

Levels of Technology Implementation (LoTi): A Framework for Measuring Classroom Technology Use

Since the introduction of the Apple IIe computer in the early 1980s, the term “technology” has represented a broad range of interests and has been the subject of numerous interpretations. In school systems nationwide, technology has been the focus of curriculum renewal projects and school funding debates. It has been the rallying cry for leading many school districts into the 21st century.

Our fascination with technology stems, in large degree, from its ambiguity within existing paradigms. Does technology represent things, like computers, modems, pencils, microscopes, and televisions; words or ideas, like “progress” and “change”; processes, like animal breeding and voting; or delivery systems, like expert systems and novice systems? Each perspective on technology has its unique attributes and leads the individual to different conclusions and implementation strategies.

Attempts in the early 1980s to bring technology into education involved the creation of computer literacy classes at the elementary and secondary levels. From region to region, these courses were quite similar in their offerings—they taught students about the parts of the computer, keyboarding fundamentals, word processing, drill-and-practice applications, and introductory programming. Even with the exponential advances in electronic technology, their legacy can still be found today in the guise of integrated learning systems and central word processing and remediation labs.

As one observes the current uses of computer technology nationwide, a few distinct patterns emerge.

- Staff development opportunities for teachers to explore the potential of computer technology are oftentimes insufficient and misdirected.
- Most computer technology is used for isolated activities unrelated to a central instructional theme, concept, or topic.
- The use of the computer is often one step removed from the classroom teacher.

- Technology is used to sustain the existing curricula rather than serve as a catalyst for change.
- The majority of district or site technology plans do not establish a significant link between the need for technology and identifiable instructional priorities (e.g., emphasizing higher order thinking skills or restructuring the science and mathematics curriculum). Instead, they emphasize a need to meet a vaguely defined computer/student ratio or establish districtwide local area networks.

At best, the role of technology has complemented the conventional instructional curriculum and its corresponding emphasis on expository teaching, traditional verbal activities, sequential instructional materials, and evaluation practices characterized by multiple-choice, short-answer, and true-or-false responses.

When planning staff development targeting classroom integration of technology (e.g., spreadsheets, graphing, telecommunications), two fundamental assumptions are often made about the educational practitioners attending such sessions:

- Participants are easily able to make connections between the technology they have available and their instructional curricula.
- Participants are ready and willing to initiate changes in their instructional practices.

Oftentimes, neither assumption is valid. These staff development sessions often lead to nonuse or low levels of use of the technology by classroom teachers because the technology-based intervention neither reflects the instructional level of the teacher (Moersch, 1994) nor addresses fundamental self-efficacy issues.

Self-efficacy theory suggests that individuals with a low level of self-efficacy will often choose a level of innovation that they believe they can handle, which may or may not be the best or most effective option. Con-

versely, those individuals with high levels of self-efficacy are most inclined to accept change and choose the best option. Olivier and Shapiro (1993) identified self-efficacy as a major predictor of adoption of innovation.

Levels of Technology Implementation

We have attempted to create a conceptual framework that measures levels of technology implementation, or LoTi™, so that we can assist school districts in restructuring their staff's curricula to include concept/process-based instruction, authentic uses of technology, and qualitative assessment. LoTi is aligned conceptually with the work of Hall, Loucks, Rutherford, and Newlove (1975); Thomas and Knezek (1991); and Dwyer, Ringstaff, and Sandholtz (1992).

In the LoTi framework, we propose seven discrete implementation levels teachers can demonstrate, ranging from Nonuse (Level 0) to Refinement (Level 6). As a teacher progresses from one level to the next, a series of changes to the instructional curriculum is observed. The instructional focus shifts from being teacher-centered to being learner-centered. Computer technology is employed as a tool that supports and extends students' understanding of the pertinent concepts, processes, and themes involved when using databases, telecommunications, multimedia, spreadsheets, and graphing applications. Traditional verbal activities are gradually replaced by authentic hands-on inquiry related to a problem, issue, or theme. Heavy reliance on textbook and sequential instructional materials is replaced by use of extensive and diversified resources determined by the problem areas under study. Traditional evaluation practices are supplanted by multiple assessment strategies that utilize portfolios, open-ended questions, self-analysis, and peer review. A detailed description of the LoTi framework is given in the Sidebar on page 42.

