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# Education and Technology

An Encyclopedia



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These questions led to the design of the Visible Knowledge Project, a five-year project that seeks to deepen these inquiries through a focus on student learning. Using national networks of institutions and faculty involved in Crossroads and related projects, the Visible Knowledge Project provides for faculty to engage in course innovations involving technology, examine the evidence of student learning as a result of those innovations, and plan for further pedagogical change. Building off Crossroads, the Visible Knowledge Project site includes resources such as an online glossary, online project posters, and a set of tools to facilitate local discussions around technology and pedagogy. In addition to the Visible Knowledge Project, the Crossroads Online Institute continues the emphasis on helping faculty work through complex questions by providing an online faculty development seminar focused on the design of online or hybrid learning modules. The modules will be placed in a digital library along with faculty reflections and evidence of student learning.

Michael Coventry

**See also** *Who Built America?*

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### CSILE/Knowledge Forum®

The origins of CSILE (Computer Supported Intentional Learning Environments) are in research on knowledge-building, on the nature of expertise, and on the sociocultural dynamics of innovation. CSILE was designed to (1) make advanced knowledge processes accessible to all participants, including children; (2) foster the creation and continual improvement of public artifacts or *community knowledge* (Scardamalia



2002); and (3) provide a community space for carrying out this knowledge-building work collaboratively. It has evolved to the second-generation knowledge-building environment, known as Knowledge Forum.

The term "knowledge-building" (as a definable educational enterprise) originated with CSILE and accompanying scholarly works and represents an integrated framework for knowledge-building pedagogies, practices, and environments (Bereiter 2002; Bereiter and Scardamalia, 1989, 1993; Scardamalia et al. 1989; Scardamalia 2002). CSILE was first prototyped in a university course in 1983. By 1986 a fully functioning networked version was in daily use in an elementary school. In 1995 it was reengineered, with its affordances for knowledge building substantially enhanced, and published as Knowledge Forum ([www.knowledgeforum.com](http://www.knowledgeforum.com)) by Learning in Motion. Currently in version 4, with version 5 under development, Knowledge Forum continues to evolve in response to research findings and new opportunities. Thus, for example, while CSILE was built prior to the World Wide Web, Knowledge Forum now offers browser as well as client versions that can link Knowledge Forum classrooms to one another via the Internet. Current developments are taking advantage of the potential of wireless technologies to allow synchronization of online and offline knowledge-building. Knowledge Forum is used in education (grade 1 to graduate), health care, community, and business contexts in the Americas, Asia, Australia, Europe, and New Zealand. Knowledge Forum's cross-sector, cross-age, cross-cultural framework reflects the theoretical idea that the socio-cognitive and cultural processes underlying knowledge acquisition and knowledge creation are fundamentally the same (cf. Piaget 1971; Popper and Eccles 1977) and so must apply to knowledge-builders of all sectors, ages, and cultures.

From the earliest days of educational computing, leadership was defined through model-school projects that demonstrate what classrooms enhanced with information and communication technology should look like. Typically, these classrooms exemplify discriminating consumership and creative use of off-the-shelf technology. Creating model-school projects was the idea behind the Apple Classrooms of Tomorrow program (Dwyer 1993). However, Apple's first venture into advanced educational software (Bowen 1990) did not come out of their model classrooms. It came from CSILE, which Apple released in 1993 under the name Collaborative Learning Product. Apple's press release announced:

#### APPLE INTRODUCES GROUND-BREAKING PRODUCT . . .

During a meeting of key education press at Apple headquarters today, the company introduced . . . Collaborative Learning Product, an integrated, research-based product and the first collaborative learning offering available for the K-12 education market.

Apple distributed the product via e-mail, citing its importance in education, its role in helping students identify and develop the necessary skills for the future, and the following skills: "the ability to learn a variety of things, to solve problems, and to evaluate information."

As the Apple press release noted, "of educational technology, the challenges of the future are to make learning more productive and personally designed. Knowledge Forum is a tool; it was a result of research, and a result of the efforts of organizations and individuals. However, Knowledge Forum has been in use for the years based on the communities of practice. Knowledge Forum uses advanced knowledge-building techniques."

The heart of Knowledge Forum is a working model of a shared space for the creation of knowledge. It is made of objects that change over time and are subject to search and advancement.

#### Multiple Perspectives

User-created content is conceptually rich and diverse. As an organization, it is the same group of people.

The notes are contributed by the organization. The notes are organized by who had the notes and the general student.



Apple distinguished this product from bulletin-board services and e-mail, citing its affordances for inquiry-based work and knowledge construction, its basis in research, and its ability to address the skill requirements identified by a U.S. Department of Labor commission on achieving necessary skills for the workplace of the twenty-first century. It cited the following skills: "the ability to organize resources, to work with others, to learn a variety of technologies, as well as the ability to acquire, understand, and evaluate information."

