RUNNING HEAD: Integrating TECHnology

Premises, Principles, and Processes for Integrating TECHnology into Instruction

Abstract

Assistive and instructional technology, when integrated into well-designed and meaningful instructional activities, promote learning for students with and without disabilities. In this article, three premises for integrating technology into instruction are identified, and a checklist for principles to be followed when integrating technology is provided. Finally, TECH is described as a process designed for educators to more smoothly integrate technology into instructional activities.

Keywords: assistive technology, instructional technology, technology, instruction

Advances in technology as used in the business world abound. Tasks once considered quite onerous, such as using whiteout to correct typed errors or retyping an entire document when minor revisions were needed, are now quite efficiently accomplished in the world of enterprise. The speed with which written communication occurs with electronic mail has dramatically increased in the last decade. Documents are more commonly, quickly, and inexpensively disseminated via electronic mail and internet sites rather than postal mail. Businesses examine efficiency and cost factors before purchasing technological equipment or devices. Moreover, expenses encompass more than just the initial cost of the technology. Cost considerations also include the initial training for personnel on how to use the technology, maintenance of the equipment, material needed for the equipment (after all, how helpful is a printer if there are no funds for purchasing paper), technical support as personnel are learning how to use the technology, and ways in which the equipment can be used beyond that which was the original impetus for the purchase.

Similarly, when educators have opportunities to invest in instructional technology, their investment is not just the initial purchase price. Although the school system typically purchases the technology, educators also “pay a price” beyond the initial purchase price. Educators must learn how to use technology that enables them to more efficiently and effectively communicate to and with students about curriculum. For example, for educators it is not just a matter of having computers and software *in* the classroom, it is *how* those computers and that software are used to promote learning. Moreover, today’s high demand for technology in classrooms must meet educators’ needs to efficiently and effectively communicate to and with students with *diverse learning needs* about the curriculum content. Similar to how businesses capitalize on how a piece of equipment purchased for one purpose becomes an integral part of how business occurs, educators seek to capitalize on how technological equipment becomes an integral part of how instruction occurs in their classrooms. [***Last sentence, possible TEC SIDEBAR]***

For some students with disabilities, technology is necessary for them to receive information, practice it, and express what they know (MacArthur & Cavalier, 2004). When technology is necessary "to increase, maintain, or improve the functional capabilities of students with disabilities," it is considered assistive technology (AT) (IDEA, 1997; P.L. 105-17). AT is specified on students' Individualized Education Programs (IEPs) as a special education related service or a supplementary aid (Reed & Bowser, 2005). School systems often conduct comprehensive assessments to determine and specify AT needs for students with disabilities. Several instruments and checklists are used by school systems to determine whether and which AT devices and services are necessary, and AT decisions are based on students' abilities and needs as well as environmental considerations to ensure effective technology utilization (Bowser & Reed, 1995; Chambers, 1997; Zabala, 1995).

Consequently, for some students with disabilities, technology may be AT identified on their IEP as necessary for them to use. Technology may be considered *assistive technology* (e.g., a digital text may be *necessary* for students with specific learning disabilities in reading) for one student with disabilities, yet that same piece of equipment may be considered *instructional technology* for other students (e.g., some students may prefer digital text, although it is not necessary for them because they can read the text). ***[Last sentence, possible TEC SIDEBAR.]***

Another factor is how much students' performances are enhanced when technology is used, and whether or not the enhancements warrant use of technology across the school day. For example, Higgins and Raskind (2005) found that students with reading disabilities who used the Reading Pen, a technological device with voice output that identifies words when students scan the pen across them, could read at higher levels and accurately answer more comprehension questions. The Reading Pen is a good example of a technological device that can benefit students with and without disabilities who are encountering new and complex vocabulary across the school day. As a complement for educators' instruction on vocabulary, the Reading Pen could be integrated within many types of activities in multiple content areas.

Moreover, educators' and students' use of technology in general, and AT in particular, can expand beyond an academic focus in a few school settings. While some items may seem most applicable for academic and instructional purposes, other devices' functions and value increase when used in non-school and non-academic settings (Derer et al., 1996). For example, students who use communication boards need to use them in academic classes, during social opportunities across the school day, and in non-school settings. ***[Last sentence, possible SIDEBAR]*** However, inconsistent policies about whether students can take AT home impact opportunities for students to generalize skills across home, community, and school settings.