Implications for District Technology Expansion

As David Dwyer (1992) has noted, "The use of technology does not guarantee fundamental change in the teaching-learning process and consequently in learning outcomes." Other variables, including organizational leadership and structure, the teacher's role in the restructuring process, and the curriculum itself, impact the entire school restructuring process, including instructional uses of technology (Thomas & Knezek, 1991).

As school districts prepare their technology expansion plans, we offer some basic recommendations based on our work with the LoTi framework. District planning for technology should:

- Emphasize staff development because of the incremental and personal nature of innovation adoptions. Existing allocations for staff development are insufficient for districtwide changes in teachers' instructional curricula to maximize the capabilities of the new technologies.
- Emphasize front-end analysis directed at linking proposed technology expansion with long-range instructional priorities.
- Use technology to restructure science and mathematics curricula to reflect *Benchmarks for Science Literacy* and the *NCTM Standards*. The ability for technology to cut across curriculum barriers through the seamless integration of telecommunications, multimedia, and related technology-based tools helps dissolve existing boundaries that define the existing curricula (Thomas & Knezek, 1991).

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- Incorporate a variety of measures to justify the money spent on technology from sources such as bond levies, state and federal Eisenhower allocations, and district funds. Such measures might include LoTi, school dropout rates, student attitudes about school, test scores, and student achievement in areas seldom assessed by conventional means. These areas might include computer use, effective communication, social awareness and confidence, independence, problem solving, and civic responsibility (Dwyer, 1992).
- Include inservice opportunities for site administrators to develop annual technology plans consistent with district priorities for technology implementation and student performance standards. Research has documented that the actions and interests of the building principal have made a significant difference between effective and ineffective implementation of program change (Berman & McLaughlin, 1977; McLaughlin & Marsh, 1978).

The LoTi framework is currently being field-tested throughout the United States. In its current form, the framework can provide a fair approximation of teacher behaviors related to technology implementation. Documenting such behaviors can aid in designing future interventions that support the expanded use of technology as well as concept/process-based instruction and qualitative assessment practices. ■

[Christopher Moersch, National Business Education Alliance, PO Box 61, Corvallis, OR 97339]

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The LoTi Framework

Level	Category	Description
0	Nonuse	A perceived lack of access to technology-based tools or a lack of time to pursue electronic technology implementation. Existing technology is predominately text-based (e.g., ditto sheets, chalkboard, overhead projector).
1	Awareness	The use of computers is generally one step removed from the classroom teacher (e.g., integrated learning system labs, special computer-based pullout programs, computer literacy classes, central word processing labs). Computer-based applications have little or no relevance to the individual teacher's instructional program.
2	Exploration	Technology-based tools serve as a supplement to existing instructional program (e.g., tutorials, educational games, simulations). The electronic technology is employed either as extension activities or as enrichment exercises to the instructional program.
3	Infusion	Technology-based tools, including databases, spreadsheets, graphing packages, probes, calculators, multimedia applications, desktop publishing applications, and telecommunications applications, augment isolated instructional events (e.g., a science-kit experiment using spreadsheets/graphs to analyze results or a telecommunications activity involving data-sharing among schools).
4	Integration	Technology-based tools are integrated in a manner that provides a rich context for students' understanding of the pertinent concepts, themes, and processes. Technology (e.g., multimedia, telecommunications, databases, spreadsheets, word processors) is perceived as a tool to identify and solve authentic problems relating to an overall theme/concept.
5	Expansion	Technology access is extended beyond the classroom. Classroom teachers actively elicit technology applications and networking from business enterprises, governmental agencies (e.g., contacting NASA to establish a link to an orbiting space shuttle via the Internet), research institutions, and universities to expand student experiences directed at problem solving, issues resolution, and student activism surrounding a major theme/concept.
6	Refinement	Technology is perceived as a process, product (e.g., invention, patent, new software design), and tool to help students solve authentic problems related to an identified real-world problem or issue. Technology, in this context, provides a seamless medium for information queries, problem solving, and/or product development. Students have ready access to and a complete understanding of a vast array of technology-based tools.