Feature

Next Steps: Using LoTi as a Research Tool

By Christopher Moersch

Subject: Research, technology use

Audience: Teachers, library/media specialists, technology coordinators, teacher educators

Grade Level: All

Technology: All

Standards: *NETS•T* II, V (www.iste.org/standards)

Supplement: www.iste.org/L&L

There hasn't been anything like the race to get classrooms connected to the Web since the days following Sputnik and the rapid mobilization of resources to improve K–12 math and science education in the United States in 1958. Today, close to 84% of teachers have at least one computer in the classroom, and more than half of these teachers are connected with high-speed access to the Internet (Educational Research Services, 2000). The proliferation of hardware and software has provided students and faculty with fingertip access to easy-to-use, yet powerful productivity tools, multimedia applications, and virtual simulations to support the learning environment in ways never thought possible. Such a massive push to wire the schools has not come without a price. During the past decade, hundreds of billions of dollars were spent on the creation of these digital environments.

Because the majority of funds for networking, hardware, and software are publicly derived, there has also been a growing demand for accountability relating to electronic technology acquisitions. Parents, board members, concerned citizens, and state and federal legislators are now asking pointed questions that extend beyond simple bean counting rituals (e.g., student-to-computer ratio, number of wireless labs, or dollars spent on technology). They want to know about classroom results such as the effect technology is having on student academic achievement and how technology funding for professional development has changed teaching practices.

In 1995, I conceptualized a framework referred to as the Level of Technology Implementation (LoTi) in an effort to create a consistent set of measures that accurately reflected the progressive nature of teaching with technology (see Levels of Technology Implementation Framework on this page).

Much effort had already been directed toward teacher competencies with technology skills (e.g., moving a mouse, using a word processor) with little consideration given to the Gestalt-like nature of classroom pedagogy involving computers. Isolating computers from other elements of the curriculum such as evaluation, teaching strategies, learning activities, and grouping via published sets of teacher competencies, professional development offerings, and budgeting considerations was, in my opinion, both shortsighted and counterproductive.

Incorporating the work of the Concerns-Based Adoption Model (Hall, George, & Rutherford, 1977; Hall & Loucks, 1979; Hall, Wallace, & Dossett, 1973) with the findings from Apple's Classrooms of Tomorrow (ACOT, 1995) research and my own observations of hundreds of classrooms nationally, I designed a conceptual model that focused more on instruction and assessment and less on technology as a detached phenomenon. To date, the LoTi framework has been employed nationally and internationally to assess tens of thousands of classroom teachers' levels of technology use at the instructional curriculum level.

To no one's surprise, instructional uses of technology cover the entire spectrum. Figure 1 shows the results of a recent LoTi survey based on responses from 24,598 classroom teachers in the 1999–2000 school year and 16,723 classroom teachers in 2000–01. The majority of educators (approximately 69%) use computers in the classroom for tasks involving lower cognitive skill development or classroom management tasks such as information gathering,

Levels of Technology Implementation (LoTi) Framework

Level 0
Category: 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., mimeograph, chalkboard, overhead projector).

Level 1
Category: Awareness
The use of technology-based tools is one step removed from the classroom teacher (e.g., integrated learning system labs, computer literacy classes, central word processing labs). Technology tools are used almost exclusively by the classroom teacher for classroom and/or curriculum management tasks (e.g., using gradebook programs, accessing e-mail, retrieving lesson plans from a curriculum management system), and/or to embellish or enhance teacher-directed lessons or lectures (e.g., multimedia presentations).

Level 2
Category: Exploration
Technology-based tools supplement the existing instructional program or complement selected multimedia projects at the knowledge/comprehension level. The electronic technology is employed either as extension activities, enrichment exercises, or technology-based tools and generally reinforces lower cognitive skill development relating to the content under investigation.

Level 3
Category: Infusion
Technology-based tools including databases, spreadsheet and graphing packages, multimedia and desktop publishing applications, and the Internet complement selected instructional events (e.g., field investigation using spreadsheets/graphs to analyze results) or multimedia projects at the analysis, synthesis, and evaluation levels. Though the learning activity may or may not be perceived as authentic by the student, emphasis is nonetheless placed on higher levels of cognitive processing and in-depth treatment of the content using a variety of thinking skill strategies such as problem solving, decision making, reflective thinking, experimentation, and scientific inquiry.

