oldones.html), invites students to explore the nature and expression of Navajo people's environmental awareness by examining their weaving and legends.

Cathy Jennings' WebQuest, The World of Puppets (http://www.itdc.sbcss.k12.ca.us/curriculum/puppetry.html), helps students relate puppets with which they are familiar, as well as modern Western puppetry traditions, to Japanese Bunraku puppetry, Vietnamese water puppetry, and Javan and Balinese shadow puppetry. WebQuest sites are replete with well-selected links to related information resources, directions for multimodal, inquiry-based activities, and creative suggestions for teachers who want to incorporate the WebQuests into their instructional plans. Their text is written in accessible, engaging language, and

page formats are carefully crafted for clarity, comprehension, and pleasing aesthetics.

Shelly Peretz' secondary-level How Do We Inherit Marfan Syndrome? (http://www-ed.fnal.gov/help/97/peretz/inherit/inherit2.html) Web site is another excellent example of how Web pages can be used to guide students' exploration of a particular topic, in this case, a genetically influenced condition. Shelly presents the case study of Anne by describing her genetic characteristics:

> *Anne is 16 years old and is a junior in high school. She has read some information in the popular press on Marfan Syndrome and she and her parents are concerned that Anne might have this syndrome. Her general physician has referred her to the Genetics Counseling Clinic. Anne is 5' 11", and wears contact lenses to correct for myopia (nearsightedness). She plays on her school's varsity volleyball and basketball teams. NCAA scouts are already interested in her playing ability and there is a chance she will be offered college scholarships in both sports. Her armspan:height ratio is 1.08:1. (In one group of 27 adults, this ratio was 1.006 with standard deviation = 0.03.)*

> (http://www-ed.fnal.gov/help/97/peretz/inherit/inherit2.html)

Shelly goes on to inform the page's visitors of the characteristics and abbreviated medical histories of each of the members of Anne's extended family, including her parents:

> *Parents:*

> *Mary:*
> *Age 47, 5' 7", wears glasses, has hay fever. Has been diagnosed with carpal tunnel syndrome and mild diabetes. Had two miscarriages in addition to her three children.*

> *Peter:*
> *Age 49, 6' 1", wears glasses, concave chest, high blood pressure, partial lens dislocation in left eye, long fingers and toes. Has complained about chronic tennis elbow.*

> (http://www-ed.fnal.gov/help/97/peretz/inherit/inherit2.html)

After reviewing this information, Shelly's students learn the specifics of the project in which she is inviting their participation:

> *Your assignment for the next three weeks will be to investigate this disease and prepare a "story book" about the disease. The genetics counseling community ascribes to a belief in non-directive counseling. That is, they feel that it is their duty to provide all of the information that is available and desired by a family so that they*

can make the decisions that are appropriate to them based on their own cultural, moral, religious, etc. beliefs.

Your investigation should include medical information important for people with this disease so that they can live a healthy and prolonged life. This might include:

- *a pedigree for the family described*

- *family members who appear to possibly have the disease*

- *a prediction of the chances of their offspring having this disease*

- *the ethical and social issues involved in this particular case for the child and the parents*

    (http://www-ed.fnal.gov/help/97/peretz/inherit/inherit2.html)

Shelly goes on to offer her students 12 Web-based exercises that can help them fulfill the inquiry-based expectations for the assignment. These range from review of organized collections of information on gene testing and genetic counseling, to a remotely accessible interactive program based on the principles of Mendelian genetics, to a mentor network whose members can answer specific genetics questions. Interestingly, Shelly tells her students that completing the exercises prior to preparing the disease storybook is optional but highly recommended. Her project guidelines share an important characteristic in common with the WebQuests: they provide multiple paths and many "hooks" to engage students in active exploration rather than a dependence upon assignments and assessments to motivate students to explore curriculum-related topics in meaningful ways.

Of course, teleresearch on the Internet, especially when it addresses recent discoveries or controversial topics, yields many different types and levels of information. Therefore, ways in which located information can be collaboratively examined and critiqued, as discussed previously in this chapter, become important to consider.

Purpose 3. To review multiple perspectives on an issue

Some students might be convinced that there are discrete, simply stated answers to many questions. Fortunately, the world is much more complex and interesting than that. Online information-seeking can help learners to consider multiple perspectives upon issues they are exploring. For example, Keith Nuthall's Hello, Dolly! WebQuest (http://204.102.137.135/teach/clone/dolly.htm) gives students the following guidelines:

Hello Dolly! Out of the blue, researchers from the Roslin Institute announced that they had successfully cloned a lamb. The next day, the Pope denounced the discovery as a "lack of respect for life". The scientific community hailed the discovery as a break through for mankind. Your task will be to analyze the differing perspectives,

and draw your own conclusion about the social, economic and political effects of cloning on individuals, families and communities. You will be assessed on how you support your conclusion, communicate effectively, and collaborate with your peers.

(http://204.102.137.135/teach/clone/dolly.htm)

To set the stage for this inquiry, Keith collaborates with two biology teachers in his school, telling their students that legislation has been proposed to prohibit the cloning of humans and providing them with a draft of the proposed bill. Mentioning that the U.S. House of Representatives "is assembling a group of specialists to investigate the widespread implications of cloning on the social, economic, and political fabric of American society," Keith creates roles for students within eight different groups, each of which has a separate "dossier" of background information. The groups are:

- *U.S. Department of Agriculture*

- *Friends of Animals*

- *Professors of Biomedical Ethics*

- *CLN Pharmaceutical*

- *Clone Tech, "a San Diego biotech firm that currently has several cloning patents involving cloning of human body parts"*

- *Roslin Institute Team, the team of scientists who cloned the sheep named Dolly*

- *Institute of Theology and Ethics*

- *U.S. Senate subcommittee*

(http://204.102.137.135/teach/clone/dolly.htm)

All teams must do research to inform themselves according to the perspective they are adopting. To assist in this, Keith provides a list of links to information on cloning. The teams are directed to use the information they locate to make plans for the groups' reports and presentations to the Senate subcommittee considering the proposed legislation.

As this well-designed project implies, information accessed online might be more recent, more varied in form, and perhaps more plentiful than information available locally, but online information, no matter how much it is hyped by technocentric advocates, should not replace locally available information. Instead, *all* kinds of information should be used in combination, according to the requirements each learning situation dictates.

Purpose 4. To generate data needed to explore a topic

One of the most recent and exciting educational uses for Internet connectivity involves teleoperating robotic tools. WestEd's (http://www.wested.org/tales/ 00wested.html) Tales From the Electronic Frontier (http://www.wested.org/tales/ 00contents.html), an inspiring collection of teacher-written stories of the powerful educational use of Internetworked tools and resources, includes a particularly moving story contributed by high school physics teacher Greg Lockett. His narrative is introduced with a passage written by one of his students:

> *Penumbra is a woman caught between two worlds, one of light and one of darkness. The world of light exists within the imagination and memories of Penumbra. The world of darkness is the reality around her. Together, these worlds form a shadowland where Penumbra is lost.*

> (http://www.wested.org/tales/02pen02.html)

Penumbra (http://www.wested.org/tales/02pen01.html) tells the story of an artistic, isolated young woman who had recently moved to a small town and was fascinated by fantasy and role-playing games. She struggled to define her first student research project until she located a reference in a magazine to astronomer Edmund Halley, who said that he had "talked with elves and faeries." This inspired Karolyn, the student, to "be an astronomer." She and a new-found friend attempted to use resources available online through the Remote Access Astronomy Project (http://www.wested.org/tales/02sb1raap1.html) and in the process discovered her research question in her desire to generate astronomical images. To aim the telescope, researchers have to determine when the interstellar photo should be taken, what astronomical object should be photographed, and how long the exposure should be. Karolyn and her partner hypothesized that exposure length should be related to object brightness. After some refinement, their hypothesis turned out to be correct. During the five-month project, they also came to realize the necessity of learning to use image-viewing and image-enhancing software to complete their satisfying project.
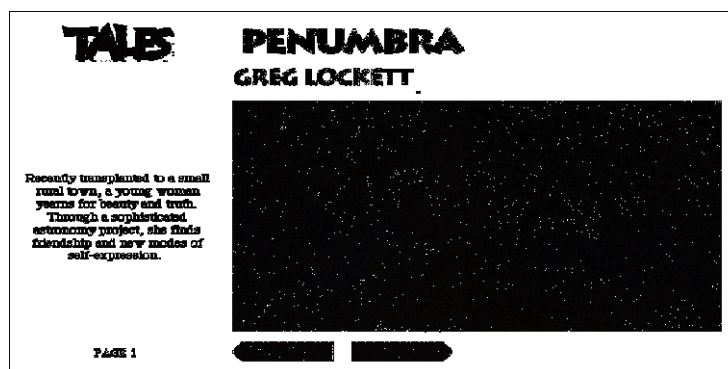
Details on other telerobotic tools used for educational purposes (http://www. iearn.org/iearn/webtour/2/future1.html), such as a garden that can be remotely

tended, a model of a house where the lights and heating/cooling systems can be controlled, and a robot in Australia that can be commanded to build with blocks, are shared by Margaret Riel as part of her excellent online WebTour (http://www. iearn.org/iearn/webtour/).

Purpose 5. To solve authentic problems

Advocates of constructivist notions of learning and teaching stress the importance of students exploring and finding solutions to real-world, complex problems. Online information-seeking can greatly assist these efforts.

In Linda Jungwirth's WebQuest on possible relationships between population declines among Antarctica's penguins and changes in the Earth's ozone layer (http://www.itdc.sbcss.k12.ca.us/curriculum/ozone.html), students are invited to research and prepare a presentation for the International Symposium on Environmental Issues, to be held in Sydney, Australia. Linda describes "The Task" to her students as follows:

> *Your task is to investigate the Antarctic ecosystem, to determine if there could be a relationship between the depletion of high altitude ozone and a decline in the penguin population, to propose three actions that would most effectively prevent the depletion of high altitude ozone layer, and to present your findings to the International Symposium on Environmental Issues.*
>
> *Include in your presentation:*
>
> - *Information on the ecosystem of Antarctica*
>
> - *A chart describing the living and non living ecological features of Antarctica*
>
> - *A diagram of a food web for Antarctica and a food chain for the penguin*
>
> - *Information on high altitude ozone: what it is and how it is destroyed*
>
> - *Information on ultraviolet radiation: what it is and what is its relationship to ozone*
>
> - *A graph depicting the level of UV-b radiation levels versus latitude*
>
> - *The effects of UV radiation on phytoplankton levels*
>
> - *A hypothesis based on your readings stating the relationship between ozone depletion and changes in the penguin population*

- *A proposal which advocates three actions that would most effectively prevent the depletion of our protective high altitude ozone layer*

   (http://www.itdc.sbcss.k12.ca.us/curriculum/ozone.html)

Although student teams are free to develop and follow their own investigations, hypothesis formation, and presentation preparation procedures, Linda suggests that they use these general guidelines:

1. *Discuss and record group expectations.*

2. *Establish who will assume each role in your team: life scientist, physical scientist, and earth scientist.*

3. *Before you begin your research, brainstorm as a team what members know relating to the tasks for each role. Next, develop questions based on this information. Use these questions to guide you in your research.*

4. *Each team member is responsible for keeping a journal to record thoughts, questions, and information. Be sure to include in this journal a record of where you find your information. Each team member will act as a recorder for his/her part of the brainstorming and question development session.*

5. *Meet as a team on a regular basis to reflect and record in your journal individual and group effectiveness.*

6. *Using your brainstorming questions to guide you, research topics relating to your role.*

   (http://www.itdc.sbcss.k12.ca.us/curriculum/ozone.html)

Linda also provides "learning advice," graph-making suggestions, "presentation advice," links to relevant online resources, evaluation and self-reflection rubrics, ideas for extension activities, and notes to teachers wanting to incorporate this WebQuest into their curricula.

Note that the activity climax for these students' exploration of penguin population trends does not stop with their own edification. Instead, they share with other students the fruits of their new understanding in the form of technology-assisted public presentations. This points to an important and analogous goal for the use of knowledge synthesized from information collected online: publishing syntheses and critical appraisals of content from a full range of located resources. In this way, the results of students' explorations can become the information "crops" that other students can harvest.

Purpose 6. To publish synthesized and/or critiqued information overviews for other students to use

Perhaps the single most important trend in the evolution of online resources is the development of a technologically simple way for Internetworked explorers to share the fruits of their information-seeking and information-synthesis labors worldwide. The most common way to do this is with a locally maintained but internationally accessible WWW server. In mid-1997 there were more than 7,000 elementary, middle-level, and secondary schools in the world with such Web servers, and this number promises to grow rapidly as the turn of the century approaches.

