Technology Integration: Best Practices– Where Do Teachers Stand? 5(11)

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Abstract

As technology becomes more available in k-12 classrooms and teachers apply it their teaching, it is important to consider how we are going to evaluate the technology integration efforts of teachers. This article summarizes the stages of technology integration, and then goes on to present examples of best technology integration practices. Finally, it offers questions to consider when assessing teachers and their uses of technology.

The idea of "technology integration" has evolved during the last several decades from teaching programming, to utilizing drill and practice, to implementing integrated learning systems, to addressing computer literacy skills, to participating in web-based communities. A more current view of technology integration involves the practice of using technology in ways that are both curriculum-based and future-oriented. According to Ertmer (1999), teachers should focus on meeting content objectives within the "three Cs": communication, collaboration, and creative problem-solving. It also requires that attention be given to preparing students for the future: theirs, not ours. The challenge for today's educators is not programming the computer or learning cumbersome DOS commands. It lies in using computers and other technologies in ways to promote meaningful learning for students.

The purpose of this paper is to describe teachers' transformation process into technology integrators, to explore best practices in teaching with technology, and to suggest how administrators might consider evaluating teachers' integration efforts. Now that computer technology is more prevalent in classrooms, it is becoming less a decision of whether or not to adopt, and more of a dilemma of how to implement it effectively into instruction.

Standards. Competencies. Assessment. Accountability

Educational standards, competencies, assessment, and accountability are discussed in newspapers, magazines, professional journals, and the media. We talk about them with colleagues during meetings, at lunch, and in the hallways. Until fairly recently, most of these conversations focused on teaching and learning as they related to math, science, language arts, and social studies *without* technology thrown into the mix. Within the last few years, however, the International Society for Technology in Education (ISTE) and its partners have developed both the National Educational Technology Standards for Students (NETS-S) and the National Educational Technology Standards for Teachers (NETS-T) . Standards, competencies, assessment, and accountability for technology usage are coming to the forefront. Teachers are expected to integrate technology in ways that ensure that their students achieve success in learning, communications, and life skills, as well as becoming technology literate in the process.

Reports produced by the U.S. Department of Education and Education Week's Technology Counts '99 issue reveal some good news. First, more and more teachers and students have access to computers in their schools. In 1999, 84 percent of the teachers reported having at least one classroom computer and 95% reported having access elsewhere in the school . In addition, the ratio of students to multi-media computers is dropping . Second, teachers are increasingly requiring students to use computers for class assignments. The most frequently used technology tools include word processors, spreadsheets, and the Internet . Third, although improvements still need to be made in the area of technology integration training for teachers, 57 percent of teachers surveyed by *Education Week* indicated that they had received both curriculum-integration training and basic-skills training during the past year . According to findings from the Department of Educations' survey, approximately thirty-three percent of teachers reported feeling adequately prepared to use computers and the Internet for classroom instruction .

We are making progress both in terms of access and training. The technology standards for students and teachers indicate that greater value is being placed not only on using computers, but infusing them into the curriculum in such ways as to create meaningful learning experiences and increase technology literacy. State and local assessments of teachers' technology competencies are on the horizon. Educational leaders need to be aware of the process that teachers go through as they learn to use technology and what best practices are as they relate to technology integration.

Teacher Transformation: Five Stages of Technology Integration

The growth process by which a teacher passes from novice technology user to expert technology integrator is a transformational one. As transformational learning theories suggest, it involves a change in assumptions, perspective, behavior, and self . Transformational learning theory "explains the process whereby adult learners critically examine their beliefs, assumptions, and values as they acquire new knowledge and experience a 're-framing' of their perspective circumstances, issues, and subsequent actions" . Adult learning is transformational when individuals progress from some new idea or skill to a changed state of knowledge or functioning.