Level 4A
Category: Integration (Mechanical)
Technology-based tools are integrated in a mechanical manner providing rich context for students' understanding of the pertinent concepts, themes, and processes. Heavy reliance is placed on prepackaged materials and outside resources (e.g., assistance from other colleagues) and interventions (e.g., professional development workshops) that aid the teacher in the daily operation of their

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operational curriculum. Technology is perceived as a tool used by students to identify and solve authentic problems relating to an overall theme. Emphasis is placed on student action and on issue resolution requiring higher levels of student cognitive processing and in-depth examination of the content.

Level 4B
Category: Integration (Routine)
Technology-based tools are integrated in a routine manner providing rich context for students' understanding of the pertinent concepts, themes, and processes. Teachers readily design and implement learning experiences (e.g., units of instruction) with little or no outside assistance and empower students to identify and solve authentic problems relating to an overall theme using the available technology. Emphasis is placed on student action and issue resolution requiring higher levels of student cognitive processing and in-depth examination of the content.

Level 5
Category: Expansion
Technology access is extended beyond the classroom. Classroom teachers actively elicit technology applications and networking from other schools, business enterprises, governmental agencies, research institutions, and universities to expand student experiences directed at problem solving, issue resolution, and student activism surrounding a major theme. The complexity and sophistication of the technology-based tools used in the learning environment are commensurate with the diversity, inventiveness, and spontaneity of the teacher's experience-based approach to teaching and the students' level of complex thinking and in-depth understanding of the content.

Level 6
Category: Refinement
Technology is perceived as a process, product, and tool for students to find solutions related to an identified "real world" problem or issue of significance to them. At this level, there is no longer a division between instruction and technology use in the classroom. Technology provides a seamless medium for information queries, problem solving, and product development. Students have ready access to and a complete understanding of a vast array of technology-based tools to accomplish any particular task at school. The instructional curriculum is entirely learner based. The content emerges based on the needs of the learner according to his or her interests, needs, and aspirations and is supported by access to the most current computer applications and infrastructure.

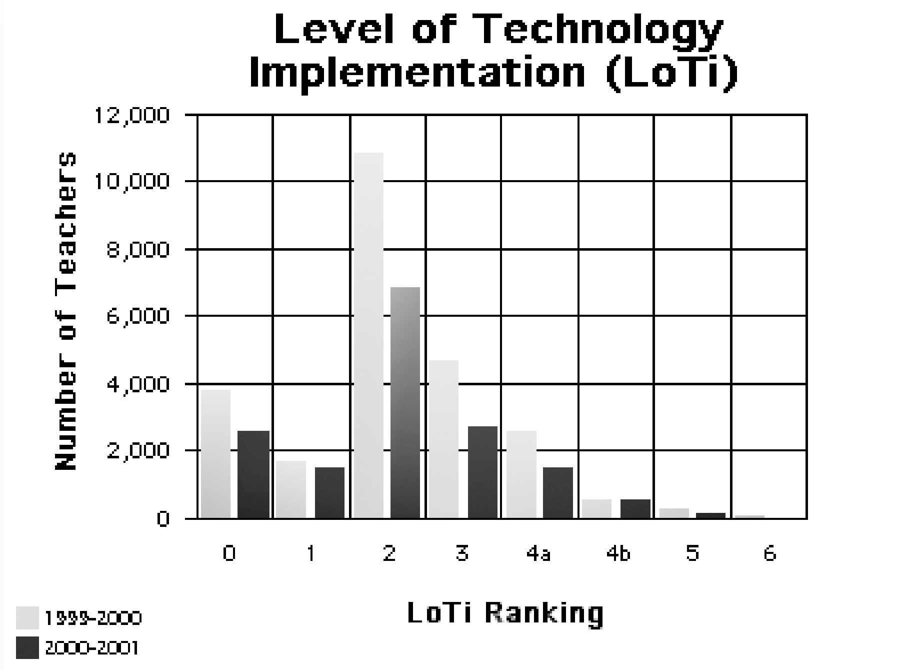

Figure 1. Results of LoTi survey of classroom teachers.

multimedia and Web-based products, tutorial programs, and gradebook/attendance programs associated with LoTi Levels 1 and 2. Roughly 14% of the teachers surveyed were documented at the Target Technology Level (Level 4a and above) as defined by the CEO Forum on Education and Technology (1999). Teachers at this level are employing technology-based resources to promote student use of higher-order thinking skills associated with challenging performance tasks, authentic learning experiences, and student relevancy.

Yet, what effect is teachers' use or nonuse of technology, regardless of the LoTi Level, having on student performance in the classroom or the way teachers interact with students or organize their curriculum? In other words, what variables might affect classroom pedagogy and student performance that enable students to perform at an optimum level and empower teachers to use computer-related tools to expand and extend student learning experiences?