As the Apple press release claimed, CSILE represented a new generation of educational technology that specifically addressed the educational challenges of the twenty-first century. CSILE was not management, planning, or productivity software retooled for children; it was technology specifically designed to support knowledge creation. It was not a collection of tools; it was an environment to support the kinds of inquiry, information search, and creative work with ideas that go on in knowledge-building organizations of all kinds. There have since been a number of experimental efforts to construct knowledge-building tools and environments. However, Knowledge Forum is the only product continuously improved over the years based on research results arising from active and diverse user communities and reflecting knowledge-building theory, principles, and practices. Knowledge Forum development is not driven by technology but uses advances in technology to continually enhance and unfold the knowledge-building agenda.

The heart of CSILE/Knowledge Forum is a multimedia community knowledge space. In the form of notes, participants contribute theories, working models, plans, evidence, reference material, and so forth to this shared space. The software provides knowledge-building supports in the creation of these notes as well as in the ways they are displayed, linked, and made objects of further work. Revisions, elaborations, and reorganizations over time provide a record of group advances, like the accumulation of research advances in a scholarly discipline.

### **Multiple Perspectives, Multiple Literacies, and Teamwork**

User-created graphical views constitute a higher level of organization and conceptually useful workspaces. A given note may appear in multiple views. As an example, four views provide different ways of conceptualizing the same group of notes.

The notes, represented by small icons, are produced by grade 1–3 students contributing information and graphics concerning their favorite dinosaurs. The notes appear on a blank white background, and show no particular organization. However, from the note titles children discovered classmates who had the same favorite dinosaur (triceratops, brontosaurus, etc.). Several students had produced graphic rather than text notes, and others



wanted to link their notes to these graphics. So students added these graphics to the background of a new “dino types” view. Knowledge Forum’s keyword searches were used to collect all relevant notes (e.g., all notes with the keyword “triceratops”) and move them to the appropriate picture. The result was a new view. At about the same time, students in a university course were provided with access rights to this grade 1–3 dinosaur knowledge space. The university students noted, in reading these same notes, that they contained references to geological time. The university students created a new “geological time” view and entered a geological-timeline graphic from the Internet as a background. Student notes were searched again, now for periods of time (e.g., Jurassic), and the new collection was added at the appropriate point to the geological timeline. Students who had not yet identified the time when their dinosaur roamed the earth quickly extended their research so their note would appear in this new view. There was yet another sequence with these same notes. A biologist was invited to join the knowledge-building collaborative efforts. She signed in from afar and created the “food chain” view that referenced students’ dinosaurs as plant or meat eaters. The work illustrates the following knowledge-building affordances:

- Notes and views support teamwork and collaborative design. Notes are multimedia objects that can be coauthored. View backgrounds are not simply white backdrops or static bulletin boards (although they can be used that way); they are collaborative design environments with a built-in graphics program that makes it easy for users to design their own backgrounds.
- Views provide different perspectives on information. As the work of the biologist presented suggests, this networked technology is used to expand perspectives rather than to solidify roles in which students ask questions and experts answer them.
- Multimedia and other supports provide a way in for all participants to a common discourse. Notes and views support a range of multimedia objects, from text to video. As an example, some of these grade 1 students were not writers at the beginning of the year but did represent their ideas graphically. Easy assignment of keywords (touching a word in a note with a movable key icon is all it takes) made it possible for these young students to keyword their notes. These notes were then available, via keyword searches, for incorporation into new conceptual views.
- Notes and views can be individually or group authored. They can also be entered into private or public spaces; the default option is that they are contributed to a public forum. Accordingly,

- Emergent boundaries represents collective input from within the emergent

## Creating Connections

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- *Flexible browser*—allows that a built-in browser rearrange content into concepts and contrasts in threaded Internet, a WebCT® linking identified content, entrap identified full range of forms are processed slowly page tech

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the environment encourages openness in knowledge work while enhancing both individual and group processes.

- Emergent ideas and goals are supported. Knowledge Forum represents an open environment, without predetermined boundaries or structures around ideas or activities. Through collective responsibility for public knowledge spaces, with input from varied sources of expertise, the environment favors the emergence of big ideas and deep principles.

### **Creating Connections and Public Knowledge**

Notes are situated in build-on structures that result in visible links to parent notes, with both notes and links modifiable.

