

# Categories of Technology Use in Education

## Introduction

Before evaluating the effectiveness of technology use in education, it is critical to understand that there are various major categories of technology application in schools, and the approach to evaluating each use needs to be very different.

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## Categories of Technology Use in Education

We can categorize technology use in education into the following four broad areas:

1. **Enhance Professional Productivity**
    - Administrative (e.g. student records, class scheduling, budget)
    - Library cataloguing and circulation
    - Improved communication (email, word processing)
    - Teacher tools (computerized gradebooks, test/worksheet generators, templates)
  2. **Computer Literacy: students learn about computers**
    - Name hardware components and their functions
    - Able to use application programs (e.g. word processor)
    - Computer programming
  3. **Computer Assisted Instruction (CAI): students learn from computers**
    - Tutorials
    - Drill & practice
    - Games
    - Based on behaviourism, reinforcement
  4. **Cognitive Tools: students learn with computers**
    - Computer-based tools and learning environments which serve as extensions of the mind (e.g. databases, spreadsheets, semantic networks, computer conferencing, hypermedia construction, microworld environments)
    - Learner enters intellectual partnership with computer, accesses and interprets information, organizes personal knowledge
    - Facilitates critical thinking, higher-order learning
    - Also known as Mindtools
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## Evaluating Technology Use in Education

The following is a brief description of how to evaluate the four categories of technology use listed above:

**Enhancing professional productivity** means automating or attempting to perform tasks more efficiently with a computer, similar to most business uses of technology. This type of use is virtually self-assessing. Either the task is accomplished more efficiently with technology, or a decision is made to return to the traditional method of doing it.

**Computer literacy** involves teaching about computers as a subject in itself. There is currently a de-emphasis on this type of learning because educators have realized that it is not necessary to study a tool in depth in order to make effective use of it (just like we don't need to understand all the details of how a telephone works to make use of it). To evaluate this type of teaching, standardized factual tests on computer knowledge can be developed, and student performances can be compared.

**Computer-assisted instruction** requires developing software which replaces or supplements the teacher's traditional role. The student is expected to learn a certain topic, or even a complete course, by studying computerized materials. To evaluate this type of instruction, student performance on standardized tests can be compared with the performance of students receiving traditional methods of instruction in the same subject matter.

The use of computer technology as a **cognitive tool** requires a more complicated evaluation process. Student project portfolios must be evaluated on criteria such as originality, complexity, use of inferences, coherence, and resource / tool use.

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# Mindtools

## Introduction

This section is based on the following publication:

Computers in the Classroom  
Mindtools for Critical Thinking  
by David H. Jonassen  
1996, Prentice-Hall

Jonassen describes Mindtools as "a way of using a computer application program to engage learners in constructive, higher-order, critical thinking about the subjects they are studying". The learner enters an intellectual partnership with the computer and begins to access and interpret information, and organize personal knowledge in new ways. Mindtools are computer-based tools and learning environments which serve as extensions of the mind. Examples of mindtools are:

- databases
- spreadsheets
- semantic networks (concept maps)
- computer conferencing
- hypermedia construction
- microworld environments

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## Theoretical Reasons for Using Mindtools

- **Constructivism:** knowledge is built by the learner, not supplied by the teacher. The learner is actively engaged in interpreting the external world, but with social negotiation of meaning, i.e. common representations are shared with others. Mindtools facilitate this knowledge construction, in which learners organize and represent what they know. The learning processes of mindtools are active, creative, and student-controlled.
- **Reflective Thinking:** involves inferences, implications, reasoning which requires some deliberation. Opposed to experiential thinking, which occurs automatically or reflexively during one's experiences in the world. Mindtools engage learners in reflective thinking, which leads to knowledge construction.
- **Constructionism:** an extension of constructivism which states that the learner can especially construct his or her own knowledge when building an external or sharable product, such as a sand castle or a hypermedia computer project.