For most people, change can be difficult. According to Merizow's theory of transformational learning , adults may experience ten phases of perspective transformation as they revise their meaning structures: disorienting dilemma, self-examination, assessment of assumptions, recognition that others share similar transformations, exploration of options for new roles, developing a course action plan, acquiring knowledge and skills to implement action plan, trying-out new roles, building of competence and self-confidence, and a reintegration into life based on new perspectives (adapted from p. 8). Merizow indicates that all of these steps or stages may not be clearly defined nor followed for each adult learner. Transformational learning is both a process and an outcome of adult learning. We believe that this process is evident in teachers as they try to assimilate new beliefs, feelings, and actions involving the adoption and integration of technology into their existing frameworks.

It is not uncommon for teachers to feel defeated at the end of the day when they are first learning to use technology in their classrooms. For veteran teachers using traditional lecture and seatwork during the majority of their instructional time, merging technology, curriculum, and pedagogy can make them feel like a first-year teacher again. Research on teacher developmental stages is described in ways similar to technology integration stages. The growth process of inservice teachers has frequently been described as starting with survival, progressing through adjustment, and ultimately leading to some mature stage of effective functioning. At the survival stage, beginning teachers experience a lack of confidence to try new things, report limited knowledge of pedagogy, and indicate problems with classroom management skills . As teachers progress through the adjustment stage, they learn more about planning and organizing instruction. Their confidence increases. They begin to see students' as complex individuals and try a wider variety of teaching strategies to meet their needs . Once teachers reach a more mature stage of effective functioning, they have a good command of teaching strategies, instructional planning, and management of classroom environment. They have reexamined their beliefs about education, their subject matter, and themselves. These teachers are immersed in the educational process . We assert that teachers' experiences in the developmental stages of survival, adjustment, and maturity are similar to their experiences in the technology integration stages of entry, adaptation, and invention.

More than a decade ago, Apple Computer Incorporated in conjunction with schools, universities and research agencies began the research and development project Apple Classrooms of Tomorrow (ACOT). It provided technology, integration training, and support to teams of teachers. During this longitudinal study, one of the findings revealed that teachers' instructional practices went through a five-stage evolution process as they learned to integrate technology into their curriculum: Entry, Adoption, Adaptation, Appropriation, and Invention .

At the Entry phase, teachers use primarily text-based materials. Like a novice teacher in "survival mode," they are reluctant to try new things and experience problems with discipline and resource management as they relate to technology. The computer is relegated to the back of the room and is often used for student rewards or free time activities such as playing games and exploring software. Instruction is implemented using traditional teacher-directed activities. Some common instructional technologies include blackboards, textbooks, workbooks, and overhead projectors. In addition, technical issues also plague entry users. It is during this phase that teachers may experience "disorienting dilemmas" in which they are overwhelmed and

intimidated by the technology. They may also be overly "self-critical" as they examine their problems and limited progress.

Moving into the Adoption phase, teachers begin to show more concern about how technology can be integrated into daily lesson plans. They begin to critically assess their assumptions about teaching and learning and explore options for new roles. Traditional whole group lecture and seatwork still tend to dominate instructional strategies. Nevertheless, at this phase children are being taught how to use technology. Activities using keyboarding, word processing, or drill and practice software are common. Teachers begin to anticipate management problems and develop strategies to solve them. They also begin to develop basic technology troubleshooting skills. Increased sharing of strategies and ideas leads teachers to recognize that others share a similar transformational process.

Adaptation and integration of new technologies into traditional classroom practice occur in the third phase. During this "adjustment stage," teachers are learning more about planning and organizing technology-connected activities for their students. Although traditional instructional methods remain the dominant forms of classroom practice, there is marked increase in students' use of word processors, databases, some graphic programs, and computer-assisted instructional packages. Productivity is a major theme. Students are producing more quality work and at a faster rate. Teachers are learning to use computers to save themselves time, rather than creating additional demands. At this point, teachers understand how to plan for technology integration and have begun acquiring additional skills to meet the new demands.