Several teleresearch projects incorporate such publication efforts into plans for students' learning events. In Leni Donlan and Debbie Abilock's Road to the White House II Project (http://www.town.pvt.k12.ca.us/Collaborations/Election/election.html), which took place prior to the U.S. Presidential election in the fall of 1996, students were invited to "become civic activists" by researching, collaborating, and publishing information relevant to the primary issues upon which that election was based.
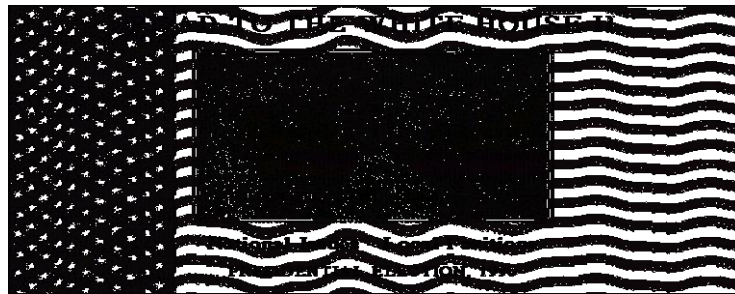
Specifically, student activities described by the project's creators included the following:

Research

- *developing in depth knowledge of the "issues" of this election*

- *developing an understanding of party and candidate stance on the issues of this election*

- *developing an appreciation for the impact this election will have on these issues, in their locale*

- *developing and writing their informed "opinions" as position papers*

Publish and Disseminate Information

- *sharing their position papers via student developed Web pages*

- *sharing their viewpoint with peers and politicians via online conferencing*

- *voicing their personal political convictions in classroom/school debate*

Collaborate

- *developing strategies to share their informed opinions with participating classes*

- *developing strategies to share their informed opinions with politicians*

- *participating in a Student National Election to give voice to their political convictions*

(http://www.town.pvt.k12.ca.us/
Collaborations/Election/election.html)

Additional examples of publishing synthesized online information for educational use are impressively numerous. One has to explore only a few of the many school-based servers online to see evidence of this trend. Fortunately, "Internet angel" Stephen Collins has made such investigation easy for us by creating and maintaining a centralized International WWW Schools Registry (http://web66.coled.umn.edu/schools.html). This useful Web page contains links to all known elementary, middle-level, and secondary servers, plus sites set up by local, statewide or provincewide, regional, and national school administrative organizations for the benefit of precollege students and teachers. It is updated frequently.

Teleharvesting, Telepackaging, Teleplanting

Those of you raised in urban environments might be surprised to learn, as I was, that crop harvesting is not only the collection and bundling of mature plants. Instead, it involves much preparation of the gathered crops to get them ready for sale. At the point of harvest most crops are not yet ready for consumption. Instead, the plant material must undergo several levels of processing before it is ready to be packaged and shipped.

The same is true for *teleharvested* information, which has been remotely cultivated, and, perhaps, *teleplanted*, by groups of students and their teachers. (I am indebted to my friend and colleague, Cathy Gunn, a faculty member at the University of Northern Arizona, for the creation of the concept and term *teleharvest*, and to Diana Paulina, a teacher at the CEC Alternative School in Iowa City, Iowa, for originating and sharing the term *teleplant*.)

The effective processing and packaging of Internetworked information—that is, its use by learners in the construction of knowledge—is a primary challenge to students and teachers in the Information Age. Like the ancient farmers who invented agriculture, we have much to learn and share about the art and practice of "infoculture." Yet the patterns of these interrelated processes are satisfyingly

recursive. For, in an overall progression from surfing to serving we see an unending, but ever-deepening and organic, educational teleresearch cycle enacted.
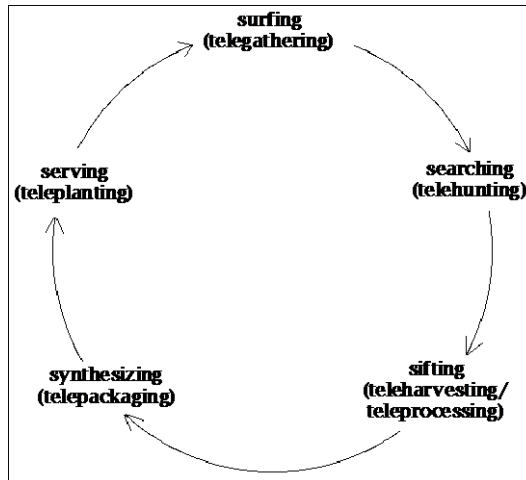
This cycle complements another cycle that is even more important for us to remember. Arthur C. Clarke perhaps said it best when he wrote:

> *Before you become too entranced with gorgeous gadgets and mesmerizing video displays, let me remind you that information is not knowledge, knowledge is not wisdom, and wisdom is not foresight. Each grows out of the other and we need them all.*

(http://www.nap.edu/readingroom/books/techgap/)

4

"The *bathroom??*" (Is that what you're thinking?) Delicacy aside, please think about this analogously with me. What's probably the smallest room in most houses (excluding closets), but one of the most necessary and most often used? In the bathroom, we attend to matters necessary for the health, cleanliness, and the comfort of ourselves and those around us. The procedures carried out in the bathroom may not be academic, idealistic, or particularly creative, but they are necessary for the rest of our lives to function well. This is true, also, of the steps taken to implement the project designs that Chapters 1, 2, and 3 were written to inspire. The "nuts and bolts" of planning and directing a curriculum-based telecollaborative project may not be the most interesting aspects of Internet-assisted learning to consider, but, like what we do in the bathrooms of our houses, enacting them regularly, consciously, and conscientiously is necessary for the logistical success of the project and comfort of its participants.

Unfortunately, effective procedures for directing a telecollaborative project are *not* intuitive for most of us at first. This is because the contexts in which communication takes place, frequently time-shifted and text-only, often require many subtle adjustments in action by project collaborators to make sure that both the content and tone of their contributions are made clear. Fortunately, there is advice from experienced project facilitators to consider and Internet-based resources that can assist your implementations of carefully crafted activity designs. In this chapter, the design and implementation of curriculum-based telecomputing projects will be described as a series of steps. Specific suggestions about how to design Web pages to support those projects will then be offered.

Project Design and Direction, Step by Step

The design and implementation of a curriculum-based educational telecomputing activity can be described as a series of eight steps, which appear in the following sections. Please note, though, that many teachers prefer to begin their experiences with integrating telecomputing activities into their curricula by *joining* a project that someone else has already designed, organized, and made available to the Internet community. The best place to find out about projects in

search of partners is the Global SchoolNet Foundation's international Projects Registry Page (http://www.gsn.org/pr/index.html). Both ongoing and one-time projects are listed in the Registry and are organized according to when new participants are being accepted.

When you are ready to design, create, and implement your own project, though, the following steps might be helpful.

Step 1—Choose the Curriculum-Related Goals

Access to telecomputing facilities in most schools will continue to be limited for a few more years. Therefore, when designing an online activity, it is very important to be sure that the learning goals specified for the activity are tied directly to the curriculum and could not be accomplished at all, or as well, using more traditional teaching/learning tools. (This point was explained in Chapter 1.) By establishing these two aspects of the goals toward which students will be working, you will begin to ensure maximal time-effectiveness and energy-efficiency of everyone's online efforts.

When choosing the curriculum-based goals for an online activity, it is advisable to think not only about what students will be learning as they participate (the *content goals*) but also about what they will be doing online and whether this effort matches any of the *process goals* that you or your pupils have set. Most e-mail-based projects, for example, require participants to write to communicate with an audience of their peers. It is advisable for teachers to ask themselves whether such authentic writing goals are among those that they would have students address by participating in the proposed online activity.

Step 2—Choose the Activity's Structure

There are a number of different ways to organize productive online projects. These *activity structures,* or flexible frameworks for designing educational telecomputing activities, were described in Chapter 2. They can be used at many grade levels and in any curriculum area, and were conceptualized by reviewing thousands of successful online projects that classroom teachers created, tested, and shared via the Internet. Effective models for structuring online projects are often unfamiliar to folks who are just beginning to use Internet-based tools for instructional purposes, because the asynchronous, widely distributed, text-heavy, and quick-turnaround attributes of telecommunications media create unique contexts for teaching and learning. This is why it is helpful to review possible activity structures and choose or create the most appropriate one at this point in the planning process.

The 18 activity structures that have been identified to date fall into three structure genres that contain several specific activities. Here is a summary list from Chapter 2:

- *Interpersonal Exchange*

  1. Keypals

  2. Global Classrooms

  3. Electronic Appearances

  4. Telementoring

  5. Question-and-Answer Activities

  6. Impersonations

- *Information Collection and Analysis*

  7. Information Exchanges

  8. Database Creation

  9. Electronic Publishing

  10. Telefieldtrips

  11. Pooled Data Analysis

- *Problem Solving*

  12. Information Searches

  13. Peer Feedback Activities

  14. Parallel Problem Solving

  15. Sequential Creations

  16. Telepresent Problem Solving

  17. Simulations

  18. Social Action Projects

New project structures will emerge as more teachers and students learn to use the Internet to assist their teaching and learning. As these are identified, they will be posted, with classroom-tested examples, at this book's Web site (http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/).

Step 3—Explore Examples of Other Online Projects

A good example is often worth a hundred hours of planning time. After you have chosen the proposed activity's structure, it may be helpful to see how other teachers have organized and described similar learning experiences that have been completed. There are a number of "treasure troves" of such project descriptions freely accessible on the Web. Sample projects indexed by activity structures are accessible on the University of Illinois' Learning Resource Server (http://lrs.ed.uiuc.edu/Activity-Structures/) and on the site created to support this book (http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/). Notable project idea collections, many of which supplied examples cited in Chapters 2 and 3, can also be found at the following URLs:

- Blue Web'n Library
  http://www.kn.pacbell.com/wired/bluewebn/

- ED's Oasis
  http://www.EDsOasis.org/Treasure/Treasure.html

- Electronic Elementary Magazine
  http://www.inform.umd.edu/MDK-12/homepers/emag/

- The GrassRoots Program
  http://www.schoolnet.ca/grassroots/

- A Handbook of Engaged Learning Projects
  http://www-ed.fnal.gov/help/index.html

- I*EARN
  http://www.igc.apc.org/iearn/projects.html

- KIDPROJ
  http://www.kidlink.org/KIDPROJ/index.html

- NickNacks Telecollaborations
  http://www1.minn.net:80/~schubert/EdHelpers.html

- oz-TeacherNet Curriculum Projects
  http://owl.qut.edu.au/oz-teachernet/projects/projects.html

- TEAMS Distance Learning Classroom Projects
  http://teams.lacoe.edu/documentation/projects/projects.html

- The WebQuest Page
  http://edweb.sdsu.edu/webquest/webquest.html

Step 4—Determine the Details of Your Project

Folks associated with the Global SchoolNet Foundation, which originated in southern California as the FrEdMail network, perhaps have the most experience helping teachers design, organize, and carry out collaborative educational telecomputing projects. They shared some of their best advice in a helpful article

published several years ago (Rogers, Andres, Jacks, & Clausen, 1990; available online at http://lrs.ed.uiuc.edu/Guidelines/RAJC.html). In this article, they make it very clear that a detailed, specifically stated project description is essential for success. They suggest that the following elements be included in every telecomputing project plan document:

- The project's title

- The project's educational purpose(s)

- The organizer/contact person for the project's name and e-mail address

- The precollege curricular areas that the project addresses

- The approximate grade levels for which the project is designed

- The number of collaborators that will be accepted

- A summary of the project's plan

- Directions for registering for or joining the project

- A detailed timeline for the project, including specific tasks to be completed and all interim deadlines

- Detailed, specifically stated, numbered procedures for participation in the project

- A sample of student work that the project will generate

- A description of how the project will end, including plans for how project results will be shared with all participants

Waugh, Levin, and Smith (1994, available online at http://lrs.ed.uiuc.edu/Guidelines/WLS.html) suggest that grade levels or age groups *not* be specified initially during project planning because cross-age communication can be very beneficial to students. They also recommend that timelines be kept somewhat flexible to accommodate the inevitable scheduling conflict or technical failure. Finally, they suggest planning in such a way as to encourage distributed project ownership, focusing upon specific rather than general topics for study.

Margaret Riel, facilitator for the many successful Learning Circles (http://www.iearn.org/iearn/circles/lc-home.html) and Passport to Knowledge (http://quest.arc.nasa.gov/antarctica/passport.html) online projects, recommends that teachers plan to network with more than 1 or 2 other classrooms; ideally, 5 to 10 classes should be included in an extended project. In this way, it is easier to take maximal advantage of the cultural or regional diversity of all of the participants, and even if several classes encounter network access difficulties, fruitful communication can continue. Margaret points out that it is important to make sure that the amount and scope of information requested of each participating class be reasonable. She also suggests that networked projects be planned so that they fit well into the larger framework of classroom activity, and that the

information created as a result of telecollaboration be of interest to a wide local audience of students, teachers, parents, and other community members. Therefore, when the project is complete, the fruits of the students' and teachers' labors can be proudly shared, and community support for educational networking efforts can be garnered or strengthened.

Step 5—Invite Telecollaborators

After you have written a detailed file of project specifics that can be included in an e-mail note to each interested party who contacts you or that can be published on a Web page, it is time to write a brief activity description. The description should be posted in public discussion areas that are frequented by other K–12 teachers with Internet access. Waugh, Levin, and Smith (1994) suggest that this brief file be used to advertise the availability of the project, making an offer to send more details (e.g., text, URLs) to any interested parties who request them by private e-mail. My experience in organizing online projects has confirmed the effectiveness of this method, especially since the Internet addresses of interested teachers can be retained for use later when organizing other projects.