## Educational Reasons for Using Mindtools

- **Cognitive Processing Tools:** perform lower level operations, thus enabling the learner to devote more time to more meaningful mental processes. More responsibility is placed on the learner, who becomes a more self-reliant thinker and problem-solver.
  - **Unintelligent tools:** the learner provides the intelligence, not the computer.
  - **Cognitive Partnership Tools:** help learners transcend mental limitations such as memory. Certain tasks, such as unproductive memorizing, can be off-loaded to the computer.
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## Practical Reasons for Using Mindtools

- **Lack of Software:** available Computer Assisted Instruction materials only cover a fraction of the curricula.
  - **Cost:** purchasing even just a few CAI programs is very expensive.
  - **Efficiency:** a small set of mindtools can be used across the curricula. This is also more time efficient, because less time spent learning to use different programs.
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## Pedagogical Criteria for Evaluating Mindtools

- The application can be used to represent knowledge.
  - Generalizable to content in different subjects.
  - Engages learner in critical thinking about subject.
  - Develops skills transferable to other subjects.
  - Significantly restructures or amplifies thinking (provides alternative simple, powerful formalism for representing ideas).
  - Software should be learnable in 2 hours or less.
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## Features of Higher-Order Thinking

- Nonalgorithmic: the steps required to solve a problem are not completely identified in advance
- Complex: the complete solution is multi-dimensional
- Often yields multiple solutions
- Involves nuanced judgement interpretation
- Involves multiple, sometimes conflicting, criteria
- Involves self-regulation of thinking process (nobody else dictates each step to take)
- Requires finding meaning and structure in apparent disorder
- Requires considerable mental effort, elaborations and judgements are required

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## Critical Thinking Skills

Critical thinking is the dynamic reorganization of knowledge in meaningful usable ways and involves the following mental processes:

- **Evaluating:** making judgements, measuring against a standard, assessing reliability and usefulness, determining criteria for judging, prioritizing, recognizing fallacies or errors, testing hypotheses
- **Analyzing:** separating whole entity into parts and understanding interrelationships of parts (recognizing patterns, categorization, identifying assumptions, identifying main ideas, sequencing)
- **Connecting:** link wholes (comparing, contrasting, logical thinking, inferring deductively, inferring a principle inductively from data, identifying causal relationships, predicting effects)

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## Creative Thinking Skills

Creative thinking is closely related to critical thinking. Creativity requires going beyond accepted knowledge to generate new knowledge. This involves the following mental processes:

- **Synthesizing:** thinking analogically, summarizing main ideas in own words, hypothesizing, process planning
- **Imagining:** visualizing processes, outcomes, possibilities (expressing ideas fluently, predicting results of conditions, speculating, wondering, using intuition)
- **Elaborating:** adding personal meaning (expanding by adding details or examples, changing ideas for different purposes, applying to a different context, assuming different point of view, concretizing general ideas)

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## Complex Thinking Skills

Complex thinking combines the basic learning and recall of accepted information, critical thinking, and creative thinking into larger, action-oriented processes. The following are 3 major types of complex thinking:

- **Problem Solving:** systematically pursuing a goal (sensing, researching, and formulating the problem, finding alternatives, choosing a solution, building acceptance)
- **Designing:** producing new ideas (imagining and formulating a goal, inventing, assessing and revising a product)
- **Decision Making:** selecting between alternatives in a systematic way (identifying an issue, generating alternatives, assessing consequences, making choices, evaluating)

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## Collaborative Use of Mindtools

The following sequence of activities describe how a teacher can assist in forming collaborative groups to utilize Mindtools:

- **Form Heterogenous Groups:** stratify according to cognitive controls: field independence, cognitive flexibility, and cognitive complexity. i.e. Mix global (socially-oriented, better communicators, sensitive) and analytic (better at organizing content, seeing how things fit together) learners.
- **Clarify Goal:** clearly identify the group goal and content domain
- **Negotiate Member Roles:** delegate tasks and sub-tasks to individuals, group brain-storm
- **Monitor Individual and Group Performance:** leadership skills should be modeled by the teacher and then assigned to students.
- **Reconcile Differences:** communication skills are very important, cooperation will be tested (asking for / receiving feedback, paraphrasing without evaluating, negotiating meaning, sharing, accepting, supporting needs and wants of others)

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