- *Flexible build-ons:* The first five panes show the varied forms that a build-on structure can take. The note complex has been rearranged a number of times to give greater meaning to the concepts of frequency and amplitude. This flexibility can be contrasted with the downward branching of these same notes in threaded discourse. Threaded discourse now dominates the Internet, despite the fact that in many ways it defeats knowledge-building. Thus, for example, popular applications such as WebCT® and Blackboard® were built without supports for linking ideas across threads or for placing them in new and varied contexts. Linear discourse forms and isolated “conferences” entrap ideas. Knowledge Forum’s client version supports the full range of connections elaborated below; these more varied forms are being incorporated into the browser version (a process slowed by the limited interactivity allowed by current webpage technology).

Idea connectedness is further facilitated through the following means:

- *Annotation, citation, and reference links:* Annotations and reference links can be added to any note. References include pointers back to source notes, so ideas can be viewed in both original and new contexts. Links to views and subviews can be embedded within either notes or views. Deep embedding of ideas facilitates deep processing of information.
- *Interconnected views:* Views can be interlinked: Views reference other views, and different levels of access to views can be used to indicate the centrality or distance of particular views to the current work of the community.



- *Multifaceted indices:* Author-assigned indices (keywords, scaffolds, problem fields, titles) and automatically assigned indices (author, date, semantic field) make notes available through a variety of search parameters; a note-sorter allows the notes resulting from a search to be sorted for viewing or transported into another view. Citation, commentary, and notification enhance engagement by drawing all relevant authors back into the discourses that involve their ideas.

### Advanced Knowledge Processes

Software typically includes palettes for text, graphics, and other productions. CSILE/Knowledge Forum introduced palettes for high-level knowledge processes.

*Scaffolding knowledge processes.* Scaffold supports are Knowledge Forum's most imitated feature. They were originally designed to provide procedural facilitation (Scardamalia and Bereiter 1983) for fostering expertise in writing and were titled "thinking types." Others refer to them as prompts and have used them to serve purposes similar to templates or fill-in-the-blanks forms. Knowledge Forum scaffolds can serve these purposes, but the following uses represent the real goals underlying their design:

- Scaffolds give ideas defined roles in such processes as theory refinement (e.g., "This theory cannot explain . . .") and constructive criticism. The opportunistic rather than mandated use of scaffold supports helps students embed these forms of discourse in their everyday work with ideas; "forms of discourse become forms of thinking" (Pontecorvo 1993, 191).
- The supports contained within any particular scaffold can be used opportunistically and flexibly in any order. Once selected, the term is entered into the main body of the text, at the point assigned by the author. The scaffold support then additionally serves as a searchable parameter. Scaffolds can be yoked to views, so different discourse forms can be encouraged in different views. It is also easy to toggle between scaffolds, so that multiple scaffolds can be used within any view or hidden when not wanted.
- Scaffolds are customizable. They can be easily added or modified to support the discourse needs of a particular community.

*Reference and contribute.* Knowledge Forum replaces the common "say it in your own words" norm with the more mature "contribute-and-

reference" norm (distinct), with compilation of ideas because they serve

*Problems of* encourages a shift in the forum's "problem" understanding to the problems of the problem space

**Rise-Above and** "Rise-above" based on the positive way of dealing with a winner or a co-serves the value of compatibilities. In distillation; in idea that all the ideas.

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reference" norm. Cited material is automatically quoted (made visually distinct), with automatic links back to original sources and automatic compilation of a bibliography. Users are especially drawn to this feature, because they see their work referenced rather than copied.

*Problems of understanding.* A problem field at the header of the note encourages a shift from topic- to problem-based inquiry. Knowledge Forum's "problem space" encourages the identification of problems of understanding to guide inquiry. "Problem" searches produce an overview of the problems that others are working on, so it is easy to contribute to those problem spaces or start a new field of inquiry.

### **Rise-Above and Improvable Ideas**

"Rise-above" notes play a pivotal role in idea improvement. The idea, based on the philosophical concept of dialectic, is that the most constructive way of dealing with divergent or opposing ideas is not to decide on a winner or a compromise position but rather to create a new idea that preserves the value of the competing ideas while "rising above" their incompatibilities. In the simplest cases a rise-above may be simply a summary or distillation; in the most compelling cases, the rise-above presents a new idea that all the participants can recognize as an advance over their previous ideas.

A student's high-level summary of knowledge advances over a period of several months. This student packaged the set of notes that led to the discovery reported here; his older notes are now accessible only through this rise-above note. Rise-above notes are also used to synthesize ideas, create historical accounts and archives, reduce redundancy, and in other ways impose order on ideas.

The rise-above idea can be applied to views rather than notes. The linked views (e.g., eye, circulation) were created first, and this higher-order "human body" view then served to integrate these separate views and to support a new discourse on how different parts of the body work together. As this suggests, notes and views operate as a form of zoom in/zoom out, encouraging users to think in terms of relationships.