Appropriation has been described as more of a milestone than a phase. Teachers' personal attitudes toward technology become the benchmark for this milestone in instructional evolution. Teachers understand technology's usefulness, and they apply it effortlessly as a tool to accomplish real work. They take on new roles and incorporate new teaching strategies that include more project-based instruction, cooperative group work, and uses of computers to support curriculum.

The pinnacle is the Invention phase. Teachers experiment with new instructional patterns and begin to see knowledge more like something students must construct and less like something to be transferred. At this stage of "effective functioning," teachers have a repertoire of teaching and technology integration strategies. Interdisciplinary project-based instruction, team-teaching, and individually paced instruction are hallmarks at the Invention phase. Students work together in more collaborative ways and serve as experts to assist their peers with both curriculum and technology issues. Having experienced success and survived failure, teachers are more confident in their technology integration abilities. According to Mezirow's theory, they have reintegrated into their professional life based on new perspectives.

Best Practices in Teaching and Technology Integration

The use of the term "best practice" is widespread. In the fields of medicine and law, "best practice" indicates work that is sound, highly regarded, and state-of-the-art. In the field of education, it is usually associated with work that is serious, thoughtful, and informed by current

research in teaching and learning . In fact, these practices are considered "best" when leaders in the field who understand and represent exemplary teaching strategies also recommend them.

According to Zemelman, Daniels, & Hyde , a consensus has emerged among experts and practitioners from diverse fields such as mathematics, science, art, reading, writing, and social science. Documents from professional organizations, such as the National Council of Teachers of Mathematics (NCTM), the American Association for the Advancement of Science (AAAS), the National Council of Teachers of English (NCTE), the National Council for the Social Studies (NCSS), and the like make similar recommendations about teaching and learning. The current educational reform efforts suggest that teaching methods based on constructivist principles promote learning in a way that teaching-by-telling cannot do. The social aspect of learning by collaboration and an individual's need to explore and experiment are best directed through pedagogies based on constructivist theory . Some of these constructivist-based strategies identified as "best practice" include student-centered instruction, experiential and holistic learning, authentic experiences, reflective exercises, social interactions that scaffold learning, collaborative grouping, problem-oriented activities, and integrated thematic units .

Using a variety of these methods throughout the school year helps to achieve a balance of activities for students. In addition, they help to foster a supportive classroom climate. This is a climate where students make choices, take responsibility, express themselves in a variety of ways, and create a community of learners.

These ideas are not necessarily new to education, and some educators might consider them "recycled." Nevertheless, many of us in the field of instructional technology believe that an instructional context based on these principles has significant implications for uses of technology that promote meaningful learning. According to Grabinger , a constructivist pedagogy combined with purposeful technology integration creates a rich learning environment for students. Technology can play an important role in increasing students' motivation to learn, in helping learners to visualize problems and solutions, in acquiring technology literacy, information literacy, and visual literacy and in supporting a variety of instructional approaches such as co-operative learning, shared intelligence, and critical thinking . Perhaps one of the greatest benefits of integrating technology into classroom practices is that technologies can be "used as engagers and facilitators of thinking and knowledge construction;" thus becoming something students learn *with,* not *from.*

It is not the computer alone that will impact learning, but a pedagogical shift towards student-centred classrooms with more project-based activities and opportunities for collaboration and co-operation on life skills. With regards to technology integration, constructivist-learning environments would allow students to engage in meaningful and useful activities through which learning is accomplished. Good teaching combined with appropriate and effective uses of technology makes for a dynamic, rich learning environment.

