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ABSTRACT

This seminar report focuses on two major topics: (1) uses of technology with mildly handicapped students which are based on research and promising practices; and (2) the role of technology resource personnel (TRP) in helping teachers to integrate technology and instruction. The report is presented in three sections: Section One outlines a consulting model for working collaboratively with teachers; Section Two presents a case study of computers and writing that describes key elements of a successful TRP consulting model, and suggests specific hardware, software, and teaching strategies to support students with special learning needs in writing. Section Three highlights research conclusions that have important implications for practice. These include: technology alone is rarely the answer; the principles of effective instructional design and teaching practice also apply to technology-based instruction; computers can help special needs students develop automaticity and problem solving skills; the computer is a collaborative tool; and students need basic machine skills. A list of 17 recommended readings to support the findings is also included. (DB)

Final Report

of the Seminar on Technology Integration

Center for
Special Education
Technology

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Preface

In November 1990, a group of researchers and school practitioners met in Reston, Virginia to reflect on what we have learned about using technology to support students with mild learning handicaps in mainstream and special education classrooms. The goal of the seminar, planned and directed by the CEC Center for Special Education Technology and funded by the U.S. Office of Special Education Programs, was to identify key research findings related to technology integration at the classroom level and to explore ways of presenting this knowledge so that the technology specialist's work with and support of teachers over time is illustrated in a 'real' classroom-based problem solving context.

Representing a wide range of talents and experience, the group generated lively and thoughtful discussions during the seminar that led to the general framework and content of this report. While Bridget Dalton and Rich Devir took on the job of translating the group's work into a written report for school personnel interested in special education technology, both the process and products were viewed as a collaborative endeavor of the invited participants.

Seminar Participants:

Robert Bresnahan, Cahokia Unit School District, Illinois

Becky Daly, Fairfax County Public Schools, Virginia

Bridget Dalton, Education Development Center, Inc., Massachusetts

Rich Devir, Walden School, BOCES, New York

Dave Edyburn, Learning Technology Center, Peabody College, Vanderbilt University, Tennessee

Jeffrey Hummel, Technology Integration Project, Center for Technology in Human Disabilities, Maryland

Pat Jamison, Center for Effective Special Education, Prince George's County Public Schools, Maryland

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Introduction

Ms. Diaz, the technology resource person (TRP) for several elementary/middle schools, returned from lunch to find several pink message slips on her desk:

> Three of the four printers in the lab are jammed again! Help! (A.S., resource room teacher)
>
> I need to submit the teacher training budget for next year. Let's meet to discuss needs in the technology area. (K.L., director of special education)
>
> The drill and practice math software I'm using isn't helping the kids who need it the most! Any suggestions for new software, strategies? (J.J., fourth grade teacher)
>
> I've got a child with mild cerebral palsy who's having a tough time on the computer. Can we get her a modified keyboard? (M.L., special needs consulting teacher)
>
> We want to use a database program to collect and analyze the data from our science project on school garbage, but are afraid the LD students will get lost. Can you help plan/teach the database lessons? (R.E., eighth grade teacher and D.D., resource room teacher)

As Ms. Diaz skimmed through her messages, she remembered how just a few months ago she felt overwhelmed by the range and diversity of the requests for help. Despite her technology training and teaching experience in a special needs resource room, she felt ill-prepared to be an "expert" in so many areas—technology, special needs, staff development and support, and curriculum and instruction! She had quickly learned, however, the value of collaboration, relying on other teachers' and school personnel's expertise to complement her knowledge of technology and special education. By asking key questions and listening carefully to teachers as they described their instructional goals, their students, and their classroom practices, she found she was able to use her specialized knowledge to guide teachers in making their own decisions about how best to use technology to enhance the learning of their students, and particularly, those students with special learning needs.

Scooping up software and teacher resources on writing, Ms. Diaz headed out the door for a 'coaching' session with a small group of teachers who were learning to use a word processor. She continued to think, however, about the requests on her desk and how she might help. She'd take care of the printer crises later today (she had a new *Troubleshooting Printer Problems* guide sheet she wanted to give A.S.).

Several teachers were concerned about developing their students' math facts automaticity—perhaps she and J.J. could get a small group together to try out

some promising new software she'd seen demonstrated at a recent TAM conference on special education technology. A garbage database? She wasn't sure what R.E. and D.D. wanted her to do—she'd better set up a planning meeting...