Here, for example, is a message I used in 1993 to tell potential telecollaborators about a multisite, collaborative inquiry into Texas history. Please note that this project was organized before we had easy access to a World Wide Web server, so participants' contributions were posted to the Armadillo Gopher (gopher://chico.rice.edu:1170/1) instead of the much expanded, current collection of resources offered on Armadillo's WWW Server (http://riceinfo.rice. edu/armadillo/).

```
                    ==> PLEASE JOIN US! <==

  ...for a collaborative investigation of *Texas history*
           from 1830 - 1900,

  ...completed by students exploring and sharing
       information about **your community.**

By contributing to Armadillo, the Texas Studies Gopher, teachers
and students from communities located all over the state will
explore the history of the period from 1830 (before the
Revolution) through Statehood, the Civil War, Reconstruction, and
beyond, to the dawn of the 20th century.

The focus of study will be upon the location of each participating
classroom's school building, and the community surrounding it.
Students will be asked to research and write about the local:

        ~ agriculture,
        ~ climate,
        ~ culture and languages,
        ~ ecology (characteristic),
        ~ economy,
        ~ entertainment,
        ~ famous people,
        ~ folklore,
```

```
        ~ landscape,
        ~ latitude, longitude, and elevation,
        ~ plants,
        ~ politics,
        ~ population characteristics,
        ~ sanitation,
        ~ and transportation
```

...during the 70-year period from 1830 through 1900, then post a
document about their community's history on the Armadillo Gopher
for other students in other communities to read. Each
participating class will post one document summarizing their work
on the Gopher.

Then, volunteer classrooms from anywhere in the state will become
responsible for comparing, contrasting, and summarizing
information about each of the community attributes listed above
for each of the following Texas geographic regions:
```
        ~ the Coastal Plain,
        ~ the Central Lowland,
        ~ the Central Hills,
        ~ the Edwards Plateau,
        ~ the High Plains,
        ~ and the Basin and Range.
```

Each of these documents, also, will be posted for everyone to use
on the Armadillo Gopher.

By participating in this collaborative "electronic event," we hope
that students will:

```
        ~ become knowledgeable about their community's
        history during a very important time in the state
        of Texas,

        ~ discover the many relationships between
        historical conditions and local ecology,

        ~ use a variety of computer-mediated and non-
        computer-mediated learning tools for research,

        ~ and experience the study of history as a dynamic,
        collaborative, and exploratory endeavor.
```

```
                .-=:> TIMELINE <:=-.
```

```
 by October 29, 1993
            Register to participate in Phase 1 (see below)

 November 1 - December 10, 1993:
            Participating students research topics listed
            above in relation to the communities in which
            their schools are located

 by December 17, 1993:
            Post completed documents on
            the Armadillo Gopher; directions on how to do
        this will be distributed electronically

 by January 28, 1994:
```

```
                    Register to participate in Phase 2 (see below)

 January 31 - February 25, 1994:
                    Participating students read the documents
                    posted on the Armadillo Gopher from a
                    particular ecological region, comparing and
                    contrasting the community attributes listed
                    above among communities within the region.

 by March 4, 1994:
                    Post completed summary documents on the
                    Armadillo Gopher

                    .-=:> REGISTRATION <:=-.

 Would you and your students like to join this exciting
 project? If so, please send an electronic mail message
 to:  Judi Harris (jbharris), stating:

 1.    your name, electronic mail address, surface mail
       address, and telephone number,

 2.    the grade and class (subject, etc.) that you teach
       that you would like to involve in this project,

 3.    your school's name and location in Texas,

 4.    your local Educational Service Center number (along
       with the names of the Tenet Master Trainers in that
       ESC, if you know them),

 5.    and in which of the two phases of the project (1
       and/or 2) you would like your class to participate.


 *-*^*-*^*-*^*-*^*-*^*-*^*-*^*-*^*-*^*

 Hope that we will "hear" from
 many classrooms across the state!

 *-*^*-*^*-*^*-*^*-*^*-*^*-*^*-*^*-*^*


            _____  _____  _____
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      / o |        ||||         |
     /    |        ||||         |\  armadillo@chico.rice.edu
    /__)_/\        ||||         | \
        \___"""""_____/   )
           ))          ))
            "           "
```
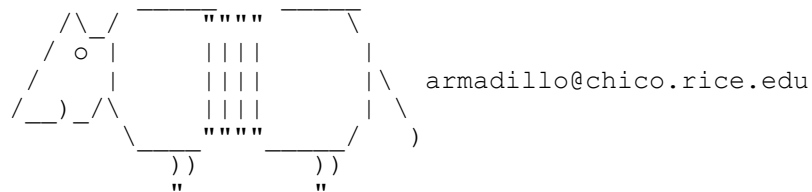
New projects on the Internet can be registered either at the Global SchoolNet Projects Registry Web page (http://www.gsn.org/pr/addproj.html) or by e-mail (proj.register@gsn.org). The following information about the planned activity is requested of the designer and is then posted for potential telecollaborators to review:

```
Name of Project
First and Last Name of Contact Person
```

```
Email address of the Contact Person
Brief Description of the Project
When does the Project begin?
How long the project will last (approx.)
List Educational/Learning Objectives of Project
(Optional) The URL where potential participants can
        find additional information
How will you share the results of your project?
```

Rogers, Andres, Jacks, and Clausen (1990) suggest that teachers "try out" a new project idea with a small group of close colleagues first before opening it up to the larger online community. In this way, the operational fine points of the plan can be uncovered with relatively little embarrassment and in small scale.

Step 6—Form the Telecollaborative Group

As soon as possible after the excited responses from potential telecollaborators arrive, you should send the author of each message either the long, detailed project file you prepared in advance or the URL where the details can be reviewed. Be sure that the file or Web page specifies procedures for how interested teachers can register to participate in the project, the maximum number of classes that can take part, and the deadline for requesting participation by return e-mail.

You can then save the information from each teacher's registration message in a file. The registration should include the teacher's name, full Internet address, school name, school location, school telephone number (to use only in "emergencies") and FAX number, the URLs for the class and school, and the number and grade levels or age groups of the students involved in the project. Designers should respond to each teacher's request for registration as quickly as possible, perhaps using another previously written file that has additional information about how each participating classroom can begin to work on the project. Waugh, Levin, and Smith (1994) suggest that this occasion be used to advocate distributed project ownership by encouraging participating teachers to collaborate to plan the finer details of the effort.

If more teachers than you can handle want to participate in the project, you should send a friendly, polite apology to each applicant you can't accommodate. These teachers' Internet addresses might be retained, with their permission, to use as part of a distribution list for notifying potential telecollaborators about future online projects.

To give you a sense of what a more detailed description of an online project sent in response to a potential participant's e-mail message might contain, here is the message I sent to teachers who responded to the invitation to participate in the Texas history project described in step 5:

```
                    Texas History Project
                        Fall 1993

Thank you *very* much for your recent email message indicating
```

```
your interest in joining the Texas history project that we are
organizing. The focus of this first phase of the project is the
communities in which participants' schools were located in Texas
during 1830 - 1900. By helping students from many grade levels to
research and communicate information about their schools'
communities during those years, we hope to add many rich resources
to the Texas Studies Gopher called "Armadillo," that students and
teachers in the future will use in addition to the resources
available to them in their classrooms and libraries. (A "Gopher"
is an easy-to-use, menu-driven system of information that
retrieves and displays text documents online. Gophers can also
facilitate the retrieval of graphics images and software programs,
which can then be displayed and used offline.)

Work with your students on this project can begin as soon as you
can schedule it, but *should* begin by November 1, 1993. Below
please find a schedule of project activities:

               .-=:> TIMELINE <:=-.

 by October 29, 1993:
            Register to participate in Phase 1

 November 1 - December 10, 1993:
            Participating students research topics listed below in
            relation to the communities in which their schools are
            located

 by December 17, 1993:
            Post completed documents on the Armadillo
            Gopher; directions on how to do this will
            be distributed electronically

You are encouraged to help your students to find out as much as
possible (from ANY and ALL sources of information in your town)
about as many of the following aspects of the community in which
your school is located, during the time period 1830 - 1900:
        ~ agriculture,
        ~ climate,
        ~ culture and languages,
        ~ ecology (characteristic),
        ~ economy,
        ~ entertainment,
        ~ famous people,
        ~ folklore,
        ~ landscape,
        ~ latitude, longitude, and elevation,
        ~ plants,
        ~ politics,
        ~ population characteristics,
        ~ sanitation,
        ~ and transportation.

**By December 17, 1993**, all of this information should be
organized into ONE TEXT-ONLY document (with margins of at least
1.5" on each side) that will be posted on the Texas Studies Gopher
("Armadillo") for students and teachers from all over Texas to
read and use. The document should include:

        1.  a title chosen collaboratively by the students who work
             on the research project,
```

```
2.  the name of the community in which these students'
        school is located,

3.  the geographic region in which this community is
        located, chosen from the following list:
        ~ the Coastal Plain,
        ~ the Central Lowland,
        ~ the Central Hills,
        ~ the Edwards Plateau,
        ~ the High Plains,
        ~ and the Basin and Range,

4.  an approximate location of the community in the state,
        indicated by the character 'O', placed on a text-
        character map of Texas:

           ############
           ############
           ############
           ############
           ############
           ##################
           ##############################
           #############################
           #############################
           ##############################
 ###########################################
  ###########################################
   ##########################################
    #######################################
     ########    #######################
       ###         ################
                   ############
                    #########
                    ########
                     #######
                     #######
                      ######
                       #####
                         ###

5.  a section of well-written, historically correct
        information for *each* of as many of the following
        categories as possible (referencing only the time
        period 1830 - 1900):
        ~ agriculture,
        ~ climate,
        ~ culture and languages,
        ~ ecology (characteristic),
        ~ economy,
        ~ entertainment,
        ~ famous people,
        ~ folklore,
        ~ landscape,
        ~ latitude, longitude, and elevation,
        ~ plants,
        ~ politics,
        ~ population characteristics,
        ~ sanitation,
        ~ and transportation,
```

```
    6.  a summary section that reviews the main points made in
        the document,

    7.  a list of all references consulted to obtain the
        information communicated in the document; these could
        include, books, journals, maps, videos, museum
        personnel, museum exhibits, historical society
        documents, family history information, etc.,

    8.  the names of all of the students who contributed to the
        document, along with your name,

    9.  and the name of the school which these children attend.

Programmers at Rice University are working on an easy way for you
to post these documents to the Armadillo Gopher from your account
on Tenet. Directions on how to do this will be sent to you in
December. In the meantime, please be sure to arrange the
operational details of the project so that the final document will
be prepared with a word processor and saved as a text-only file,
so that it can be sent easily through electronic mail.

Once all of the participants for the project have identified
themselves, a mailing list will be set up so that everyone will be
able to keep in touch with each other via email, sharing
suggestions, posing requests for information, etc. You will
receive electronic mail from me once this list is set up.

In the meantime, WELCOME! I am *so* happy that you are willing to
participate in this new Texas history project! If you have any
questions, suggestions, or requests, please do not hesitate to
sent them to me here on Tenet.

-Judi
```

Folks at the Global SchoolNet Foundation, who authored a helpful online tutorial called Harnessing the Power of the Web (http://www.gsn.org/web/index.htm), recommend that parental permission be obtained at this stage of project development if you are planning to publish any of the students' work, photos, names, or e-mail addresses on the Web. (If you are planning to publish only on your school's or district's Intranet, there probably isn't a need to obtain this permission.) They suggest that you first familiarize the parents with what the students are doing by holding an open house. It is also a good idea to help the parents understand what the issues and possibilities are surrounding publishing information about children on the Internet. An excellent overview of these topics, along with suggested guidelines for online publishing, is provided both in paper form and online (http://www.4j.lane.edu/InternetResources/Safety/Safety. html) by the National Center for Missing and Exploited Children, in collaboration with Tom Layton, a teacher in School District 4J in Eugene, Oregon.

Step 7—Communicate!

Online exchange is different from most other forms of communication in significant ways. It is asynchronous, primarily text-based, geographically and

temporally (time-zone) widely distributed, and relatively fast. Therefore, it requires somewhat different communications techniques if it is to be used for maximal educational benefit by students and teachers.

Since each telecollaborative activity structure requires a slightly different type and sequence of online interaction, only general suggestions for facilitating online discussion will be shared here. You will undoubtedly discover and share more as you communicate with other teachers and students online. Waugh, Levin, and Smith (1994) suggest that teacher-designers:

- Form a distribution list of all project participants so that periodic reports of progress and materials sent to meet interim deadlines are easily shared and filed.

- Sign all e-mail with all of the names of the people contributing to the message. (I would add that including the school name and location is helpful, too.)

- If there is discussion taking place online, provide a brief synopsis of the discussion to date before adding another perspective to the conversation so that all readers clearly understand the context in which the message's author is asking a question or making a comment.

- Be willing to share what you know (especially in terms of technical assistance) freely with newcomers, who may often feel intimidated when first being online.

- Focus the discussions carefully and solely upon the preselected topics for collaborative study.

- Use short private messages to keep communications alive. These might include the following:

  ▸ "Return receipt messages" sent to team members if the recipient is busy, telling them that their message has been received and will be answered soon.