Methodology and Findings

So what might you expect from a teacher who is using best practices as they relate to technology integration? In answer to this question, we conducted an in-depth, qualitative study of four

elementary teachers identified in their school district as "technology integrators ." One taught third grade, another fourth grade, and two taught fifth grade. The schools in which the teachers worked served between 700 and 1,100 students. The average class size for these four teachers was twenty-four students. Two teachers had five networked, multimedia classroom computers with Internet access, and the other two teachers had only one. A variety of computer-related technologies were available at these schools, such as digital cameras, scanners, and various display devices. Each school had a computer lab with a fixed-rotation schedule. The schedules varied at each site. Time allotments ranged from twenty-five minutes to fifty minutes approximately every six days.

Data were gathered from multiple sources: interviews, participant observations, and documents such as lesson plans and web pages. Each teacher participated in four informal interviews with a focus based on Seidman's interview protocol and in observations that followed each interview. The teachers were observed for four observation periods ranging in length from forty minutes to six hours. On several occasions, observation periods continued into a second day, depending on the activity that was being observed. Since the purpose of the study was to identify best teaching practices as they related to technology integration, observations were scheduled with the teachers so as to coincide with technology-connected lessons. The teachers provided us with lesson plans reflecting the activities we observed, as well as others previously used along with artifacts such as web pages that they had created.

Through inductive analysis, categories, themes, and patterns emerge from the data . Boyatzis' thematic analysis was employed as a means to interpret the data collected. This began as data were first collected and ran throughout the study. Triangulation was evident after a review of observation field notes, and documents confirmed the trustworthiness of the interview data.

After the study, we had informal discussions about technology integration practices with several high school and middle school teachers who were known for teaching with computers and found similar patterns of technology usage. From these observations and discussions with teachers who infuse technology into their instructional practices, a general conclusion emerged that best teaching practices and best technology integration practices go hand-in-hand. It has less to do with the pizzazz of a PowerPoint presentation or graphics whizzing onto a web page and more to do with teaching methods . Here are five of the common practices that we found.

Multidisciplinary Units and Situated Learning

In order to promote problem solving and to bridge the gap between inert knowledge and knowledge application, it is important to anchor instruction within an authentic context that will mirror real-life problems . We have seen teachers integrate technology best in conjunction with multidisciplinary units in which activities or lessons are contextualized for students. The design of these units enables learners to acquire and use knowledge, skills, and tools in contexts that reflect the way information will be used in real life. Usually, teachers are able to facilitate only one or two such units a year because they are in-depth and time-intensive. For example, one teacher created a stock market unit in which her fifth grade students collaborated with ninth grade students for a six-month look at how the stock market worked. Both classes researched a variety of stocks and used e-mail to exchange information once a week. With the fifth graders

acting as stockbrokers and the ninth graders taking the role of investors, students worked in "firms" buying, selling, and trading shares. They computed costs, losses, and gains, prepared stock reports, and created investment portfolios. Using word processing tools, graphing software, and Internet tools during this project helped to increase students' understanding and extend the learning environment.

Objectives Drive Technology Use and Flexible Instructional Roles

One of the best practices used by technology-integrating teachers is focusing on the objectives first and then deciding *when* and *if* to use technology to help meet these objectives. Both behavioral and constructivist-based instructional development models include identification of "learning objectives" as one of the beginning components for planning instruction . In a behaviorist model, objectives or goals are determined by the instructor and are based on an analysis of the learners' knowledge; however, a constructivist model advocates negotiated goals between the instructor and the learner . Each model assumes that instructional strategies and media selection will be chosen after the desired learning objectives are identified. In designing a technology-integrated lesson, objectives are like a travel destination, while instructional strategies and technology are like a mode of transportation. Without knowing where you are going, it's hard to know if you will need a plane, train, or automobile to get there.

Being purposeful is an important aspect of teaching with technology. Not only is it important for teachers to decide *when* and *if* to use it but also *where*. Teachers we interviewed and observed incorporated technology into a variety of instructional events: to introduce material or gain attention, to extend understanding, to provide additional practice, to enrich learning, to provide closure, to assess learning, and to provide feedback. Technology will play different roles in instruction depending on curriculum objectives and lesson design. Being flexible and not single-minded about where technology can be used in the lesson is necessary to technology integration.