The purpose of this report is to help technology resource personnel (TRP), who, like Ms. Diaz, provide support and technical assistance to teachers who are using technology to enhance the learning and development of students with mild to moderate learning handicaps in both mainstream and special education settings. As the scenario above illustrates, the demands are quite diverse and individual situations can be complex. Good decisions about how to use technology reflect an understanding of the learner, the curriculum, the instructional context, the teacher, AND the technology resources. These informed, comprehensive decisions often require collaboration among classroom and special education teachers, technology specialists, curriculum specialists, and other school personnel. And while a single teacher can be the catalyst for change in her school, successful technology integration generally requires support from various organizational levels, with the school principal playing a key role.

The goals of this paper are twofold—to highlight "what we know" about using technology with mildly handicapped students, based on research and promising practices, and to illustrate how a TRP can successfully work with teachers to integrate technology and instruction.

The report of the seminar is presented in three sections:

- Section One outlines a consulting model for working collaboratively with teachers. (Bridget Dalton)
- Section Two presents a computers and writing case study that describes key elements of a successful TRP consulting model, as well as suggesting specific hardware, software, and teaching strategies to support students with special learning needs in the important area of writing. (Rich Devir)
- Section Three highlights research findings that have important implications for practice. A list of recommended readings to support the findings discussed is also included. (Bridget Dalton)

It is hoped that this information will be useful to special and regular education teachers, administrators, teacher trainers, and consultants. The challenge is great, but so is the potential pay-off for our students, teachers, and schools!

SECTION ONE: PROCESS IS IMPORTANT

Overview

For those technology resource personnel (TRPs) who know a fair amount about technology and teaching, but are new to the teacher consulting process, there's the additional challenge of learning how to be an effective consultant. Simply having the technological know-how is not enough to guarantee teacher/school change, or student success! It's easy for the technology expert to get carried away with his or her own vision of what "could be", and lose a novice teacher in the process...

This section is designed to assist TRPs who want to develop their consulting skills. It presents a 'generic' consulting model that outlines three key phases of the consulting process, and highlights some principles for consulting in the field of special education technology. The computers and writing case study in Section 2 makes this process "come alive" as it describes how a TRP, classroom teacher and resource room teacher work together over the course of a school year to integrate technology and writing process instruction.

The Technology Consulting Process

Phase 1: Understanding The Technological Preconditions

The TRP needs to have a general understanding of the level and type of technology that is available to a particular teacher (either immediately or in the future), when considering goals and making recommendations for instructional applications. Basic questions include:

- What kind, and how much hardware is available?
- What kind, and how much software is available?
- What is the level of access to the technology?
- What is the physical environment?

Phase 2: Goals and Planning

In this phase, the TRP listens as the teacher describes her goals, which may be very general (e.g., I want to develop my kids' problem-solving skills), and asks a series of questions to elicit the teacher's assessment of her students' needs (e.g., How would you describe your students' current level of problem-solving skill? What's the range of skills?); her curriculum goals (e.g., Would you like to develop these skills in math, as well as other areas such as science and social studies? What kinds of thinking would you like to encourage?); her instructional philosophy and practices (e.g., describe a lesson or unit you thought was particularly successful for all your students—even those with learning difficulties); her classroom management style (e.g., What kinds of student groupings do you use—whole class, small group, pairs, individual?); and her ease

and comfort with technology (e.g., What kinds of experience do you have using the computer for personal, professional, and instructional purposes?)

The TRP offers suggestions, drawing on her knowledge of effective technology use, special education, and effective teaching practice. Together, the teacher and TRP (and possibly a curriculum specialist, as well) develop a plan of action for using technology to support their educational goals in a way that reflects their combined knowledge and expertise. The plan includes specific adaptations and strategies for students with learning handicaps, as well as suggestions for continued TRP follow-up and technical assistance. For example, after learning that the teacher interested in problem solving wanted her students to develop and apply their math computation and problem solving skills in another 'real' context such as science, the TRP recommended a program available in her school, the *Voyage of the Mimi Whales and Navigation* multi-media program (Bank Street College). In this unit, students learn about whales and navigation as they engage in a series of computer simulations that culminate in a race to save a whale trapped in a fishing trawler's net. Students work in teams to save the whale, gathering data, computing navigational direction, motoring speed and distance, and problem-solving as complications arise. Students not only develop math and problem solving skills in a meaningful context, but have a lot of fun in the process!