  ▸ "Cheerleader messages" that recognize and praise exceptional efforts.

  ▸ "Ping messages" that privately ask telecollaborators who have not posted something recently to the group whether they are still participating.

  ▸ "Thank-you messages" that encourage participation when sent as interim expressions of appreciation.

An important addition to this list is the use of "reminder messages" that proactively prod project partners with reference to approaching interim deadlines. These messages can be very helpful in assuring a project's success within typically constrained school week schedules.

Rogers, Andres, Jacks, and Clauset (1990) suggest that teachers involve students whenever possible in ongoing facilitation of their projects. I would add that involving parent volunteers is also a good idea. Keeping administrators, PTA members, and local news media informed of the project's existence and the students' accomplishments is also well worth the time spent doing this informal public relations work, considering the possibilities of future project support and provision of additional Internet access points at participating schools.

Step 8—Create Closure

All the authors mentioned in this chapter suggest that telecomputing projects end with a final, tangible product, such as a Web page, written report, public presentation, short videotape, or display. The product should be firmly scheduled, complete, shared with all participants, and made available to a larger, interested community. The importance of this suggestion cannot be overstated. After all of the planning, coordination, collaboration, and hard work that project participants have expended and all of the rich learning that took place, opportunities should be available for participants and their associates outside of the project group to marvel at what has been accomplished. Also, if plans for the project and its results can be made available through a Web page online, it can serve to inform, by example, other teachers' design and implementation efforts in the future.

If there is time available for postproject communication, participants often enjoy informally sharing perspectives upon and memories of different stages in the online exchanges that have taken place. It is also important to allow time and opportunity for everyone to say "good-bye" and "thank you," and perhaps to begin speaking about the possibility of working together in the future.

Virtual Space for Projects

Telecollaborative projects happen both across and within participating school sites; they have no one geographic location. It is helpful, therefore, to create a central, virtual space for sharing information about project-related activities. Many online project directors use Web pages for this purpose. Any discussion of the logistical and operational dimensions of curriculum-based educational telecomputing should include the *design* and *purposes* of project pages.

Eliel Saarinen (1873–1950), a Finnish architect and city planner who moved to the United States in the 1920s, said:

> Always design a thing by considering it in its next larger context—
> a chair in a room, a room in a house, a house in an environment,
> an environment in a city plan. (Tripp, 1970, p. 149)

Saarinen's words convey wisdom to those of us planning curriculum-based educational telecomputing projects that will be supported by Web pages. The "next larger context" for project page design is the variety of *functions* that designers intend the Web site to serve and support. Project pages should be

designed with these functions in mind. Before offering Web documents to an online community, we should answer questions like these:

- Who will be interested in exploring the site?

- What types of information should be available at the site to address different audiences' interests?

- How should this information be presented so that it is maximally helpful to project participants and/or Web strollers?

Currently, Web page design is addressed primarily in terms of *form* and *content* rather than function. For example, the following points are usually considered:

- layout options (i.e., Should frames be used?)

- overall structure (i.e., Should one long page with links to subsections be used or should several shorter pages be used?)

- transfer time (i.e., How many graphics should be put on this page?)

- browser differences (i.e., Will Lynx users be able to benefit from the site?)

- readability (i.e., Does this combination of background pattern and text color make the page difficult to decipher?)

- aesthetics (i.e., Is the combination of colors, items, and spacing pleasing to the eye?)

In this section, I will suggest that we also consider project-related functions as we design Web documents. After all, any architect (including Eliel Saarinen) would strongly suggest that form *follows* function, right?

Project-Related Page Functions

Let's examine aspects of a few Web-based educational telecomputing projects to illustrate 10 different project page functions. More information about each curriculum-based effort is available on the Web at the URLs provided in the following descriptions. Additional information is also available at the Web site supporting this book (http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/).

1. Project Overview

> Web sites can serve as succinct introductions to the goals and operational structures of educational telecomputing projects.

I*EARN's ongoing Rope Pump Project, for example, which brings clean water to villages in Nicaragua in the form of rope-operated water pumps, is described on the project's Web page (http://www.iearn.org/iearn/projects/pump.html) as follows:

> *In rural villages in Nicaragua, many children and adults are subject to disease and death because of lack of access to clean water. Through the Rope Pump Project, we are collaborating with an organization called El Porvenir ("The Future") which worked on small water projects in Nicaragua. Students in I*EARN have raised over $10,000 to fund the digging of wells and the installation of rope pumps in villages where people were drinking from polluted streams or from wells that had been contaminated by dirty buckets being thrown into them. We have received numerous letters from children in those villages, thanking our students for providing the materials (the Nicaraguans provide the labor) for their wells and pumps and describing their lifestyles and goals. We are in the process of setting up a system whereby students can communicate with children in those villages on a regular basis.*

The page also provides information on the ages of students participating in the project, the languages in which it is conducted, and the dates during which it has been carried out. The page also provides an e-mail address for obtaining more information.

2. Project Announcement

Web sites can announce curriculum-based projects, invite participation, and provide links to relevant networked resources.

The well-organized, well-detailed announcement for the Boreal Forest Watch Project (http://www.bfw.sr.unh.edu/) in Saskatchewan and Manitoba, Canada, for example, offers clearly stated explanations and descriptions of purposes, plans, and collaborators for this ambitious ecology project.
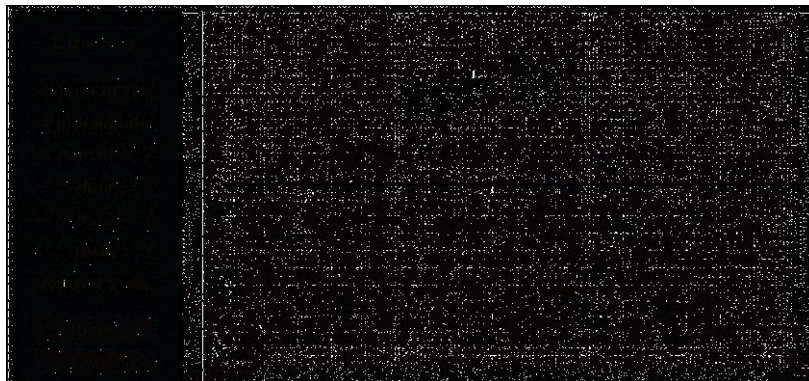
Many aspects of the project are described on its Web site, including component activities, information about participating schools, plans for creating the database
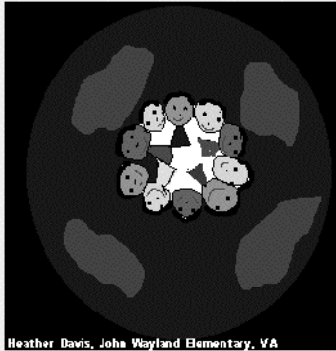
of observational data, and announcements of upcoming project-related events. An index of similar projects and content-related information on the Web is also provided.

3. Project Instructions

Web sites can provide specific instructions to telecollaborators on how to participate in the educational project.

I*EARN's well-organized Learning Circles global classroom projects (http://www. iearn.org/iearn/circles/lc-home.html), for example, are supported by a hypertextually linked set of carefully crafted and information-rich Web pages, which provide step-by-step instructions for project participation. As the following small section of the main page at this site shows, many active links to documents supporting each stage of project work are given.

The page also contains information on joining I*EARN, links to conferencing spaces in which project partners communicate, links to custom-designed Web page publication aids, and a chronologically organized timeline for the current session of Learning Circles telecollaboration.
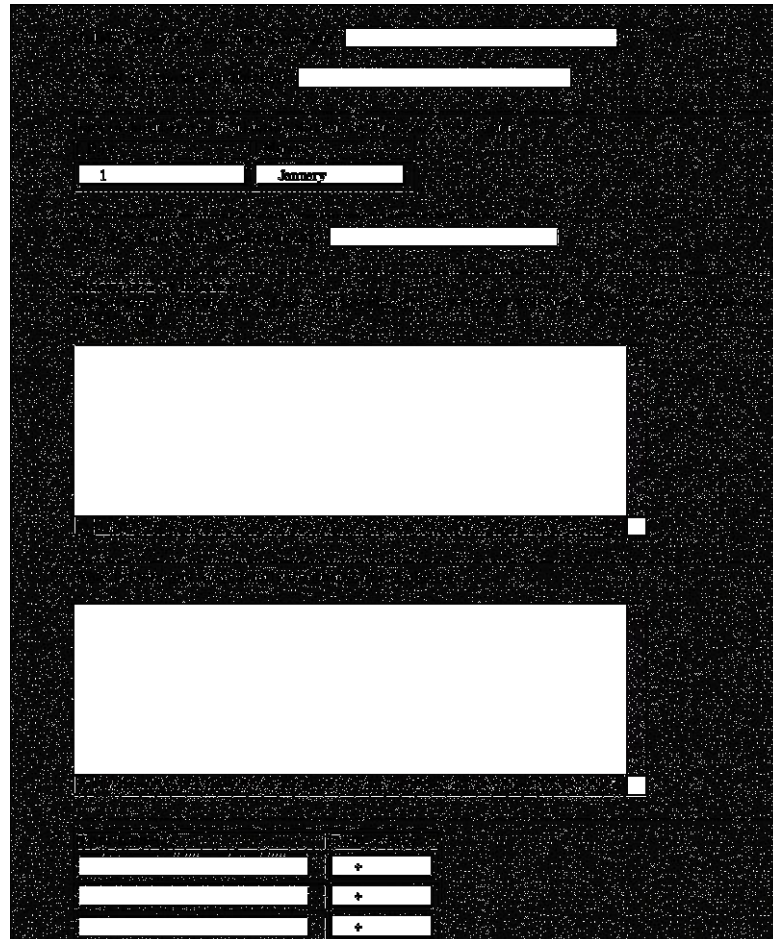
4. Information Repository and Exchange

Web sites can serve as virtual places for project participants to exchange information.

KIDLINK's long-term Multi-Cultural Calendar database-creation project site (http://www.kidlink.org/KIDPROJ/MCC/) cross-indexes student-written depictions of hundreds of holidays and festivals from around the world.

As the previous Web page shows, the holiday descriptions are accessible by month, holiday name, country, author, and user-supplied keywords. A Web-based form is also available at the site so that new entries for the holiday database can be submitted more easily. Here is a portion of the form:

5. Context for Project-Related Communication

Web pages can be co-constructed by project participants, creating an open-ended form of multimedia communication.

A few electronic teams in the Electronic Emissary telementoring project (http://www.tapr.org/emissary/), which "matches" volunteer subject matter experts with students and teachers interested in inquiry-based learning in the experts' specializations, have co-created Web pages to facilitate their virtual interactions. This is especially effective when pictures or diagrams need to be concurrently viewed, and can be supplemented by realtime audio and video interaction using CUSeeMe.

For example, a meteorologist working for the National Center for Atmospheric Research in Colorado helped a sixth-grade class in Texas learn about atmospheric science, in part by suggesting an experiment that required the assembly of a

device that would help students "measure radiative processes." The scientist posted a picture of the device on the shared Web page as a beginning to an ongoing multimedia discussion of the results that the planned experiment yielded.

6. Project Support

> Web sites can serve as organized collections of project-related resources.

CoVis' rich, well-organized site (http://www.covis.nwu.edu/) offers a plethora of materials participants can use as they explore geosciences in telementoring contexts, thus "learning through collaborative visualization."

The key to making project support sites maximally useful is to organize the materials offered for quick and efficient access. CoVis' main menu, shown in the following illustration, reflects the care and thought that project coordinators have put into the functionality of the project's Web site.

7. Project Chronology

> Web sites can present chronologies of past and ongoing project work.