In addition, the design of a lesson may cause teachers' roles to change. Both direct instruction and teacher-as-facilitator are instructional strategies used when integrating technology. Direct instruction is generally used to introduce material, clarify content-based misconceptions, or teach technology skills. Teachers we observed tried to keep these segments short, between fifteen and thirty minutes. They also acted as facilitators and coaches of learning while students were engaged in co-operative group work or in individual assignments.

Collaboration and a Community of Learners

Another best practice that we observed was teachers building a community of learners. According to Lave and Wenger , these communities participate in activities together with a shared understanding about what they are doing and what it means to them. Effective learning communities offer members opportunities to expand both the individual's and the group's knowledge, participate in decision-making, take risks without fear of failure, develop expertise, experience a variety of activities, and work on interdependent tasks with others . For the learner, such participation has the potential to "develop abilities to reason about learning and to think reflectively, to think critically, and to become motivated to learn independently throughout their lives" .

Utilizing co-operative learning within learning communities offers many benefits to students such as positive academic achievement and increased productivity , better social relations , positive changes in attitudes towards school and learning experiences, and improved self-esteem . Using computers during co-operative instruction also produces many of the same benefits, such as greater quantity and quality of daily achievement, more successful problem-solving, more task-related student-to-student interaction, and students' increased control over their own learning .

Web-based technologies such as Internet and e-mail make it possible to extend the classroom beyond its four walls. They provide students with opportunities to participate in virtual "knowledge networking." Dede describes this process as one in which members create, share, and master knowledge. "Pupils act as partners in developing learning experiences and generating knowledge, and their collaborative construction of meaning is enhanced via different perspectives on shared experiences" (p.284). Students participate in data-gathering activities with schools nationally and internationally through such websites as the Global Thinking Project. For example, one teacher had his tenth grade biology class monitor particles in the air and ground-level ozone to determine the local air level quality. Students regularly posted their data and discussed their findings with students from other schools in their state and in Russia. Language arts, foreign language and social studies teachers use e-pal projects to teach about culture, language, and communication. Sites such as Kidlink provide a place for students and teachers to connect with classes around the world.

The community of learners is not just about activities external to the classroom but also about the teacher being a learner in the process and helping students recognize each other as experts. Learning and participation in the community is intertwined. In this environment, cognitive apprenticeship is one model of how students may learn . It makes it possible for "experts" to demonstrate both process and product to their less skilled "apprentices." It also promotes scaffolding. As Vygotsky indicated, "children can imitate a variety of actions that go well beyond the limits of their own capabilities. Using imitation, children are capable of doing much more in collective activity or under the guidance of adults" (p.88).

Due to limited classroom computers, collaborative activities are a natural fit as an effective instructional method. Problem-based activities provide the perfect context for students to work together. Technology integrators use this best practice to capitalize on students' strengths, to develop teamwork skills, and to scaffold learning. For example, groups of three or four students may gather around a computer to use Inspiration® for a brainstorming session prior to starting on their group project. They also share and divide the work in such a way that all group members have task responsibilities so that each student has some individual time on the computer. While this works best in classrooms with three to five computers, we have seen it work in classrooms with only one. Student experts surface in this type of environment. Students may coach each other on a particular piece of software or participate in peer editing.

Scaffolding for Understanding

During technology-connected lessons, technology-integrating teachers regularly and systematically scaffold learning for their students within their zone of proximal development.

The zone exists between the learner's actual and potential capability . Using this method, the teacher provides the student with some type of assistance to complete a task or learn a concept. Gradually, the "scaffold" is removed until the student is doing this on his or her own. The scaffolding strategies used in conjunction with technology include the following: bookmarking websites, providing written directions for computer-related tasks, graphic organizers, note-taking guides to use while gathering information from on-line resources, verbal reminders, and peer tutoring.