A plethora of research studies have attempted to link computer use to academic achievement (Archer, 1998; Brush, 1977; Clariana, 1996; Isernhagen, 1999; West & Marcotte, 1993–94), higher-order thinking skills (Flescher, 1997; Nastasi & Clements, 1994), and teaching practices (Ryser, Beeler, & McKenzie, 1995); yet, the majority of these studies lack a consistent definition as to what constitutes computer use. In some cases, computer use represents student interaction with specific software applications such as Logo, spreadsheets, games and simulations, or drill-and-practice applications. In other cases, computer use represents an approach to using computers such as integrated learning system labs and computer station learning centers.

During the past four years, doctoral candidates have undertaken several research studies across the country using the LoTi framework to identify and/or validate some of these variables that may significantly impact instructional computing practices in the classroom. Brief descriptions of some of this research can be found in Research Summaries (p. 26) and Research in Progress (www.iste.org/L&L).

Some state departments of education are currently using the LoTi framework to determine the impact of various state-supported initiatives (such as

Research Summaries

The doctoral studies discussed here represent an attempt to uncover some of the mysteries associated with instructional computing based on the LoTi framework.

C. Deacon. (2000). *The effect of computer access and subject area on the level of teacher implementation of technology.* Unpublished doctoral dissertation, Seton Hall University, South Orange, NJ.

The purpose of this doctoral study was to determine whether subject areas (English, mathematics, social studies, science, or world language) and the type of computer access (personal computer, computer labs, class sets of computers, one or two desktop computers in the classroom) affect the level of technology implementation of high school teachers in the classroom. The high school teachers who participated in this study were part of a special technology project, Project Laptop, funded through a public/private partnership. The intent of this project was to provide teachers with adequate access to a variety of types of computer access, training for all teachers by department for general and subject area use, and on-site technical support for curriculum integration.

The research was conducted in an affluent public school district and included high school and middle school teachers. Teachers responded to two questionnaires: the Level of Technology Implementation (LoTi) Questionnaire and the Type of Computer Access Survey. The results showed no significant difference in the personal computer use behaviors (e.g., accessing the Internet, using e-mail, troubleshooting computer problems) of high school teachers compared with middle school teachers as a result of the high school teachers' participation in Project Laptop; yet, a significant difference did exist in the current instructional practices of high school teachers versus middle school teachers as a result of Project Laptop. High school teachers who participated in the project showed a greater inclination toward an instructional approach that supported a learner-based design than their middle school colleagues. The study also revealed a significant difference in the pace that teachers moved to a higher level of technology implementation (LoTi). The high school teachers who participated in Project Laptop tended to move more rapidly to a higher level of technology use than did the middle school teachers. The study also examined differences between the level of technology implementation and the teacher's content area. No significant difference was found in the levels of technology implementation based on content area taught.

The study suggests that high school teachers' ready access to computers coupled with on-site technical support, and professional development enables them to elevate their level of technology implementation and the rate of technology implementation faster than the middle school teachers who were not directly involved in Project Laptop. Similar findings were also reported from Apple Classrooms of Tomorrow's (ACOT, 1995) decade-long research project. Using computers at a higher level of use (e.g., student projects emphasizing higher order thinking) and frequent professional development were two variables identified by Archer (1998) as being associated with increased student achievement. Citing results from the National Assessment of Educational Progress (NAEP) study, Archer indicated that students (eighth grade) whose teachers used computers primarily for "simulations and applications"—generally associated with higher-order thinking—performed better on the NAEP than students whose teachers did not. Conversely, students (eighth grade) whose teachers used computers primarily for "drill and practice"—generally associated with lower-order thinking skills—performed worse.

B. Middleton. (1999). *The impact of instructional technology on student academic achievement in reading and mathematics.* Unpublished doctoral dissertation, South Carolina State University, Orangeburg.

This doctoral study investigated teachers' perceptions of their levels of technology implementation to determine if a significant difference exists between the level of technology implementation and student achievement in reading and mathematics. The technique used to collect data to examine these hypotheses was the administration of a survey to determine the teachers' perceived knowledge and use of educational technologies and the LoTi instrument. Student achievement was studied using the annual mathematics and reading scaled scores from the Metropolitan Achievement Test: Seventh Edition.

The survey was sent to all the fourth and fifth grade teachers in a local South Carolina school district. Usable responses were received from 107 (N = 107) teachers. The sample for this study consisted of 62 fourth-grade and 45 fifth-grade teachers. The results showed a correlation between teachers' self-reported LoTi levels and student math and reading achievement at selected grade levels. The reader is cautioned not to assume a cause-and-effect relationship between self-reported LoTi levels and student achievement. Self-reporting surveys are typically not used for this purpose. If higher levels of technology implementation are associated with improved academic achievement, what specific variables, such as instructional materials, teaching strategies, learning activities, professional development, or student grouping patterns are present in these classrooms that might affect student performance as well as teachers' self-reported LoTi levels? Building a stronger case for linking teacher LoTi levels with student achievement could be accomplished through future doctoral studies that attempt to isolate one or more of these curriculum variables.