The rich and varied nature of the Hobart–Malang Electronic Mail Project (http://anfi.pacit.tas.gov.au/fahan/Compute/indo.html) is excellently reflected in the project's detailed and visually appealing Web site, the first section of which is shown here:

This multiyear, multiclass, multifaceted, emergent keypals project involved Year Four students in Hobart, Australia, and Malang, Indonesia, who wanted to learn about each other's cultures, countries, and ways of life. Many topics were discussed, many sets of materials were exchanged, and many learning products were created in the course of the exchange. Much of this is available for perusal at the site, which is richly illustrated with the students' own works, photographs, project artifacts, and descriptive text. The incredible variety possible in this type of project is demonstrated by the following partial list of active links to project-related materials:
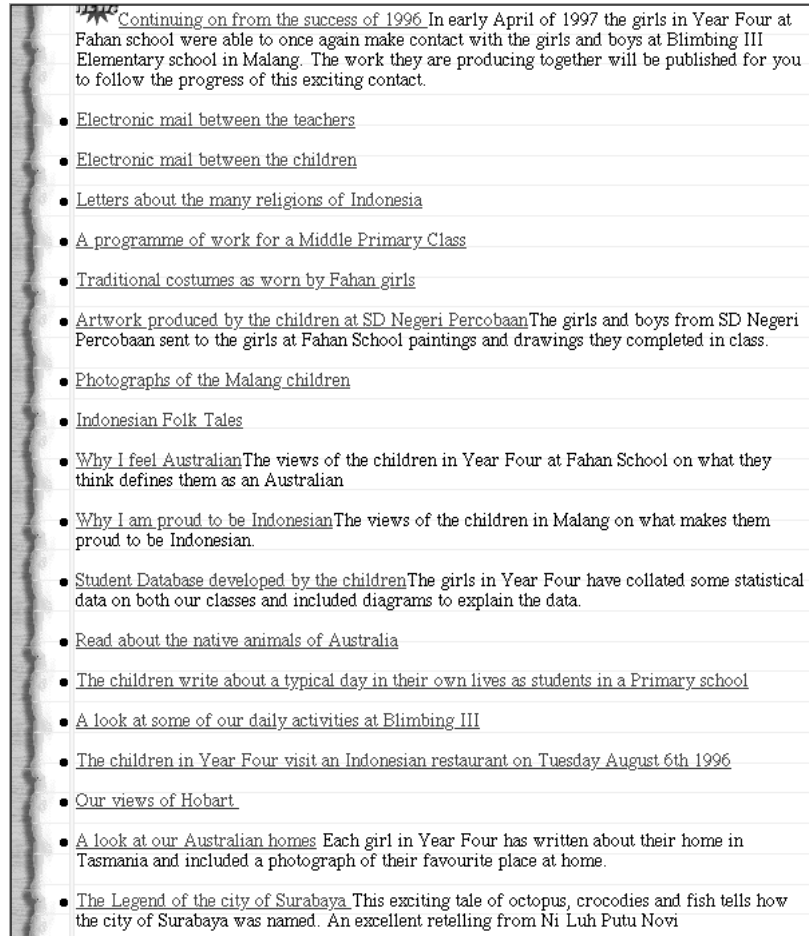
8. Showcase of Participants' Works

Web sites can provide viewing space to share project participants' creations.

Marian Herman's International Peace Museum (http://www.ih.k12.oh.us/ps/peace/) is a thematic project for K–3 students, inviting them to "think about peace and the importance of peace."

As the project's creator has said:

> *This Web project and the museum that it creates might actually be able to affect the future of the world in some small way. It's an exciting thought.*

(http://www.eduplace.com/projects/peacemuseum.html)

Participating students in different schools from around the world are asked to read books about peace, discuss the ideas they encounter in class, "decide what peace means to them," and then write a statement or poem and illustrate it. These creations are posted at the Peace Museum site in a creative and educational way. Contributions from other classes are organized into wings of the virtual museum:

In the North Wing, for example, are links to collections of peace works from other schools in the United States:
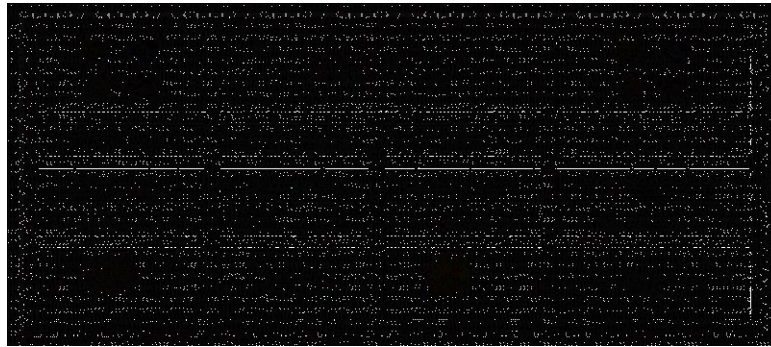
Students at the Manaugh School in Cortez, Colorado, for example, created a mural and poem that illustrates the potential power of thematically organized projects such as these:

We at Manaugh have a dream …

That Native American, Hispanic, Hawaiian, and Caucasian kids can all play together on the same monkey bars.

That all kids are treated equally.

That no one shall fight anymore.

That everyone can share friendship, harmony and peace.

Freedom is all that matters.

Mrs. Herrick's Reach Class, Cortez, Colorado

(http://www.ih.k12.oh.us/ps/peace/cortez/cortez.htm)

9. Project Center

Web sites can serve as multipurpose centers, combining several of the previously mentioned project-related functions.

The home page for Noelle Kreider's Read to Write Project (http://www.itdc.sbcss.
k12.ca.us/projects/kreider/index.html), an effort to inspire students to immerse
themselves in particular literary genres by reading, analyzing through discussion,
and creating and publishing that type of writing, shows a selection of current,
future, and past topics for exploration.

The Read to Write Web site demonstrates how engaging language, white space, and well-placed illustrations can be used to make a resource-rich project center quite easy to navigate. For example, the main page for the Historical Biographies section illustrates well how many of the page functions mentioned previously in this section can be combined to create an information-rich, facilitative, multipurpose "virtual center" for an educational telecomputing project.
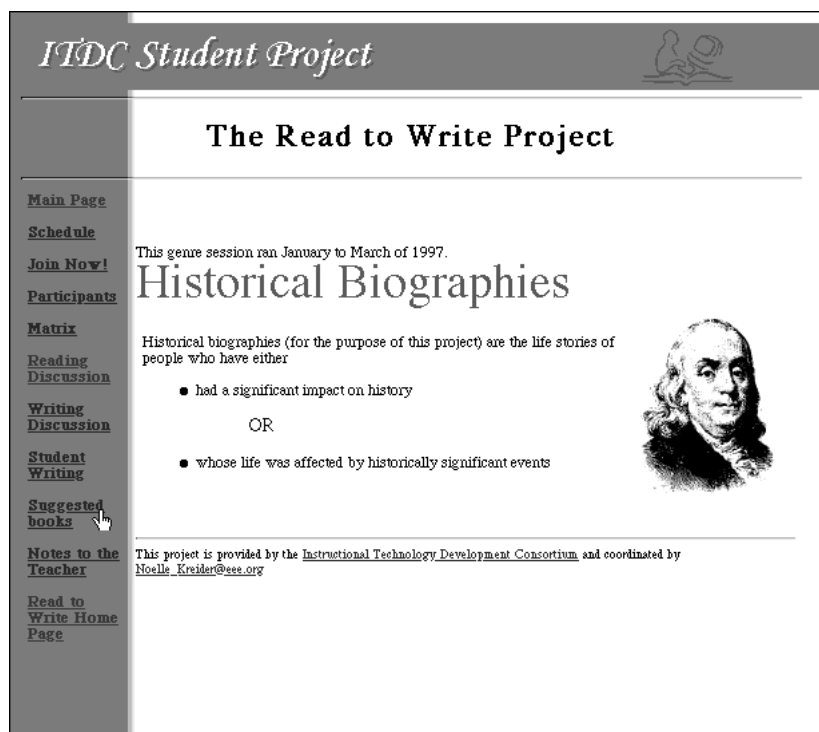
As you can see by the list of topics in the menu on the left, this project's schedule, participants, online discussions, student works, resources, registration, and instructional suggestions are easily accessible from this well-designed page.

10. Project-Spawning Service

Web sites can offer electronic services that can help initiate new curriculum-based telecomputing projects.

A growing number of services that help teachers and students locate information and interpersonal contacts with which they can begin new projects are now available on the Web. Notable among these are keypal and global classroom partner locators, including the following:

- Intercultural E-Mail Classroom Connections Service
  http://www.stolaf.edu/network/iecc/

- eMail Classroom Exchange
  http://www.iglou.com/xchange/ece/index.html

- Classroom Connect's Teacher Contact Database
  http://www.classroom.net/contact/

- Keypals International
  http://www.collegebound.com/keypals/

- Mighty Media's Keypals Club
  http://www.mightymedia.com/keypals/

- Dave's ESL E-Mail Connection
  http://www.pacificnet.net/~sperling/guestbook.html

- Virtual Handshake
  http://ananke.advanced.org/3174/
  (This service offers interpersonal connections in seven different
  languages: English, Spanish, French, German, Afrikaans, and both SJIS and
  rooma Japanese.)
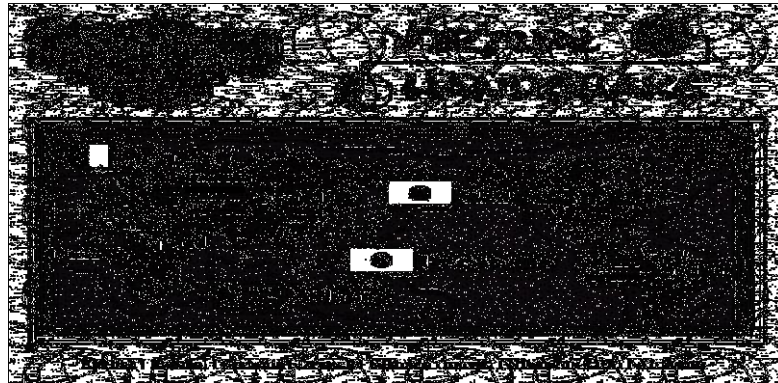
Additional correspondent locators are indexed on the Web pages supporting this
book (http://ccwf.cc.utexas.edu/~jbharris/Virtual-Architecture/).

Curriculum-based project planning tools are also beginning to appear online.
Notable among these is Pacific Bell's Filamentality (http://www.kn.pacbell.com/
wired/fil/), a well-executed instructional design tutorial that helps its users to
create WebQuest-like teleresearch sites to be used for instructional purposes. Its
witty creator explains Filamentality like this:

> *What Exactly Does this Filamentality Do?*
>
> *Maybe it doesn't slice, dice, or chop, but Filamentality does blend
> your learning goals with the outrageous resources available on the
> Web. How does Filamentality do it? By guiding you through the
> complete instructional design process. Okay, okay, we'll tell you in
> real English: Filamentality works its magic with online ideas to help
> you pick a topic (if your brain is drained), Mentality Tips for things
> like searching the Web, a bunch of "fill-in-the-blanks" to gather
> good Internet sites, and interactive pages that help you shape your
> ideas around whatever specific goal you have, and then, presto
> change-o, gives you your very own Web page on the Internet.*

Sound too good to be true? If so, why not go to Filamentality's site (http://www.kn.pacbell.com/wired/fil/) and check out the resources there for yourself?

The Next Next Larger Context—Purpose

Hopefully, the 10 Web site functions explained and illustrated in the previous section will help you allow function to drive form as you design Web pages to support current and future educational telecomputing projects. I would be remiss, however, if I did not urge us all to continue to follow the pattern of Eliel Saarinen's sage advice by considering function in terms of its next larger context: purpose. As Norbert Wiener has written:

> There is one quality more important than "know-how."... This is "know-what," by which we determine not only how to accomplish our purposes, but what our purposes are to be. (Tripp, 1970, p. 524)

In the context of educational activity design, the *next* next larger purpose always refers back to curriculum-based content and process goals. Telecomputing is not, and should not be treated as, another curriculum. Instead, it can serve existing and emerging teaching/learning goals in rich, authentic, and forward-thinking ways.

Details Make a Dramatic Difference

Granted, this chapter is filled with logistical details—the "nuts and bolts" that must accompany activity designs for creative visions to become educationally beneficial realities. Each in and of itself is rather unremarkable, and not necessarily context-altering. Yet these many procedures, like those that we use regularly in the bathroom to maintain personal hygiene and comfort, combine to create a rather dramatic effect. The necessity for careful attention to what initially may not seem to be crucial to the overall success of an educational project is clear. As Ogden Nash once rhymed,

> I test my bath before I sit,
> And I'm always moved to wonderment
> That what chills the finger not a bit
> Is so frigid upon the fundament. (Tripp, 1970, pp. 88–89)

5

Much of the time, energy, and effort that goes into designing and constructing a house is concentrated upon the *inside* of the structure because that is where most of us spend the majority of our time when at home. Yet architects must also plan for the house's exterior, considering its appearance, the land upon which it rests, and even the neighborhood in which it is situated. Homeowners must consider landscaping options and maintenance of the house's alfresco; in a way, this is how a home's inhabitants present their domicile to the world.

Similarly, curriculum-based telecomputing projects need to be designed and implemented with concurrent focus upon their relationships with the "next larger contexts," as we established in Chapter 4 for project-based Web pages. Specifically, let's focus upon three aspects of the "exteriors" of educational telecomputing projects:

1. How do these projects "interface" with the rest of the curriculum?

2. How can students' project-based work best be evaluated?

3. How can the efficacy of project designs be assessed?

Time and Space

Have you noticed that the only time it seems that there is a profusion of space in a house (or apartment, or classroom, or office) is when we first move in? Somehow, as the months pass, our roommates and possessions—or, perhaps, our expectations—multiply in such a way that we feel we need more space again. As teachers, we face a similar situation with the biggest challenge to powerful educational use of the Internet: *time*. Somehow, as the years pass, we realize that we must add more to what our students experience in our classrooms. Fortunately, Internet tools and resources are not (or, I should say, should not be) additions to our curricula; rather, they are (or should be) used as "instruments of construction" in curriculum-based learning. So, at least theoretically, once we have developed the skills prerequisite to using Internetworked tools and

resources effectively within the curriculum, going online as part of curriculum-based inquiry shouldn't take additional time or space.

Are some of you starting to smell snake oil after reading that last sentence? If you have used online facilities as part of your teaching already, does it seem that doing so took more, rather than less, time and energy? Part of this expenditure of these precious resources may have to do with developing technical expertise, arranging network access, and changing pedagogical approaches. Yet beyond that, it *does* seem that curriculum-based telecomputing projects take longer, doesn't it?