Endless improvability of ideas is further supported by the following:

- Ability to create increasingly high-order conceptual frameworks. It is always possible to reformulate problems at more complex levels, create a rise-above note that encompasses previous rise-above notes, or create a more inclusive view-of-views.
- Review and revision. Notes and views can be revised at any time, unlike most discussion environments that disallow changes after a note is posted.



- Published notes and views. Processes of peer review and new forms of publication engage students in group editorial processes. Published works appear in a different visual form, and searches can be restricted to the published layer of a database.

### **Individual and Group Portfolios: Evolution of Ideas**

The entries in a database, taken collectively, provide process accounts of the contributions of each participant, as well as accounts of how those different inputs were combined to lead to the collective achievements of the group. Portfolios are simply new views created by an author, a group, or a class to highlight different aspects of this work. The evolution of ideas can be studied through searches and analytic tools. Thus, for example, the work that led to a new theory can be analyzed. Additionally, the process of constructing portfolios affords deeper student reflection about their own knowledge and puts self- and peer-assessment into evaluative accounts of student learning.

### **Ideas and Artifacts as Objects of Discourse**

Anything that can be represented digitally can be transformed into an object of discourse, with the full range of knowledge-building activities applicable. There are four different objects, along with transparent overlays, markup, and build-ons.

### **Embedded and Transformative Assessment**

Knowledge-builders monitor their work and engage in self-assessment rather than being totally dependent on external evaluations. Individual and group portfolios help this process. Research tools work in the background of Knowledge Forum to automatically record activity patterns such as reading, building-on, referencing, and creating views. Results from these analytic tools can then be fed back into the work as it proceeds, rather than waiting until the end of a unit of work to provide feedback, when it is too late to make adjustments.

### **The Knowledge Society Network and the Virtual Suite of Possibilities**

Through Knowledge Forum's flexible database access and linking structures, knowledge-building discourse may be confined to a single classroom or distributed across the world. As this suggests, the work of local communities can be enhanced through the worldwide network of communities using Knowledge Forum. Sophisticated semantic analysis tools can be used for matchmaking (locating groups working in similar semantic fields) and common problems. Searches of the Knowledge Society Network access the published layers of all the Knowledge Forum databases linked to the worldwide network, with these published layers operating, in

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### **Toward a Know**

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effect, as websites. Thus the work of a local community "rises up" to become an object of discourse within an extended discourse community. Adults frequently find that the work of even the youngest students helps them advance their own understanding—even if only their understanding of how students think.

There are virtual tours of a database that the Knowledge Society Network enables. This tour begins with an overview of the science work of a grade 1 class, September to June. By following links it is possible to get a more in-depth view of specific units (e.g., the unit on leaves). The tour is presented from multiple perspectives (e.g., links to the students' and teacher's perspectives). Other perspectives include the curriculum, research, assessment, parents', and state-of-the-art perspectives. Access to all or parts of a database, with or without a guided tour, can be granted to visitors or telementors through the Internet. Participants can build on, comment, and in other ways create reference links to this work in the Knowledge Society Network. This network also supports virtual workshops, practica, seminars, and other events surrounding a knowledge base. Some of the most successful instances of collaborative knowledge-building have involved school students, teachers, researchers, graduate students, curriculum, and subject-matter experts coming together to tackle a problem of understanding.

### **Toward a Knowledge Society**

From the start, the CSILE/Knowledge Forum initiative has aimed at revolutionary change: from a focus on carrying out tasks and activities to a focus on the continual improvement of ideas; from an emphasis on individual learning and achievement to the building of knowledge that has social value; from a predominantly teacher-directed discourse to distributed knowledge-building discourse. In line with the magnitude of the intended change there has developed, along with the CSILE/Knowledge Forum technology, knowledge-building pedagogy, practices, and principles (Scardamalia 2002; Scardamalia and Bereiter, forthcoming). Results indicate significant advances in textual, graphical, and computer literacy, as well as in depth of inquiry, collaboration, and a host of mature knowledge processes (Scardamalia, Bereiter, and Lamon 1994). More generally, use in grade 1 through tertiary education, in health care, in public organizations, and in workplaces suggest that Knowledge Forum not only enhances learning but also enables the creative work with ideas that set students on a course of knowledge creation—a course that helps to drive lifelong learning and innovation. A worldwide community of educational innovators—the Knowledge Society Network—has begun to take shape (Scardamalia and Bereiter 1996), supported by the Institute for Knowledge Innovation and Technology ([www.ikit.org](http://www.ikit.org)).

*Marlene Scardamalia*



See also Active Learning; Computer Supported Collaborative Learning; Constructivism; Open-ended Learning Environments

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## Curriculum Integration

At the beginning of the twenty-first century there is a national movement to change the way we teach students. Teachers in our nation's schools are