Dewey's (1956) insight that the "impulses" of the learner are the real foundation of the curriculum is more relevant today than it was when he first formulated it nearly a century ago. As the objects of learning become more complex and the applications more demanding the notion that schooling is about the imparting of simple schemas for knowledge appears less and less tenable. In particular, the opportunities that new technologies afford, coupled with the challenges they imply, mean that learning must be conceived more explicitly, as it has always been in fact, as a process of constructing meaning out of ill-structured data. When we conceive learning in this way, it becomes clear that it occurs through a process in which the learner progressively expands on prior interests and knowledge to create new knowledge. As Dewey wrote much later in his life (Dewey & Bentley, 1949), we need to understand knowing, rather than knowledge.

What are the Interests of the Learner?

What then, are the interests, or impulses of the learner? There are various formulations that one might give, but Dewey's original one has worked surprisingly well for a variety of learners and learning contexts, even though it appears he had in mind the youngest of schoolchildren. He emphasized the natural impulses to inquire or to find out things; to use language and thereby to enter into the social world; to build or make things; and to express one's feelings and ideas. In Bruce & Levin (1997; in press), this framework has been extended to examine new learning technologies; the current version of it is shown below.

We have applied the extended taxonomy in several domains, including the work of scientists, who are using the most advanced modeling and visualization software (Bruce & Lunsford, 2000). We have also applied it in several learning domains, including NSF-funded science education projects and language arts software. For example, when we looked at educational software, we saw patterns that one might expect across curricular areas:
Thus, learning technologies in science tended to emphasize inquiry over expression, whereas those in language arts tended to emphasize communication over inquiry. If our educational aim is to support \textit{knowing}, and not simply the purported transference of knowledge, then this stereotypical pattern may not be optimal.

In fact, there are clear exceptions to this general pattern. For example, the \textit{Worldwatcher Project} has explicitly incorporate aspects of expressive and constructive visualization (see \url{www.worldwatcher.nwu.edu/software.htm}.) In the project, students are encouraged to use visualization tools for \textit{inquiry}, for example, to compare temperature patterns in different places at different times. They also engage in \textit{communication}, by sharing their visualizations and writing in a scientific notebook. But somewhat unusual is the explicit incorporation of opportunities for \textit{construction} and \textit{expression}. As the developers say,

\begin{quote}
Some of the most powerful learning activities that we have observed students engage in with scientific visualization technologies are those in which they use representational media to express themselves and construct hypothetical scenarios. WorldWatcher enables students to use scientific visualizations as expressions of their beliefs and hypotheses in three ways. One is through the customization of the display of visualizations using the features for changing resolution, color schemes, and magnification described under interpretive visualization. The second is through the mathematical creation of new data using the techniques for analytical visualization described above or using the model described below. The third is through a direct manipulation interface
\end{quote}
using a paint metaphor. The WorldWatcher paint interface allows the user to "draw" new data values on a visualization using a paintbrush tool for painting pixel by pixel or a paintcan tool for filling regions. Users specify the data values to paint by typing in a value or by using an eyedropper tool to select values from an image or its colorscheme.

Similar facilities are available in other systems, and researchers are beginning to focus on the fact that a more expansive view of learning not only motivates students, but in fact matches the aesthetic and constructive aspects of professional inquiry.

**Inquiry, Communication, Construction, and Expression Across Learning Contexts**

As educators, software developers, and researchers have taken a more expansive view of the curriculum, they have come to consider the many different contexts for learning and how those might interrelate. The way that learning is realized in a particular situation is a function of (at least), the student's interests, the learning technologies employed, and the contexts for learning.

Richard Lewontin (2000) has made a persuasive argument that environments do not exist independently of living organisms. Essentially, he shows that the pertinent features that turn a physical space into an environment are often constructed by the organism, but perhaps more fundamentally, what counts as significant cannot be disentangled from the needs and activities of the organism. Instead, a view of organic evolution as a constructive process is called for:

> the actual process of evolution seems best captured by the process of construction. Just as there can be no organism without an environment, so there can be no environment without an organism. (p. 48)

A similar case can be made for how new technologies enter into social systems (see Bruce & Hogan, 1997). The effects of learning technologies cannot be ascribed to specific technology features alone, nor to a static environment. Instead, they must be understood in terms of the *information ecology*--the embedding of those technologies in space-time relationships, the presence of other technologies, and the social relations surrounding their use (Nardi & O'Day, 1999).