The reasons behind this relationship probably have more to do with the *types* of telecomputing projects that we see as "worth it" (as described in Chapter 1) in terms of time, effort, and resources needed. Although I know of no research results that have reported this discovery, talking with many telecomputing teachers and being involved in many curriculum-based projects myself has made me suspect that what we see as worthy projects are those that are more student-centered, active, problem-based, multimodal, holistic, and interdisciplinary. Planning for and implementing rich educational experiences that can be described in these ways requires more time, more energy, and more resources than traditional, didactic, unimodal teaching. Use of the Internet isn't really what occupies more time and space in our schedules. Teaching well does.

Yet having asserted that, the very real limitations of curricular crowding and time shortage still need to be addressed. Unfortunately, unlike a family that may be able to move to a larger house when its members perceive need for additional space, there's not much hope of any of us getting more space in our students' schedules. Might it be possible, then, for each student-centered, active, problem-based, multimodal, holistic, and interdisciplinary project to effectively *combine* curricular goals? And, while we're making combinations, how about if we consider combining activity structures also? Let's take a look at an example project to see how this is done.

Learning: The Next Generation

Students in grade 6 at the St. Elizabeth School in Ottawa, Ontario (http://www3. sympatico.ca/st.elizabeth1/index.htm), partnered with sixth-grade students from Burrville Elementary School in Washington, D.C. (http://www.wam.umd.edu/~lcjohn/cover.htm), with the assistance of their teachers (of course) and Canada's SchoolNet (http://www.schoolnet.ca/), to actively explore possible answers to the following questions:

- What will schools be like in the 21st century?

- How will students learn and teachers teach?

Their project, Learning: The Next Generation (http://home.on.rogers.wave.ca/eliza/learn/toc.htm), involved use of the Web, audio/videoconferencing, and e-mail. The project's Web site shows, though, that telecommunications tools were

clearly not the focus for the students' educational activity—their problem-based, collaborative learning was.
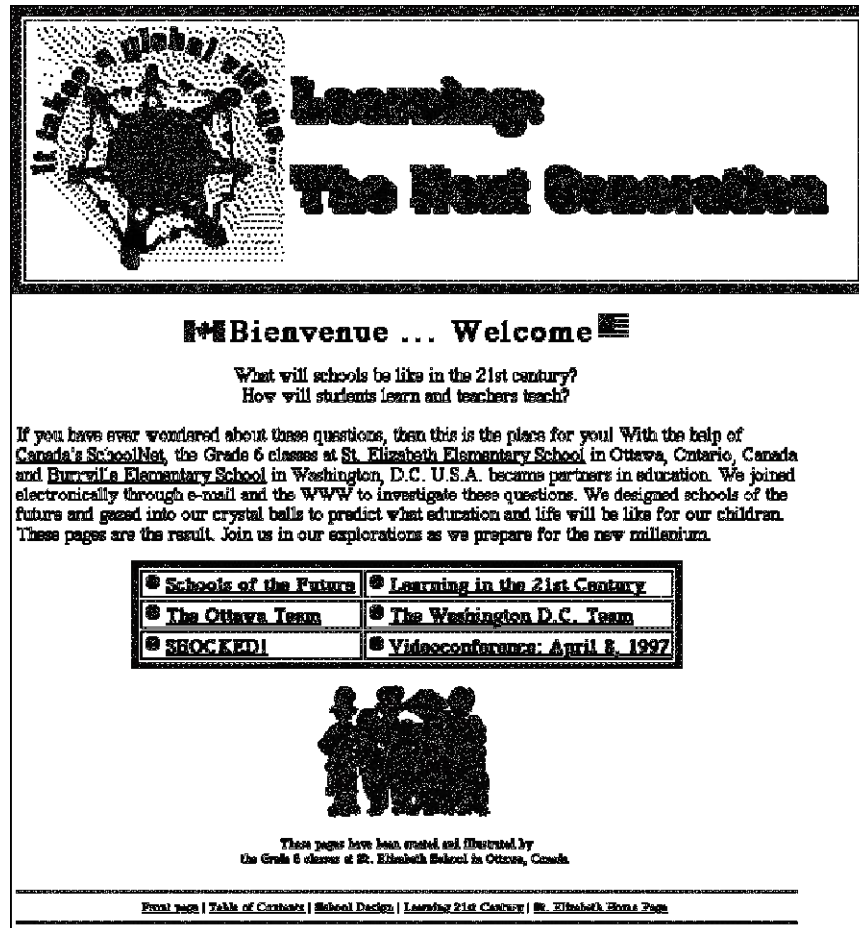
Each school's class/team introduced itself using a Web page of its own design. Each team's page displayed links, friendly invitations to the other group of students to send messages, links to other projects, and additional information about the team's school. Teams of students at each site then created and shared either architectural plans and accompanying explanations for their school in the 21st century (you were wondering why I chose this particular example for this book, perhaps? <grin>) or essays describing in detail what going to school in the next millennium will be like.

One of the "schools of the future," designed by Piotr, Daniel, Kyla, and Eve from Ottawa, is described this way by its architectural team:

> *Adventure School is a 21st century school designed for all elementary grades, right from kindergarten to grade 8. Going there will be an adventure both for the mind and for the body. While high tech will enhance learning for everyone from the tots in kindergarten to the preteens in grade 8, the school is designed to be a "total environment" school. "Total environment" means that this is a school that takes care of the mind, body, and spirit of the*

students and the community. When the school is not being used by the kids, it becomes a multi-purpose community centre opened to the public.

(http://home.on.rogers.wave.ca/eliza/learn/school1.htm)

The blueprints for Adventure Elementary School, which this talented team of designers created, look like this:
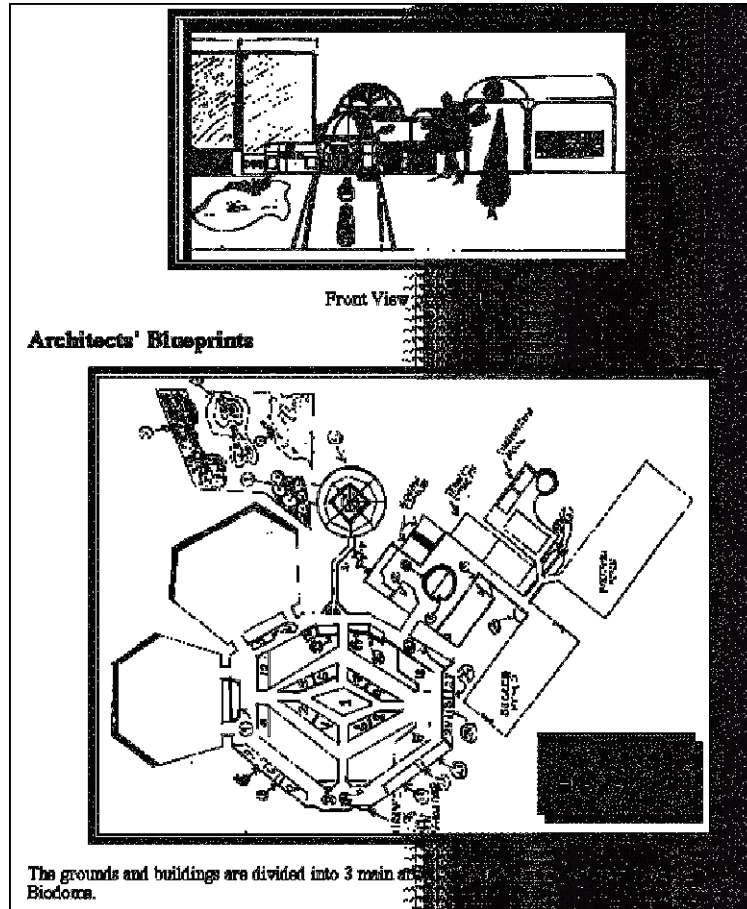
The School

Gone are the days of rectangular buildings that stretch[...]
is a one storey octogonal building with wheelchair acc[...]
here. The heart of the school is the Information Acces[...]
of the building and it is huge, about the size of a play[...]
everything and anything you want to do with informa[...]
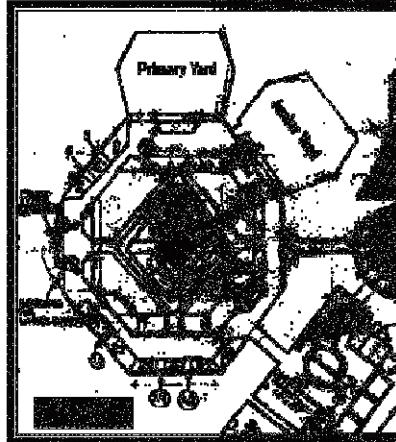
The classrooms are all networked and kids can acces[...]
through the wireless Internet that is available on ever[...]
needed to store the main computer servers, specialize[...]
and for learning new technologies. There are three co[...]
(Tech. 5), 2 multimedia studios (Tech. 6, 2), a Virtu[...]
gallery (Tech. 7), and a storage room (Tech. 3) mad[...]
still need to have the feel of real books in their hand[...]

The classrooms are located on the outside walls of the[...]
light and have easy access to the main library. There[...]
rooms to enjoy lunch (School 9, 10, 17, 18). There ar[...]
one for grades 4-8.

The Wellness Centre

There's a really cool universal sports venue in the so[...]
tennis courts, swimming pools, a soccer field, a footb[...]
rings (Gym 4), a fitness room (Gym 1), and two sets[...]
Students are required to participate in sport and fitne[...]
with high-tech instruments for monitoring the heart r[...]
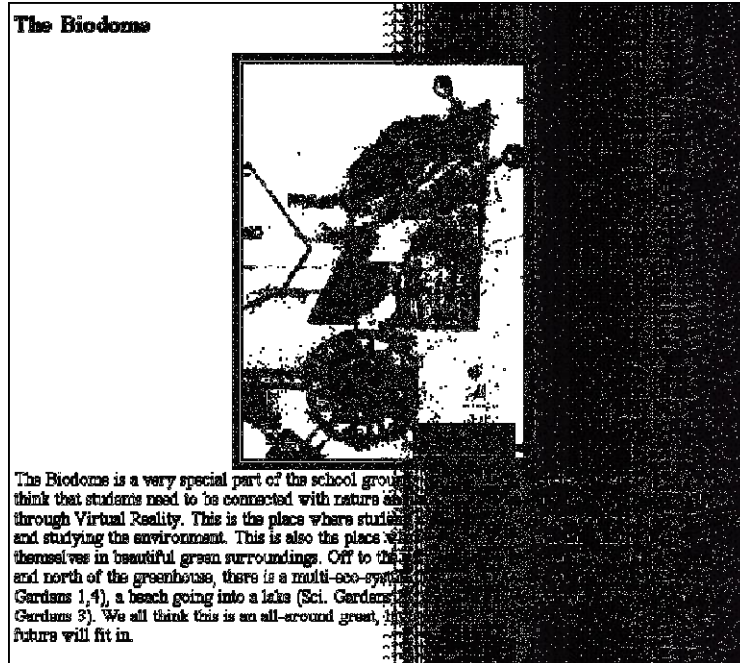
The project's Web site also documented a culminating activity for the two classes: an audio/videoconference in which, unbelievably, the First Ladies of both countries participated. The students used the teleconference link to share the results of their collaborative project with Mme. Chrétien and Ms. Clinton.

Thank You!
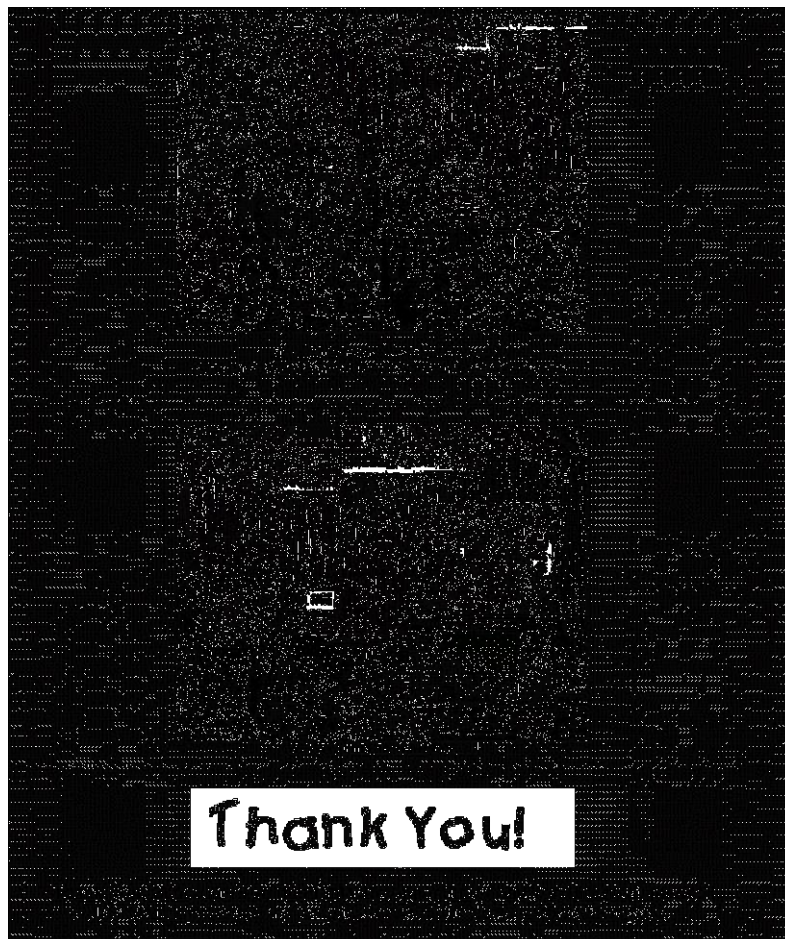
Exciting, eh? Yet, this was "way more" than "way cool," if we look at the telecollaboration from an educational standpoint.