Other researchers caution about the importance of monitoring students' performance when instructional technology, such as commercially-available software, is used. For example, Lee and Vail (2005) examined the impact of using Word Wizard for teaching sight words to students with disabilities. They measured students' acquisition, maintenance, and generalization of words across time and tasks (e.g., words read from index cards and in story books). Although all students learned the targeted vocabulary and generalized to paper/pencil tasks, the researchers noted variability in students' data while using Word Wizard. Although Word Wizard was designed for effective student-software interaction, that interaction was dependent on students' attention to computer tasks. Some students, when they appeared to be gazing at the computer screen v. engaging in the tasks, needed prompts and redirection. Most students, however, were motivated to use the computerized program, even those students who occasionally needed prompts to resume on-task behaviors. Lee and Vail note the potential that such programs as Word Wizard have to assist students with and without disabilities in their learning and practice of new skills. The researchers also note the importance of multimedia programs being built with flexible instructional design features. For instance, when students make too many errors, either educators need to be responsive or responsiveness needs to be built into the technology. Conversely, when students progress quickly and may be working on a level that is not sufficiently challenging for them, technology should be designed with the flexibility to skip levels or fast forward to a level that is sufficiently challenging. Either way, monitoring students' performance promotes responsive instructional decisions.

In this article we describe three premises for integrating technology into instruction. Examples and nonexamples of these premises are identified. Next, we identify four principles to guide selection of technology and a checklist of the principles. Finally, a process (TECH) that explains how educators can integrate technology into instruction is described.

Premises for Integrating Technology into Instruction

There are three premises for integrating technology into instruction. First, technology must be part of students' instructional programs today because the students' futures will include some need for proficiency in technological skills. Stodden, Galloway, and Stodden (2003) note the necessity of including technology in school-based activities to prepare students with disabilities for careers that will most likely include some aspect of technological aptitude. In addition, in today's world, children use technology so frequently in various areas of everyday life that it appears to be their comfort zone. Using instructional and assistive technology with students can promote their academic and social performance. Moreover, some students are quite familiar and comfortable with learning and using new technology. Consequently, maximizing the use of technology with instruction provides students opportunities to mirror in their school careers some skills that they may be using in their future employment.

The second premise for integrating technology into instruction is ensuring that the technology itself does not become the point of instruction. Copley and Zivani (2003) distinguish the notion that technology is perceived by teachers and students as a separate activity used to train isolated skills from the notion of teachers and students routinely and naturally accessing technology as part of students' daily activities. Dias (1999, p.10) contends that "…technology is integrated when it is used in a seamless manner to support and extend curriculum objectives and to engage students in meaningful learning." Technology should be used in the context of specific curriculum and social activities rather than becoming an isolated focus of instruction (Bryant & Bryant, 1998; Gardner et al., 2003; Todis & Walker, 1993).

The final premise for integrating technology into instruction is acknowledgment that keeping abreast with the newest advances in technology is a responsibility shared among educators and not the responsibility of any single teacher. There are a range of devices and pieces of equipment that are considered technological. Some are quite common and simplistic (e.g., a colored marker may be considered a type of low-technology) while other are less common, more specialized in function, and quite complex in design and detail (e.g., a wheelchair designed for a person who has limited mobility to maneuver). Consequently, when educators think of technology integration, there are many forms of technology that range from simple and common tools to more unique and complex devices. Just as educators have specific areas of expertise that are more in-depth in particular areas (e.g., science, behavior management, literacy) and may be quite accustomed to sharing those areas among their school colleagues, colleagues should anticipate that their school and school system has technological experts who are abreast of what's the latest in technology. Refer to Table 1 for a summary of the three premises as well as examples and nonexamples of each.