Phase 3: Implementation and Follow-up

As the teacher carries out her instructional plan using technology, she meets with the TRP periodically to reflect on how things are going. In addition to discussing what works and doesn't work at the class level, they review the progress of those students with special learning needs. Together, the teacher and TRP update their goals and revise their instructional plan. Continuing the example described above, the teacher decided to have the students go to a "orienteering" treasure hunt in the school to give her students, and particularly those with learning handicaps, a better understanding of how a compass is used in navigation. In addition, after observing that many of the LD students were having difficulty collaborating with their team mates, she integrated strategies for effective collaboration in her lessons, and had students focus explicitly on this important skill. These adaptations were key in making the learning experiences successful for ALL her students.

The current research emphasizes the complexity of the technology integration process. Some key findings that are directly relevant to working effectively as a TRP at the classroom level are presented below.

Technology Integration Is An Evolutionary, Dynamic Process

A TRP is always working at two levels, responding to teachers' immediate goals and needs, while stimulating and supporting teachers to develop and pursue intermediate and long term goals for effective technology use. The resource

person is also continually balancing goals with technology availability and access, working to expand future technology options while trying to maximize the potential of current resources.

Teachers Need a Variety of Supports to Integrate Technology and Instruction Successfully.

Teachers' expectations, experience, and ease of comfort using technology vary widely. However, most teachers are willing to try an innovation if they think it will help them do a better job teaching. When planning how to work with an individual teacher or group of teachers, remember that they are more likely to invest themselves in learning how to use technology effectively when they:

- See the direct link between their curriculum and instructional goals, their students' needs, and the technology (hardware and software capabilities).
- Have a basic level of "machine skills" competence so they can troubleshoot common problems as they arise.
- Have strategies for managing a computer-supported learning environment.
- Have ways on and off the computer to assess their students' progress.
- Are able to count on a resource person for technological assistance, teaching suggestions, and sometimes, just understanding and emotional support.
- Have concrete administrative support.

Collaborative Decision-making is Key

The best decisions about how to use technology to enhance learning are made when teachers and TRPs collaboratively develop goals and plans that reflect their various areas of expertise about the student, the technology, the teacher, and the curriculum and instruction. Administrators, curriculum specialists, and other specialists can also be key players in this decision-making process.

Having a vision is important, too.

Although it's important to begin by "helping teachers where they are," this strategy will only take you so far. It's equally important to give teachers opportunities to see where they might go with technology-based instruction. Often this will entail fundamental changes in how they teach and respond to their students. But that's why schools are investing in technology — so that we can do a better job educating our students! And, if you work with teachers over time, both you and they will change!

SECTION TWO: COMPUTERS AND WRITING CASE STUDY

The case study on computers and writing describes how a TRP, a classroom teacher, and a resource room teacher work together over the course of a year to integrate computers and writing instruction to benefit students with learning handicaps in a mainstream classroom. It highlights the consulting process, as well as providing specific strategies for implementing a computer-supported writing process program.

The Setting

The Players. This case study involves three educators and a fifth grade class at Elm Street Elementary School. Joe Mannow, a special education resource room teacher (RR), and Kathy Sherwood, a fifth grade classroom teacher (CT), work at Elm Street full time. Rosa Diaz, the technology resource person (TRP) whom you met in the opening vignette, is employed by the school district and visits the school weekly. She has approximately one hour a month available to devote to the needs of Kathy's class.

Computer equipment and software. The school has a moderate amount of computer equipment available. Kathy, our classroom teacher, has access to a computer lab with 20 free-standing Apple computers for three 45-minute periods per week. Ten of the lab's computers are Apple IIGS models with 512 K of memory, and 10 are 128 K Apple IIes. Kathy and Joe, the resource room teacher, each have one Apple IIe computer available for classroom use. While the software selection is somewhat limited, it does include a new word processing program.

General goals. The administration wants to encourage both the development of writing skills and informed use of technology. To accomplish these goals, the district paid some of its personnel, including Kathy, to take a short course in word processing over the summer. Rosa (TRP) taught the course. While it was Kathy's first formal exposure to a systematic use of technology in the classroom, she was excited about using computers to support her writing program. An experienced writing teacher, she uses a "writers' workshop" approach in her teaching (Calkins 1986). Kathy (CT) establishes a classroom writing community where she and her students work together to write pieces that are personally meaningful, that effectively communicate with an audience, and reflect a gradual increase in their understanding and use of writing strategies, genre knowledge, and writing conventions. Kathy thought the computer could support a process approach in a number of ways, and was particularly looking forward to getting rid of the onerous task of rewriting and revising handwritten drafts.