Standards and Structures

What kinds of learning did the students in the two participating classes do in the context of this project? In terms of activity structures, it appears that the Next Generation students took part in global classroom, information exchange, parallel problem-solving, and electronic publishing activities. To answer the question in a more curriculum-focused way, let's combine it with a concern that may have been nagging you as you read the previous four chapters in this book. Have you been wondering how these projects can satisfy the local, district or board, state or province, and national educational standards for which you are responsible?

To inspire your own answer to this question, let's begin with a very helpful Web site that has been put online by folks in the public schools in Putnam Valley, New York. Their Developing Educational Standards Web site (http://putwest.boces. org/Standards.html) is "an annotated list of Internet sites with K–12 educational standards and curriculum frameworks documents." One of the many link sets on this excellently compiled, well-organized page leads us to John Kendall and Robert Marzano's Content Knowledge: A Compendium of Standards and

Benchmarks for K–12 Education (http://www.mcrel.org/standards-benchmarks/). In this helpful set of documents, the authors combine sets of standards published by many different professional organizations within each discipline (e.g., mathematics, science, history, language arts) into sets of general standards, with more specific skills and strategies enumerated and explained beneath each.

Let's take a look at Kendall and Marzano's 13 overarching learning standards categories for language arts to see which were represented in the Learning: The Next Generation project. The standards groups are:

1. *Demonstrates competence in the general skills and strategies of the writing process*

2. *Demonstrates competence in the stylistic and rhetorical aspects of writing*

3. *Writes with a command of the grammatical and mechanical conventions of composition*

4. *Effectively gathers and uses information for research purposes*

5. *Demonstrates competence in the general skills and strategies of the reading process*

6. *Demonstrates competence in general skills and strategies for reading literature*

7. *Demonstrates competence in the general skills and strategies for reading information*

8. *Demonstrates competence in applying the reading process to specific types of literary texts*

9. *Demonstrates competence in applying the reading process to specific types of informational texts*

10. *Demonstrates competence in using different information sources, including those of a technical nature, to accomplish specific tasks*

11. *Demonstrates competence in speaking and listening as tools for learning*

12. *Demonstrates an understanding of the nature and function of the English language*

13. *Demonstrates a familiarity with selected literary works of enduring quality*

(http://www.mcrel.org/standards-benchmarks/standardslib/langarts.html)

Please reread each standard, deciding whether there is a good chance that it was addressed as students were working on activities associated with Learning: The Next Generation. You might want to visit the project's Web site online first to help you construct a more complete understanding of what the students did. (Go ahead! I'll wait, just like in Chapter 1.)

How many standards did you think were addressed? My count was 10; all but #6, #8, and #13. Of course, as these students' teachers, we would need to dig deeper into the specifics of demonstrating competence for each of these standards, but hopefully the point is still adequately made. One student-centered, active, problem-based, multimodal, holistic, and interdisciplinary project can satisfy *many* educational goals at once. And, if you aren't yet convinced of the truth of that assertion, remember that the Next Generation project also addressed mathematical (geometry), problem-solving, geographical, and interpersonal educational standards.

Evaluation of Students' Learning

I am often asked how best to assess students' learning done in telecollaborative projects. Although my usual answer may sound impertinent at first, I mean it most courteously and seriously. Students' learning that is assisted with Internetworked tools and resources should be assessed in the same ways as learning with more traditional tools is. Although that may seem counter-intuitive at first glance, think about it for a minute. Is it the *tools* that determine the quality of the learning? Not to a great extent. What folks probably are questioning when they wonder about this aspect of using curriculum-based telecollaboration in classrooms is more about how student-centered, active, problem-based, multimodal, holistic, and interdisciplinary projects should be assessed rather than telecollaboration per se. Alas, *that* is a topic for another book <grin>, but most teachers with whom I have worked use alternative assessment techniques, such as multimedia portfolios, to do this.

There are four different forms of alternative assessment that can be employed to evaluate students' learning: performance-based assessment, authentic assessment, portfolio assessment, and journal assessment. Coordinators of the pH Factor Project (http://www.miamisci.org/ph/) at the Miami Museum of Science have provided a helpful page of definitions and science-related examples of each form, located online at http://www.miamisci.org/ph/lpdefine.html. Briefly, these types of alternative assessment are described as follows:

> *Performance-Based Assessment*
> *This assessment is based on teacher observations on a student's performance or samples of various performance's done by the student. A criterion such as a rubric scale is usually established before the observations are done.*

> *Authentic/Project Assessment*
> *This assessment measures the student's ability in "real life" tasks*

and situations. An extended form of assessment that may have aspects of performance based within it.

Portfolio Assessment
This is a "purposeful" collection of work that helps to define the student's efforts and achievements in specified area(s).

Journal Assessment
This is a student's ongoing record of expressions, experiences and reflections on a given topic.

(http://www.miamisci.org/ph/lpdefine.html)

The intersections of alternative assessment with multimedia tools began to be actively explored by educators in the early 1990s. The March 1994 issue of *The Computing Teacher* (Moursund, Best, & Bielefeldt, 1994), for example, described strategies, research results, and examples of technology-based assessment. Many of the articles in this special issue suggested the use of hypermedia authoring tools, database programs, video portfolios, specialized portfolio software, and then-cutting-edge CD-ROM recording devices to ease collecting, documenting, and reviewing students' work for authentic evaluative processes. Now, increasing numbers of educators are devising and refining ways to use Web pages, often published on intranets, to house and host students' portfolios. This facilitates additional community members' involvement in the portfolio review process, making it more of a public endeavor by including parents, peers, and multiple teachers.

Supplying Our Water Needs

Let's explore an example of how several of these types of and tools for alternative assessment are used in the context of Shelly Peretz's rich secondary-level Supplying Our Water Needs Project (http://www-ed.fnal.gov/help/peretz/ peretz_description.html), which she describes in the online Handbook of Engaged Learning Projects (http://www-ed.fnal.gov/help/cover.html):

Thornridge High School is using an approach to science that integrates learning strategies, math, social studies, and science. Dennis Condon, Gary Fryrear, Bill Meder, and Shelly Peretz share the same 40 students for two, 50-minute class periods. This gives the teachers the flexibility to meet with one group of students (20), one class period (50 minutes) every day or two class periods (100 minutes) every other day, within the confines of the traditional school schedule.

The science classroom has three Ethernet ports which allow teachers to move computers around on the same network. In addition, the network is connected to a router and an ISDN phone line, so the network is connected to the Internet at relatively high speeds. Each classroom also has a telephone.

At the beginning of the period, students in Ms. Peretz's ninth-grade Physical Science class at Thornridge High School in Dolton, Illinois, enter the science room and sit with other members of their team.

Students are challenged to determine the existence—using critical thinking and analysis—of a squawking, insect-like (number of legs undetermined), penguin-eating ice borer that is found only in the Antarctic. Given an article written for the April, 1995 edition of Discover Magazine *on the penguin-eating ice borer, the role of the students was to validate it.*

The class breaks into small groups to determine the existence (or not) of the ice borer, using investigative skills and active group learning concepts. As the teams go about their work, the teacher can be seen moving from group to group. She provides feedback and assistance and keeps track of noted problems and progress.

The conclusion? The ice borer was an April Fool's joke. The lesson was learned, however. Students use this "real-world" problem as a context to learn critical thinking and problem-solving skills, and acquire knowledge of the essential concepts of the course. Students work cooperatively in groups, seeking solutions to "real-world" problems by asking and answering their own and their peers' questions. Students acquire lifelong learning skills which include the ability to find and use appropriate learning resources.

Students were told it was important for their success in the course that they be able to apply the material we study in real life situations. The teacher asks students to spend a few minutes thinking about and jotting down responses in their journals to the question, "What are all of the ways that you use water in your daily lives?" She then asks the students to turn to a partner and discuss their responses. Each pair summarizes and shares their comments with the entire group. Several answers were given: drinking, washing dishes, flushing toilets, etc.

The project on water is expected to be a multiweek inquiry. The goal is to investigate the problem, as defined by the students, using a variety of tools. Students are assigned to base groups or teams, which are frequently reorganized based on interest, but all students return to their base group to share information and help each other fill in the information gaps. During the project, each team is responsible for developing a plan for conducting their research and for managing their plan.

The class was told they were to take on the role of different experts focusing on the fictional town of Riverwood and problems with its water supply. The teacher said that the instructors would try to make this problem as real as possible—both in real events, and in

real kind of data real investigations generate. The students were told that there was a need to suspend their disbelief that everything in the role is not true.

At that point, the teacher received a phone call from the principal. She sends two students down to her office to retrieve the package wrapped in brown paper. It was labeled "perishable," and had a return address from the mayor of the town of Riverwood. The package contained five dead, smelly fish.

As the teacher opens the package, the students begin talking to each other. The teacher reads the letter from the mayor, silently to herself. The students are asking questions about what is in the package and what the letter said. She shares the contents of the package, receiving an assortment of reactions ranging from groans to comments of, "that smells." She tells the students that the letter was a request for help from the mayor of Riverwood. Copies of newspaper articles on ("Fish Kill … ." and "Townspeople React. …") introduce students to a troubling water-quality problem in Riverwood, setting the stage for the major "story line" of the unit. Students will follow the progress of Riverwood citizens in dealing with this issue.

The room suddenly gets quieter as students start to read the articles. As they read, students start talking with one another about what they have read. The room is noisy, but it is productive noise. As the teams go about their work, the teacher can be seen moving from group to group. She provides feedback and assistance and keeps track of noted problems and progress.

The teacher asks students to identify what they now know about the cause of the fish kill and what they still need to know. As a class, students generate an initial know/need to know board from the documents that they have received so far. Student questions include:

- *Can we continue to obtain enough water to supply our needs?*

- *Can we get sufficiently pure water?*

- *How do everyday decisions affect the quality and quantity of our water supplies?*

- *How can chemistry help explain water's personal and societal importance?*

She then asks students how could they find answers to their questions. The teacher tries to anticipate student needs in order to provide the resources and experiences that are requested by the

students as the information is needed. She directs them without doing the work for them.

The next day, Chris and his team are using Netscape to search for information about water use on the World Wide Web using the Yahoo search engine. Another group is using a variety of CD-ROM disks that contain images and information. Another group is investigating properties of water in the lab. The teacher encourages the students to find out more, to go back to their sources and get substantiation.

Students decide that it might be something in the water that caused the fish kill and that it would be useful to find out what is in the water, so water samples are brought in to the classroom.

Appropriate technology is used to collect and analyze water data. Telecommunications is used to gather data and for collaborative research with experts and other students. The interaction that occurs among teachers and students face-to-face in the classroom is supplemented and extended by exchanges that occur among teachers, students, and subject matter experts via electronic mail.

One group of students is working with experts from the Illinois Water Survey and the Geological Survey via electronic mail. Chemistry students (grades 11–12) working at another school site are working on a similar problem. They work to solve the problem separately at their site, then share their problem-solving methods with the physical science students (grade 9) electronically via e-mail and/or conferencing.

Another student asks if the water can be cleaned up, so a group of students try to purify a sample of highly impure "foul" water to the point that it could be used to wash their hands.

Other students are using ClarisWorks spreadsheet to collect and analyze data on the large quantities of water used routinely in a home.

Some students have decided that they need to talk to Greg Cargill at the Metropolitan Sanitary District to find out what happens with our waste water. So they call him. They are also wondering if this is the same water that we drink. Greg assures them that our water comes from Lake Michigan and is not the same water that is discharged into the Illinois-Michigan Sanitary Canal.

Students are continually updating their know/need to know board as they gather and share more information. Students are challenging each other to back up their research with facts, not just opinions. Students develop concept maps to organize their

understanding of the problems related to "Supplying Our Water Needs."

Students are asked to write out a problem statement and then share it with a partner. As a class, students tentatively come up with a problem statement (often changes with the addition of new information):

How can we … come to a decision about preventing a reoccurrence of the fish kill affecting our water supply … in such a way that we address….

- *the cause of the fish kill.*

- *the large volumes of water released from the dam.*

- *operational or structural changes in the dam.*

- *loss of income resulting from the cancellation of the fishing tournament to:*

  - *merchants.*

  - *local churches and the high school planned family social activities as revenue makers.*

  - *adverse tournament publicity in future years.*

- *safety of Riverwood drinking water*

- *increasing levels of selenium*

- *cost to the Riverwood taxpayers for the water brought in during the water shutoff.*

At the end of each period, students are given time to reflect, in their individual learning logs, on what they have learned. Some log entries are "directed entries." Other entries are "non-directed," written when students feel the need to write because of something they have seen or heard or as a result of a discussion they have had with the class, friends, parents, or us.