In this presentation, we will explore the ways that student interests are realized differentially across learning contexts, thus, examining what enters into a table such as that shown below.

**Realizations of Student Interests Across Contexts**
Conclusion

This conception of new technologies for learning challenges conventional assumptions about context-free evaluation of curricula or teaching tools. More importantly, it challenges us to think more expansively about the possibilities for learning, especially for students about to enter or re-enter a work world that is itself undergoing dramatic changes.

A Taxonomy of Learning Technologies

A. Inquiry

1. Theory building--technology as media for thinking.
   - Model exploration and simulation toolkits
   - Visualization software
   - Virtual reality environments
   - Data modeling--defining categories, relations, representations
   - Procedural models
   - Mathematical models
   - Knowledge representation: semantic network, outline tools, etc.
   - Knowledge integration

2. Data access--connecting to the world of texts, video, data
- Hypertext and hypermedia environments
- Library access and ordering
- Digital libraries
- Databases
- Music, voice, images, graphics, video, data tables, graphs, text

3. Data collection--using technology to extend the senses

- Remote scientific instruments accessible via networks
- Microcomputer-based laboratories, with sensors for temperature, motion, heart rate, etc.
- Survey makers for student-run surveys and interviews
- Video and sound recording

4. Data analysis

- Exploratory data analysis
- Statistical analysis
- Environments for inquiry
- Image processing
- Spreadsheets
- Programs to make tables and graphs
- Problem-solving programs

B. Communication

1. Document preparation

- Word processing
- Outlining
- Graphics
- Spelling, grammar, usage, and style aids
- Symbolic expressions
- Desktop publishing
- Presentation graphics

2. Communication--with other students, teachers, experts in various fields, and people around the world

- Electronic mail
- Asynchronous computer conferencing
- Synchronous computer conferencing (text, audio, video, etc.)
- Distributed information servers like the World-wide Web
- Student-created hypertext environments
3. Collaborative Media

- Collaborative data environments
- Group decision support systems
- Shared document preparation
- Social spreadsheets

4. Teaching Media

- Tutoring systems
- Instructional simulations
- Drill and practice systems
- Telementoring

C. Construction

- Control systems--using technology to affect the physical world
- Robotics
- Control of equipment
- Computer-aided design
- Construction of graphs and charts

D. Expression

- Drawing and painting programs
- Music making and accompaniment
- Music composing and editing
- Interactive video and hypermedia
- Animation software
- Multimedia composition

References


Bruce, Bertram C., & Levin, J. A. (in press). *Roles for new technologies in language arts: Inquiry, communication, construction, and expression*. In J. Flood and D. Lapp, Handbook of research on teaching the language arts. New York: Macmillan. An interactive version is also available. Login as "guest" with password "guest".

Bruce, Bertram C., & Lunsford, Karen (2000, September 18). *Studying technology use in distributed knowledge teams: Evolving strategies*. Graduate School of Library & Information Science Proseminar, University of Illinois at Urbana-Champaign.


Kanfer, Alaina, Bruce, Bertram C., Haythornthwaite, Caroline, Burbules, Nicholas, Wade, James, Bowker, Geoffrey C., & Porac, Joe (Forthcoming). Modeling distributed knowledge processes in next generation multidisciplinary alliances. *Information Systems Frontiers: A Journal of Research and Innovation*, Special Issue on Knowledge Management.


**Some Other Relevant Links**

[Inquiry Page](#)

[Distributed Knowledge project](#)

*Journal of Adolescent and Adult Literacy* [Technology Department](#)

[National Biology Digital Library](#)

[Biology Student Workbench](#)

[Plants, Pathogens, and People](#)

[Situated Evaluation](#)