The students. As of August 1, when Kathy (CT) checked her roster, the class consisted of 23 students, including two labeled as learning disabled by the district's Committee on Special Education. The first, Lynn, exhibits handwriting, coordination, and spelling problems. Her work is usually sloppy, with lots of cross-outs and smudges. The second, Patrick, lags behind the rest of the class in most academic areas. He is a reluctant student who produces very little in the way of written work. Both Lynn and Patrick will be seen regularly by Joe (RR) in the resource room. In addition to these two special education students, Kathy's class contains several students who function below grade level. The remainder of the class exhibits the usual range of problems seen in any cross-section of a normal school population, including acting out behavior.

The Goals and Concerns

As Rosa (TRP) drives to work, she is thinking about Kathy (CT) and her class. When they met over the summer in the Word Processing course, the two had talked about Kathy's prospective class and her desire to conduct a Writer's Workshop program. Rosa is looking forward to working with a teacher with expertise in writing. That expertise will complement her own knowledge of computer technology. She is especially interested in furthering good pedagogy both on and off the computer. Technology has little value in isolation, she feels, and can be most helpful when used as a adjunct to effective teaching practices. Rosa is hoping to find ways of making technology serve teaching and learning. The collaboration with Kathy and Joe seems like a great opportunity.

Kathy is determined to put her new computer knowledge to work. She wants every child to have success in the writing program. The summer course in word processing held out the promise of more effective writing instruction. Her immediate concern is with numbers. Can 23 students use 20 computers? How will they take turns? There's no denying some apprehensiveness about the year ahead.

Joe is pleased to be working on the writing project with Kathy and Rosa. His goal for the year is to ensure the smooth integration of two learning disabled students into a regular fifth grade class — a class that has its share of students with learning problems, even though they may not be 'special education' students. Moving from a small special education class to a full-sized group won't be easy for Patrick and Lynn. Joe hopes the computer program will help. He is confident that the LD students will be able to make good use of computers; they've had plenty of experience using them in their special education classroom.

The Visits

We will use Rosa's monthly visits to Kathy's classroom as opportunities to show how a technology resource person can constructively serve the needs of teachers and their learning handicapped students. Our first visit occurs in September.

September

Issue #1. Kathy opens the conversation with her *concern about numbers of computers*. What alternatives does she have when there are more students using the lab than there are computers?

Recommendation. Rosa (TRP) and Kathy agree that there are writing tasks that don't have to be performed at the computer. Kathy decides to use the two tables in the front of the room for peer conferences, student-teacher conferences and art work. Partners can sign up to use the table for their conferences, which occur throughout the composing and revising process as they share and respond to each other's writing. In addition, small groups of students can use the tables to create illustrations and design covers for their work. Rosa also suggests some students may want to write a piece collaboratively. Not only will they share a computer, but they will exchange lots of good ideas about writing while they compose together.

Issue #2. Later, Kathy tells her colleagues about a new problem. Herb, a new student whose family moved to town in August, has cerebral palsy. His speech is hard to understand and he has poor motor control. *Kathy is not sure that Herb can physically manage the keyboard.* However, as a mainstreamed student, can he be denied the same access to computers as his peers? Rosa, who observed Herb in the computer lab, agrees that he has difficulty striking the desired keys. He is able to come close to the correct key, but often as not strikes a neighboring one, or sometimes two keys at once. Writing with a word processor in this manner, with frequent deletions necessary, would be slow and frustrating.

Recommendation. Rosa recommends that Herb be given a key guard. This is a clear plastic frame which fits over the computer keyboard, with a hole drilled for each key. This device makes it almost impossible to strike two keys at once, and focuses the attention of the user on individual keys, thus promoting accuracy.

Issue #3. While most of the students manage the word processing program well on their first visits, thanks to several days of instruction and the establishment of management routines, Rosa observes that *Kathy's class has a broad range of keyboarding skills.* Some students, including Lynn and Patrick, were able to produce only a sentence or two during the period.

Recommendation. Rosa tells Kathy about a developmental keyboarding program available from the school's software library that has a systematic drill component and a game segment for further practice. She emphasizes the importance of developing students' keyboarding skills, suggesting that students practice two to three times a week for short, 10 minute sessions. Kathy decides to save the last ten minutes of her computer lab time for keyboarding and sets up practice time in her classroom.

October

On the whole, Kathy's computer-supported writing program is working well during its first month. However, several issues have emerged.

Issue #1. After Herb's keyguard was installed, his keyboard accuracy increased appreciably. However, his disability causes him to leave his finger on a key after striking it. This triggers the computer's automatic repeat feature, *causing rows of extra letters to appear on the screen*. This has been yet another cause of frustration for Herb.