An announcement is posted that the Riverwood Town Council is convening in one week to determine a solution to the problem. Students use a concept map to make their thinking visible and redefine their problem statement based on their additional information. Students make a list of all possible solutions generated and develop criteria to select the "best" solution to their problem.

Damarus, Jason, Jamaal and Amber, having selected the "best" solution to their problem based on their criteria selected, begin to prepare their presentation for the Town Council meeting using Microsoft PowerPoint. Michael and his group downloaded pictures

> *from the digital camera. They had checked out the digital camera last weekend to take pictures of Lake Michigan while on a tour boat.*
>
> *Student groups present their "best" solution to the Riverwood Town Council.*
>
> *After the Town Council meeting, the teachers debrief with the students on what they learned in terms of content, technology skills, and applications, as well as collaborative and problem-solving skills.*
>
> (http://www-ed.fnal.gov/help/peretz/peretz_scenario.html)

This excellent example shows us clearly how powerful student-centered, project-based learning can be. Please note that Ms. Peretz and her colleagues expressly linked their plans for this project to the National Science Education Standards (http://www.nap.edu/readingroom/books/nses/html/) and that five different types of alternative assessments were used to formatively and summatively document and analyze students' learning. These methods, created by the project's designers and supported by a wide variety of scoring rubrics adapted from the previously described CoVis Geosciences Project (http://www.covis.nwu.edu/globalWarming/rubrics/rubricOV.html), included a know/need to know board, search strategy logs, concept maps, thinking logs, and a final simulated town council meeting presentation. Each is summarized in the following online description at http://www-ed.fnal.gov/help/peretz/peretz_description.html.

Do you see how each type of formative and summative assessment of students' learning is congruent with their learning needs at different stages of project work, consistent with a rigorous inquiry-based approach to teaching and learning, and collaborative in nature? Do you also recognize how many different curriculum topics, thinking and problem-solving skills, computer-mediated tools,

and activity structures combine to form a student-centered, active, problem-based, multimodal, holistic, and interdisciplinary learning experience? I encourage you to explore this site more completely online to help you to more fully understand and appreciate its power as a multileveled example.

Also, if you are interested in investigating alternative assessment strategies in more depth, especially as they apply to curriculum-based telecommunications projects, the following Web sites should prove most helpful to your professional learning on this topic:

Alternative Assessment Instruments Bank
  gopher://pdx.nwrel.org/11/LNP/assessment

AskERIC InfoGuide: Portfolio Assessment
  http://ericir.syr.edu/cgi-bin/markup_infoguides/
  Alphabetical_List_of_InfoGuides/Portfolio_Assessment-5.96

The California Learning Record
  http://www.electriciti.com/~clrorg/public_html/clr.html

ERIC Clearinghouse on Assessment and Evaluation
  http://ericae2.educ.cua.edu/main.htm

National Center for Research on Evaluation, Standards, and Student Testing
  http://cresst96.cse.ucla.edu/index.htm

Pathways to School Improvement: Assessment
  http://www.ncrel.org/sdrs/areas/as0cont.htm

Assessment of Project Designs

The issue of assessing our *designs* for curriculum-based telecollaborative projects may also be of concern to you. Yet, I will ask you to ask yourself the following question. Referring back to Chapter 1, if we are sure that what our students will be doing in a particular project is what they need to do, presented in a way that is motivating to them, and is something that they either couldn't do without telecomputing tools or couldn't do as well, then how, if at all, should our self-assessment of our instructional design be any different for a telecollaborative project than for any other student-centered, active, problem-based, multimodal, holistic, and interdisciplinary learning experience?

As a matter of fact, I have asked many different groups of teachers throughout the United States and Canada to determine, as a group, what the characteristics of powerful educational activities are, whether the activities incorporate the use of the Internet, or whether computers in general are used in the activities. During workshops I have taught over the past two years, I asked each class to divide into groups of five to eight members each and share with each other overviews of one of their favorite student-centered, active learning experiences. After everyone in the group shared a summary of this favorite educational activity, I asked the groups to brainstorm a list of the attributes of powerful educational activities,

using the examples offered by their teammates as inspiration. We then combined the attributes from all of the groups into a common list, identifying the themes undergirding it. Here, for example, is a list of characteristics generated by a group of teachers participating in a symposium at McGill University in Quebec:

Attributes of Powerful Educational Activities

1. student-centered
2. authentic
3. builds independent thinking skills
4. creative
5. students have significant ownership
6. collaborative
7. open-ended
8. self-assessment is incorporated
9. students learn from other students
10. intrinsically motivated
11. addresses differences
12. interdisciplinary
13. inclusive
14. process-oriented
15. fun
16. instant feedback
17. learning is interactive
18. active participation
19. nonthreatening
20. up-close and personal
21. challenging
22. meaningful
23. community involvement (local and global)
24. teacher isn't directing; facilitating instead
25. incorporates critical thinking

26. metacognition is involved

27. geographically dispersed

28. "messy" learning

29. communication skills are developed

Here's another list, developed by a group of educators at a statewide conference in Iowa:

Attributes of Powerful Educational Activities

1. freedom of inquiry

2. exhibited to the world/audience

3. problem-solving

4. active involvement

5. higher-level thinking

6. students finding own resources

7. students making connections

8. real-life

9. collaborative

10. independence in learning is encouraged and demonstrated

11. interdisciplinary

12. multiple solutions to problems are incorporated into the design

13. students given options for assignments

14. multiple intelligences are exercised

15. fun

16. meaningful

What kinds of overall patterns do teachers see in these lists of characteristics? A group of teachers in Honolulu, Hawaii, offered these ideas with reference to the attributes that their groups named:

Themes

◆ conflict/resolution; problem-solving; challenge resolution; tension/release

◆ student-driven or student-generated; teacher-guided; teacher-facilitated; teacher-generated but student-driven; student as worker, teacher as coach

◆ engaged learner; students and teachers enjoy what they're doing

- creative

- communication

- risk-taking

- decision-making

- student takes responsibility for preparation

- use of prior experience in present learning

- cooperation/collaboration

These all sound familiar, don't they? Isn't it amazing how much agreement there seems to be in what constitutes a powerful student-centered learning experience, especially considering all of the very different ideas that we seem to have about teaching and learning?

My suggestion is simple. Do the "powerful attributes" exercise yourself, or with a group of colleagues, if you'd like. Create your own collection of attributes and use it as a checklist when you review your plan for a new project or activity. Try to incorporate as many characteristics on the list as possible into each design, understanding that no one endeavor can be described with them all. Then, as the project progresses, and certainly when it is complete, sit down with your questions, memories, notes, and colleagues, reviewing and refining the characteristics list, noting what to revise in your plans for the later stages of the current project and what to change in the next activity you design and direct.

There's nothing unique about these suggestions, of course. You already *know* what good teaching and learning look like, sound like, and feel like. And yet, as reflective practitioners, all of us need to build learning activities in ways that remind ourselves of what we already know, and what we continue to discover at ever-deepening levels. For, as Nietzsche wrote more than a century ago,

> When one has finished building one's house, one suddenly realizes that in the process one has learned something that one really needed to know in the worst way—before one began. (Tripp, 1970, p. 198)

It is only (metaphorically) in the *building* of the house that we discover our lessons, and therefore the need for continual redesign. In the art and craft of teaching/learning, our houses are never complete, but we relish the creative excitement of inhabiting and transforming them in the midst of the remodeling.
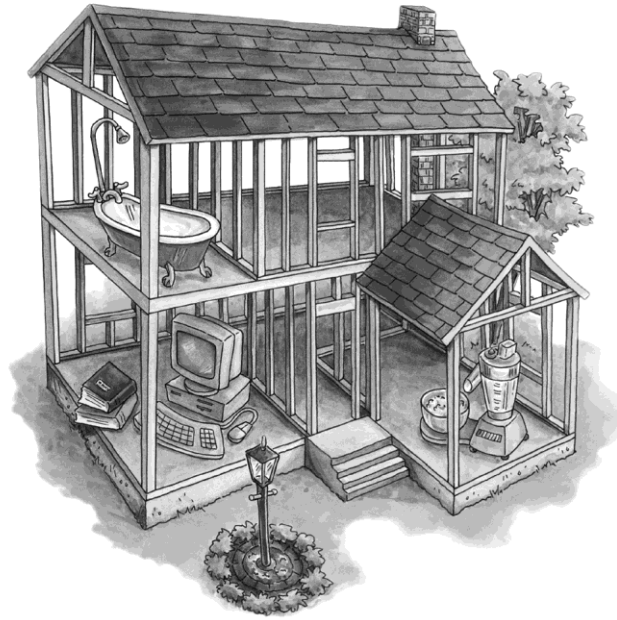
A Short Glossary of Telecomputing Terms

account holder
A person who has access to Internet services through a unique user name located on an Internet server somewhere in the world.

activity structure
A flexible framework that can be used in combination with other activity structures in the design of educational projects. Each individual activity structure is applicable in designs for learning in any content area and most ability levels. See "wetware."

asynchronous
Not simultaneous in time, such as the communication that occurs when folks send and receive e-mail messages or post items to public discussion groups on the Internet.

browser
A piece of software that makes it possible for users to access information and services on the Internet, specifically using the organizational structure called the World Wide Web. See "World Wide Web."

chats
Realtime (synchronous) communication that occurs online. Can be text-based or audio/video.

connectivity
Having the hardware, software, and wiring in place to support the use of Internet tools and resources.

CU-SeeMe
A free piece of software, written by folks at Cornell University, that allows Internet users with high-speed online service (56 kilobits per second or higher) to see and hear each other. Requires use of a digital camera, such as the Connectix QuickCam.

cyberspace
The collection of interconnected virtual "places" that are created when Internet resources and services are made available and used.

electronic mail
An Internet-based tool that allows account holders to communicate with each other by sending and receiving private and/or public messages.

gopher
The World Wide Web's predecessor. Gophers are hierarchically organized menus of information that run on larger servers, allowing users to locate specific information without having to know its exact location.

host
A larger-capacity computer connected to the Internet that is specially configured so that it can offer information (in the forms of World Wide Web pages, files, and other formats) and (in many cases) personal accounts to Internet users.

hypertext
Multimedia materials, including text, that are linked to each other in a nonlinear way so that users can "jump" from one piece of information to another without having to follow a predetermined sequence.

Internet
The worldwide collection of interconnected information networks that allow computer users to share information with each other in different forms. The Internet is part of the Global Matrix. It is possible to have a user account on the Matrix without having full access to the Internet's resources. In these cases, users would be able to use, for example, electronic mail and World Wide Web browsers but not be able to directly download files.

Internet Relay Chat (IRC)
A program supported on several large Internet servers that allows users from all over the world to "talk" with each other by typing. When someone uses IRC, they select "channels" on which to communicate. Whoever is on the same channel at the same time can chat by typing.

information network
A collection of computer hardware interconnected by wires and/or other types of wireless connections and distributed over a large geographic area. This network, through use of software, makes information of many different types available to users.

links
Those elements on World Wide Web pages that allow users to "travel" electronically to other places on the Internet that are related to what is currently being displayed on the page. See "hypertext."

listserv
Technically, this is a piece of software that runs on a larger-capacity computer connected to the Internet. It allows single messages to be copied and distributed to many different e-mail addresses. Although there are other such programs (such as majordomo), "listserv" has come to be used as the generic word.

newsgroups
Virtual, public places in cyberspace in which users can engage in asynchronous public discussions. Newsgroups can be available Internet-wide, but most that teachers and students use are set up for local or regional clientele.

online
The state of currently using Internet tools or resources of any type.

realtime
Simultaneous in time, such as the kind of communication that use of IRC or CU-SeeMe allows. "Realtime" and "synchronous" are synonyms, but "realtime" is the more commonly used term.

search engine
A program available on the World Wide Web that allows users to locate specific information without having to browse to find it or without knowing the World Wide Web page address on which the information is located.

server
See "host." More often, servers offer personal account services to users. In some communications circles, "host" is the more general term.

synchronous
Occurring simultaneously in time. See "realtime."

tele-
A prefix meaning "at a distance." Therefore, "telecommunications" means "communications done at a distance."

telecollaboration
Using a computer connected to a telecommunications network, like the Internet, to collaborate with others at a distance.

telecomputing
Using a computer to do telecommunications.

teleresearch
Using a computer connected to a telecommunications network, like the Internet, to do research at a distance.

URL
Uniform Resource Locator; a unique address for a collection of information on the Internet. URLs are often referred to as "Web addresses," differentiated from electronic mail addresses. URLs can refer to WWW pages, Gophers, file archives, newsgroups, and interactively accessible resources, such as online databases.

video conferences

Realtime communications among two or more locations that occur online using video and audio rather than text. See "CU-SeeMe."

wetware

A thinking tool, differentiated from hardware tools and software tools. Activity structures are examples of wetware.

World Wide Web

An easy-to-use way of organizing access to information and displaying it in many forms (e.g., text, still pictures, video clips, audio files) on the Internet. Abbreviated as "Web" or "WWW." See "browser."

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