Insert Table 1 about here

Principles for Integrating Technology

Four principles guide integration of technology into instruction. The first principle is the technology's content should clearly align with the curriculum outcomes so that use of the technology as a complement for students' learning is straightforward. ***[Last sentence, possible TEC SIDEBAR]*** This principle of curriculum alignment is examined to ensure that the technology does indeed promote students' learning. For example, some computer instructional games may be enticing for students to use, but the games may be more focused on students' engagement in fun and less focused on students' engagement in learning. In some classrooms, students may be engaged in fun work that keeps them busy but does not promote their learning. Students' engagement in computerized instructional games, for example, should not be just a busy activity, nor should it be simply a fun activity. That students are engaged in fun and motivating computerized instructional games is desirable, but the technology must *also* promote learning. These questions can guide teachers *and* students for ensuring this principle is met:

- What learning outcome is this technology helping you to learn?
- How do you know the technology is helping you learn that outcome?
- In what way is your understanding of or skill in that learning outcome enhanced when you use the technology?

The second principle is that students' instructional needs or levels of learning must match the technology's aspects or range of activities. ***[Last sentence, possible TEC SIDEBAR]*** For example, if software is designed to increase students' fluency of math facts, the software's purpose is likely not demonstration of how to calculate math facts. Some computer programs, such as PowerPoint, provide flexibility for teachers *and* students to represent and solve problems using pictures, tables, graphs, and other symbols. When such software is used in a more directed format for teachers to demonstrate or present the math content, the technology is used in an explicit manner to enhance students' acquisition of content. Alternatively, students who are practicing or acquiring fluency with content might use the same program (i.e., PowerPoint) to explore new ways of representing data on graphs or solving problems using tables.

Whatever the technology is, the way in which it is used (e.g., to demonstrate new concepts or to provide practice of content already demonstrated) must match the students' instructional needs (e.g., the content is neither too complex nor too easy) or levels of learning (e.g., some students may be ready to practice at more abstract or complex levels, while others need more practice with visuals to acquire mastery). Blackhurst (2005) discusses the importance of careful consideration of students' learning stages before selecting an appropriate software program. He notes that drill and practice programs, for example, may impede rather than support instruction for students "in the early acquisition state of learning" (p. 17).

The third principle for integrating technology into instruction is the extent to which the technology, particularly AT, has students "standing out" from their peers. ***[Last sentence, possible TEC SIDEBAR]*** Some researchers emphasize seeking students' input when technology is selected, and that whatever technology is used should be "cool" as perceived by peers whenever possible (Parette, Wojcik, Peterson-Karlan, & Hourcade, 2005). For example, a bulky headset (although quite in style two decades ago!) selection instead of an i-pod or more compact earphones might look odd to peers.

The fourth principle is the parsimonious principle. ***[Last sentence, possible TEC SIDEBAR]*** Parsimony means that decisions to choose a specific piece of technology are made in light efficient and cost-effective choices that "get the job done." That is, if using chart paper and colored markers suffices to convey information, choose low-technology (yet high-instructional value) materials. For example, students may be graphing data representing class characteristics:

- How many students have birthdays in each month?
- When given choices of several fruits, which fruit is selected most frequently? Least frequently? Compare and contrast these choices.

Students could use a technological graphing program to depict their responses, or they could draw a graph. Depending on how frequently the technological graphing program is used, it may not be a wise time investment for students to learn how to graph these data. That is, the parsimonious principle may indicate that hand-drawn graphs are the most efficient and equally effective way for students to represent their data. So the parsimonious principle emphasizes that when given a choice of various ways to convey information, practice information, or express information, choose the one that "gets the job done" versus choosing a more time-consuming or more complex technology that also gets the job done, but may not be the wisest and most efficient and cost-effective choice for this task at this time.

However, also consider that the technological graphing program enables students to manipulate data to show different comparisons and is more efficient to share graphs among multiple students (or group members). These considerations *may* indicate that the parsimonious choice, in the long run, is to invest in students learning to use the technological graphing program versus drawing a graph and plotting data by hand. Indeed, the parsimonious principle also embeds a "business decision" described at the beginning of this article: investing in technology for instructional activities includes examining both the immediate purpose of the technology (graphing) as well as the potential the technology has for other instructional purposes (e.g., comparing data; graphing multiple variables or sets on one graph; sorting data).

When integrating technology into instructional activities, educators may find the checklist shown in Table 2 helpful. Educators may also find the checklist helpful when developing rationale for choosing (and requesting the purchase of) specific technology. That is, each principle promotes thoughtful decision-making that can assist educators for both making a decision among many technological choices and for presenting the rationale to administrators. Administrators may desire or need this type of documentation to justify a funding decision.