In addition to these strategies, the teachers also employ cognitive technologies such as spreadsheets, graphing programs, concept mapping software, multimedia tools and the like as a way to scaffold learning. Jonassen calls these "mindtools." "Mindtools are computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher order learning" (p.9). For example, one teacher frequently used Graph Club by Tom Snyder to help her fourth grade students graph data that they collected. By using the graphing program, students reorganized information into a variety of graphs in order to select the most appropriate one to display the data. Using this software also promoted hypothesis testing. Students interchanged data sets to check their hypothesis and confirm or disconfirm their predictions. Jonassen suggests that mindtools help to "amplify the learners' thinking by transcending the limitations of the mind" (p.10). Thus, cognitive technologies provide scaffolding within the learner's zone of proximal development.

Using Multiple Hard and Soft Technologies

Another best practice related to integrating technology is the use of multiple hard and soft technologies. Research indicates that some of the most interesting and innovative uses of technology take place in classrooms where multiple uses of technology are implemented . Findings from our study and prior research seem to indicate that frequent computer usage combined with multiple uses of technology tied to constructivist strategies may constitute best practices as related to technology integration.

Teachers who use technology effectively do not limit integration to a narrow set of technology tools, but rather chose a variety of tools in relation to their teaching goals. These include soft technologies such as the Internet, word processors, graphing programs, databases, cognitive mapping, and multimedia software. They also include hard technologies such as flex-cams, digital cameras, scanners, and some type of display device (which is critical to whole class instruction). One of the fifth-grade teachers we observed used the digital camera throughout the year as a way to record the "class history." She and her students used the digital pictures in multi-media presentations that reflected what students had learned from a recent fieldtrip. They imported pictures into classroom newsletters as a way to communicate with parents about special events, and students printed out pictures to use in classroom art projects.

Teacher Evaluations and Technology Skills

With the emphasis on NETS for Teachers and its performance indicators, it will be important for school administrators and others in leadership roles to understand what constitutes best practice

in technology integration. It is imperative that administrators know what technology integration looks like when evaluating teachers' classroom practice. They should not be overly impressed by the mere use of technology. They should be discerning about the pedagogy that accompanies its integration. Based upon our research, and that of others, some of the questions that should be addressed when evaluating teachers' effective integration of technology into the curriculum are the following:

To what extent…

- does technology bring additional value to multidisciplinary units?
- is the integration of technology driven by instructional objectives?
- does technology cut across different events within a unit or lesson?
- does the teacher adapt flexible roles and teaching/learning strategies in order to maximize learning outcomes through the integration of technology?
- does the teacher use the integration of technology to build a community of learners?
- does the teacher use various scaffolding strategies in order to maximize learning outcomes through the integration of technology?
- does the teacher use multiple hard and soft technologies in order to maximize learning outcomes through the integration of technology?

Just as an evaluator might have one set of expectations for a beginning teacher and a more demanding set for an experienced teacher, so too should considerations be given for teachers as they fall within the five stages of technology integration. Therefore, administrators should also consider the following:

- At what level does the teacher appear to be working with regard to the five stages of technology integration?
- How might the teacher's technology integration stage affect what I see in the classroom?
- What scaffolding techniques can I provide in order to support and encourage this teacher to reach her or his highest potential regarding the five stages of technology integration?

In closing, effective integration of technology has everything to do with teaching pedagogy and very little to do with the technology itself. We should not be impressed with the mere "use of technology" *unless* that use is supported by a carefully crafted pedagogy. Although this article does not specifically address staff development and support, we caution you that, before embarking on the very important task of evaluating teachers' integration of technology, you should consider what scaffolding strategies and training opportunities you can offer to the person you are evaluating. One component of the evaluation process is to document current performance. Equally important is to determine a plan by which to improve performance. In order for teachers to transform from a novice technology user to expert technology integrator, they will need support and guidance from their administrators.

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