E. L. Schechter. (2000). *Factors relating to classroom implementation of computer technology in elementary schools.* Unpublished doctoral dissertation, St. John's University, Jamaica, NY.

This doctoral study examined the levels of educational computer technology integration and stages of instructional practices in elementary schools in a selected New York City school district. This study had a fourfold purpose:

1. to ascertain the reliability of the LoTi instrument,
2. to determine whether and how educational computer technology is being integrated in the public elementary school district in New York,
3. to evaluate the relationships between teachers' personal computer use, levels of technological implementation (LoTi), and teachers' current instructional practices, and
4. to determine factors that both hinder and contribute to classroom teachers' use of technology.

K–6 classroom teachers (N = 237) in 12 elementary schools completed the LoTi questionnaire and addenda questionnaire. Reliability calculations using Cronbach's alpha indicated that the LoTi instrument demonstrated internal consistency on LoTi, personal computer use, and current instructional practice components (r = .7427, .8148, and .7353, respectively).

A profile of teachers' levels of technology implementation was constructed. Results indicated that approximately 25% of teachers did not use computers at all in school, 39% were just beginning to make use of them, 32% were beginning to integrate technology to solve authentic problems within their classrooms, and 5% provided students with ready access to computers to solve authentic problems.

Hardware and software problems, time management problems, and inadequate staff development accounted for 89% of all responses to questions concerning factors that hinder computer implementation. Not owning a computer and lack of technical support were also mentioned often. Technophobia was cited 1% of the time.

District staff development, new or better software, formal coursework, and purchasing their own computers accounted for 71% of all responses to questions concerning factors that aided classroom implementation of computer technology. Other factors mentioned included teacher trial and error, use of manuals and other literature, administrative support, and the help of others. Factor analysis revealed LoTi levels to be significantly correlated to personal computer use (r = .579) and to current instructional practice (r = .422).

Schechter's findings corroborate the results from Figure 1 that show approximately 69% of the teachers at a Level 2 or below. This study also revealed the internal consistency of the LoTi instrument as a reliable tool to assess teachers' level of technology implementation in the classroom.

Preparing Tomorrow's Teachers to Use Technology), hardware acquisitions, and professional development on the level of technology implementation at the building and classroom levels. School districts are exploring variables such as the availability of multimedia computers at home, Internet connections in classrooms, and the role of building principals as instructional leaders that may contribute to the level of teachers' technology use in the classroom.

Conclusion

Some have argued that we have only scratched the surface of the potential of new technologies to address the intellectual, vocational, social, and personal goals of schooling. The doctoral studies involving the LoTi framework are not only adding to the field of instructional computing but also enabling stakeholders to channel precious resources toward proven practices that will eventually elevate the level of technology implementation systemwide.

Embracing an empirically tested set of measures to ascertain teacher growth with technology use in the classroom will give policy makers, school administrators, and classroom practitioners the most consistent data to make informed decisions as to the real needs for improving the technology infrastructure beyond hardware and software issues. Furthermore, the findings stemming from these research studies can help shape the type of professional development interventions needed to maximize the level of technology implementation in the classroom.

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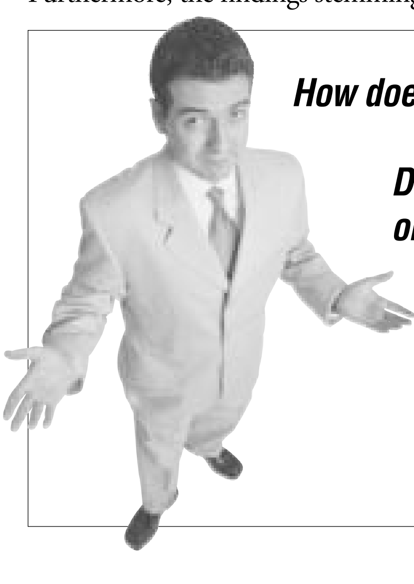

How does your school or district measure teachers' use of technology?

Do you measure your own from semester to semester or year to year? If so, how?

Do you have any assessment tools you'd like to share?

L&L *wants to hear from you. Share your responses, ideas, and experiences. Send them to Kate Conley, editor, at letters@iste.org or to the postal address listed on p. 3.*