Insert Table 2 about here

TECH as a Process for Integrating Technology

Educators are now aware that there are a number of technology choices to select from (refer to Figure 1 for some examples of low-, medium-, and high-technology choices), and we have provided premises and principles as considerations for decision-making. Sometimes technological choices can be overwhelming, so it is helpful to have a process to follow when making these choices. TECH is an acronym designed to guide teachers through the process of integrating technology into instruction. TECH is comprised of four steps (refer to Table 3):

- **T**arget the students' needs *and* the learning outcome.
- **E**xamine the technology choices, then decide what to use.
- **C**reate opportunities to integrate technology with other (various) instructional activities.

- **H**andle the implementation, and monitor the impact on the students' learning.

Insert Table 3 about here *[possible TEC GRAY BOX]*

Each step is described next with several examples of what might be considered within that step.

***T**arget the students' needs and the learning outcome.*

"Learning outcome," as used in this article, is synonymous with curriculum standard or content goal or similar terminology that school systems or states may use to describe the learning that students should achieve as well as content identified on students' IEPs. In the first step of TECH, it is important to note that some learning outcomes are more easily learned or more complex than others. The degree of difficulty for a learning outcome is dependent on two things. First, the learning may be difficult for students who have limited background knowledge in an area or who have particular difficulty with some aspect of learning. Second, the learning outcome itself may be quite complex, and most students (whether they have disabilities or not) may have problems quickly grasping the outcome or demonstrating proficiency without sufficient and varied practice opportunities. So it is not just that a learning outcome is targeted in this step of TECH, but also that the learning outcome's complexity as perceived by the students is factored into the educators' choice of *which* learning outcome may be targeted. Some examples are:

- **Example 1:** A student with learning disabilities has difficulty remembering the steps to solve polynomial equations, so the teacher targets "solve polynomial equations."
- **Example 2:** A student with expressive communication difficulties is working on full participation in all classroom activities as well as on initiating conversations with peers as stated on the IEP.

***E**xamine the technology choices, then decide what to use.* Does your school, grade level team, or department have a recent and comprehensive listing of their technology resources?

Ask questions like this to make sure that you are aware of resources already available. When you know what you have to choose from, then you are better able to see if there is already technology available, or if there is a need to request specific technology. Refer to Figure 1 for a listing of some low-, mid- and high-technology choices. There are varied definitions to characterize low-, mid-, and high-technology items (e.g., Behrmann & Jerome, 2002; Blackburst, 2005). In this article we refer to low-tech technology as items that are not electronic (e.g., using sticky notes to guide students through reading a passage). Medium-technology items are simple electronic equipment like single message communication devices, tape recorders for taking notes, and manual wheelchairs for mobility. High-technology items are more complex and/or specialized, such as computers, software programs, and eye-gaze devices.

Insert Figure 1 about here

Ensure that you are aware of AT specified on students' IEPs. The TECH process applies for AT as well, because there is still the need to integrate the AT into instruction. Continuing with each of the examples used in T of TECH above, the scenarios proceed:

- **Example 1:**
  - Targeted learning outcome: *remembering the steps in solving polynomial equations*
  - Examining technology choices, then decide what to use:

Technology choices for remembering the steps in solving polynomial equations can include low-technology, such as writing the steps on an index card for the student to use, medium-technology, such as referring to an internet site that identifies the steps, or high-technology, such as software that features solving polynomial equations and includes prompts and examples of solutions that students can use as guides throughout solving the equations. Which choice encompasses all four principles described previously for integrating technology into instruction? The index card is the best choice here, and so the decision should be made to use the low-technology method. Keep in mind, also, that the medium-technology choice of using an internet site that identifies the steps may also be motivating and provide some variance in how the student accesses the steps. However, the high-technology choice is not necessarily helping the student *remember* the steps if the software program actually guides the student to doing the next step in solving the equation.

Although all three technology choices could be used at various points during the instructional unit, none of these choices in isolation assists the student in remembering the steps. The index card or internet site (the low- and medium-technology choices) must be preceded by teacher demonstration of how to solve the polynomial equation. In fact, the high-technology software noted above may be an excellent match for demonstrating the content. Vary the practice activities and opportunities that all students have to acquire proficiency in solving the equations. For example, have students develop a mnemonic that aids them with remembering the steps in solving the equation (similar to how My Dear Aunt Sally reminds students solving division problems to multiply, divide, add, then subtract as the steps). These types of activities lead to the C part of TECH on creating the learning activities that incorporate the technology. First, read how TE work for Example 2:

- **Example 2:**
    - Targeted learning outcome: Full participation in all classroom activities as well as on initiating conversations with peers.

- Examining technology choices, then decide what to use: In this case, after examining different possibilities and trying them out with the student, the decision was made for the voice output communication device.

C*reate opportunities to integrate technology with other (various) instructional activities.* A natural extension after examining the technology that meets the students' needs and learning outcomes, then deciding which technology to use, is to plan the instructional activities that either feature the technology as one method of instruction or practice, or integrates the technology as part of an instructional or practice activity.

- **Example 1:**

Continuing with the learning outcome of solving polynomial equations, and also staying focused on students with learning disabilities who have memory issues (so remembering the steps in problem-solving is more difficult for them), educators' planning expands to create opportunities to integrate the technology as an activity choice or as part of an activity. Whether the technology is used as a single activity or within an activity, the technology is not a stand-alone or fragmented activity. Careful planning must occur to create both natural and motivating opportunities that support and promote seamless technology integration. Thus, after allowing student to work on polynomial equations using a software program, a teacher may consider taking a screenshot of that program and using that screenshot with manipulatives during instruction or guided practice activities.

Educators create the activities' sequence and flow so that students have multiple and varied opportunities to learn, practice, and use the instructional content. Creating the opportunity to use the technology is followed by the actual implementation of the activity, and complemented with monitoring students' learning to ensure that the instructional activities promote desired growth.

- **Example 2:**

In the example of using a communication device for students to participate in classroom activities and conversations with peers, professionals then consider the multiple opportunities across the school day in which they can create opportunities for technology integration of the voice output communication device. At this point in the TECH process, it may also become apparent the range of pre-recorded messages that can be used, what the students and others need to know about how to use the device. As these items are identified when creating opportunities to integrate the technology, the flow to the H step in TECH is quite natural.

H*andle the implementation, and monitor the impact on the students' learning.* Educators know that it is not simply a matter of deciding what to do for an instructional activity; there are many factors to be handled to grow the idea of the activity into the activity-in-action for the students. In Example 2, handling implementation requires programming and modifying the pre-recorded messages to fit multiple situations. Involve students by having them choose pre-recorded messages. Consider that their participation in the history Jeopardy game is as important as their expression of preferences or communicating with peers.

Aspects of handling the implementation of instructional activities include the following:

- Identify and acquire any materials needed for an activity (e.g., are batteries needed for the technology?).
- Decide how the students will do the activity (if it is a practice activity) or how the teacher will present the activity (if it is a demonstration activity).

- Demonstrate and practice the activity with students so they know how to use materials, what to do first, etc.
- Determine when within the instructional sequence the activity fits (e.g., is it a demonstration activity? Guided practice activity? Independent practice activity?) and how it is possible to extend technology utilization across other activities as well.
- Designate where the activity occurs (e.g., is an electric outlet needed for technology? Is internet access necessary?).

Planning for implementation can be time-consuming, but is necessary for the implementation itself to run as smoothly and efficiently as possible so as not to waste instructional time and learning opportunities. Additionally, ensuring that the learning opportunities are resulting in desired increases in students' achievement requires that some type of monitoring of students' performance is occurring. This does not mean that students are assessed in a formal or lengthy way after each instructional activity, but it does mean that the series of activities (which now include technology either as an activity choice or imbedded into the instruction) promote students' proficiency toward the learning outcome. To monitor students' growth, a variety of brief and informal methods can be used, such as:

- Feature the learning outcome as a warm-up activity after students have had some demonstration and initial practice activities (e.g., solving a polynomial equation; identifying the steps in solving a polynomial equation).
- Develop curriculum-based assessment probes that incorporate problem types representing the unit's or semester's learning outcomes, and have the students complete as many of those problems as they can in a brief period of time (e.g., one minute). Use the probes

across the instructional sessions, graph the number of correct responses, and examine the data points to ascertain an ascending aimline, indicating growth in learning.

Conclusion

Educators *and* students have diverse needs. Technology can be used to facilitate meeting those needs by maximizing how technology is used, with whom, and for what purposes. Getting the most out of the technology we have or have access to requires thoughtful planning and decision-making. Moreover, the skills and technical assistance required for educators to integrate technological activities into curricular tasks cannot be minimized. If technological devices are available but technical support is not, the devices' use is limited. Consequently, when selecting technology and integrating it into curricular activities, calculating the costs of technical assistance and support is also necessary. It is important to make sure that technical support and resources are available to ensure educators know how to use the technology, have sufficient resources to use it, and have timely responses when equipment is not working.

Finally, monitoring how well students are performing when technology is integrated is essential. If students' performance is not resulting in satisfactory and sufficient gains, then educators need to know that and make refinements and revisions. Ultimately, technology as an instructional tool is among many choices educators make when planning, delivering, and assessing the impact of their instruction. Acknowledging the premises and adhering to the principles described in this article, as well as following a process such as TECH, may increase the likelihood that those instructional decisions are sound and result in enhanced learning for students with and without disabilities.

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Table 1. Three premises for integrating technology into instruction.

Premise 1: Technology used well in schools today better prepare students with disabilities for careers that require some level of aptitude with technological skills.	
Example: Students who use writing or graphic or calculation software to perform school-based tasks acquire marketable skills.	**Nonexample:** Students who never get a chance to practice sending an email or using an ATM.
Premise 2: Technology enhances the learning process; technology is not the learning.	
Example: Students who use a communication device with preprogrammed grammar rules to fully participate in the language arts overview lesson.	**Nonexample:** Students whose IEP goals state that they will learn how to use a communication device with 90% accuracy.
Premise 3: Technology changes quickly. Educators pool their expertise to keep up with what is available and how technology can most effectively enhance instruction and practice.	
Example: Ms. ABC, the mathematics chairperson in a middle school, sets aside time during monthly department meetings for the technology specialist to share software and internet programs. The technology specialist focuses most on finding resources related to math concepts that the math teachers previously identified as particularly complex for students to understand.	**Nonexample:** Mr. XYZ, the fourth-grade team leader, is the only one on the team who is interested in keeping up with technology. He feels overwhelmed; by the time he’s reviewed a piece of equipment or software and had it approved for use, there’s something new out that is less expensive and seems easier to use.

Table 2. Checklist for Principles for integrating technology into instruction.

[***THIS CONTENT COULD BE A GRAY BOX OR SIDEBAR IN TEC]***

Principles for Integrating Technology Into Instruction	
	The technological content matches specific curriculum outcomes.
	The technology is used at a point during instruction that matches the technology's purpose and the students' learning stages.
	The technology is age-appropriate and does not unnecessarily draw undesired attention to the student's disability.
	Low-tech, less-expensive options are first considered and utilized if they address the purposes of instructional activities and support students' abilities and needs.

Table 3. TECH as a Process for Integrating Technology into Instruction

[***THIS CONTENT COULD BE A GRAY BOX OR SIDEBAR IN TEC]***

Target the students' needs *and* the learning outcome.
Examine the technology choices, then decide what to use.
Create opportunities to integrate technology with other (various) instructional activities.
Handle the implementation, and monitor the impact on the students' learning.

Figure 1. Checking out choices for integrating low-, medium-, and high-technology into instruction.

Speech recognition software	Clear or colored transparencies for reading, writing, and math	Talking spell checkers and single word scanning devices	Illustrations with text
Language master	Graphing and computation programs	Slant boards and pencil grips	Augmentative and alternative communication (AAC) devices
Multimedia software for students' productivity and publishing	Colored markers, color-coding, and highlighters	Templates and graphic organizers	Video and computer simulations
Audio and video recorders	Portable and talking word processors	Manipulatives and calculators	Word prediction and abbreviation expansion software
Electronic books and instructional games	Single message communication devices and eye gaze boards	Symbol charts	Simple to more complex switches