Recommendation. Kathy tried calling Rosa about the problem, but was unable to reach her for several days. Once she reached Rosa, however, the solution was easy. It involved using the Apple II GS's control panel - a set of electronic adjustments that affect the running of the computer. Using the control panel is a complex process for a beginner, so Rosa conveyed the instructions to Joe, who was able to turn off the automatic feature on Herb's computer.

Issue #2. *Kathy was quite frustrated when she couldn't reach Rosa for technical help.* She felt Herb had lost valuable writing time and that he was viewing the computer as yet another hassle. She was also afraid that other technological glitches would come up that she wouldn't be able to handle.

Recommendation. After talking with Kathy, Rosa agrees to set a time each week when she will be available for telephone consultation. This time is to be publicized in the school district's staff newsletter so that other staff members can take advantage of Rosa's expertise as well.

Issue #3. *Several of the students write very little during their lab sessions.* Kathy has heard about "pre-writing" software and wonders if it might be helpful.

Recommendation. Although Rosa is familiar with some of the pre-writing software, she thinks that it is often too constraining, turning writing into a boring step-by-step procedure. She suggests that Kathy think about the different strategies she used to help students generate and develop their ideas — before they wrote on computers — and apply them in this case. Kathy and Joe brainstorm various strategies (modeling, dialoguing, drawing, brainstorming, oral

retelling) and decide to gather a small group of students together before the next computer session to work on this issue.

Issue #4. Another issue is spelling. Kathy is aware *that a spelling checker is available as an add-on to the word processing software, but is not sure about making it available to the students.* The convenience of automatic correction is appealing, but she feels that spelling is important enough that she should know which students are making mistakes so that she can help them improve their spelling skills.

Recommendation. Rosa, Joe and Kathy agree to hold off on teaching students how to use a spelling checker until the second semester. For now, students can use the dictionaries available in the lab. In addition, Kathy will have a hand-held Franklin spelling checker available at the editing table. Students can type in words they are unsure of and get several suggested spellings. They have used this editing tool in the classroom and are familiar with it.

November

Kathy (CT) has two questions this month. First, she reports on keyboard skills.

Issue #1. Kathy has been using the keyboarding program recommended by Rosa for ten minutes each lab period with generally good results. However, *several students are fooling around, skipping the skills development section and playing the game.* Given the size of the group, Kathy can't monitor all the children all of the time.

Recommendation. Rosa suggests a different keyboard program that has no game and that prints out a status report on each student. Joe volunteers to work with students who need extra help. He will schedule extra time in the resource room and observe students closely to determine what seems to be the problem. He thinks students will enjoy using a computer graphing program to record and printout a chart of their progress, and the information will help Joe and Kathy monitor their progress.

Issue #2. Kathy's second question is about curriculum. Since students are now comfortable with the word processing software, she would like to *expand their computer writing skills to another content area.* For example, the fifth grade social studies curriculum includes a special unit on local history. Does Rosa have any ideas?

Recommendation. In discussing further uses of writing, the three teachers devise a social studies timeline project. Rosa suggests Tom Snyder's Timeliner, a program that produces graduated timelines with sufficient room for text to be added for any period from a day to a decade. After the timeline is printed, with

each decade marked, the students can be assigned particular eras in the history of the community. Kathy and Joe discuss how students can use their upcoming visit to the local historical society's museum to gather information about events or artifacts from his particular era.

They agree to schedule the visit so that Joe can accompany the group and help some of the students take notes. After the visit, students will write their reports on the computer, print them out and mount them on the timeline at the proper place. Then the timeline will be ready for display in the school library, along with students' artwork and crafts illustrating the town's history.

December

Rosa, Kathy and Joe gather this month a little weary and looking forward to the holiday break. After a few minutes sharing successes of the local history timeliner writing project, they switch gears to problem-solving issues.

Issue #1. Kathy passes on a question concerning Herb, the student with cerebral palsy. *Herb's parents want to buy him a computer*, since they feel it will help Herb communicate better, aid him with school work, and occupy his spare time constructively. Herb's mother would also like to use the computer to help keep the financial records of a volunteer organization of which she is treasurer. Would Rosa recommend that the parents buy the same model Herb is using at school to insure compatibility?

Recommendation. Rosa makes a different recommendation. She feels the parents should find a computer suited to their needs that can be adapted for use by Herb (e.g., it should have an adequate software library and accept a keyguard). Too often, parents buy a computer just for their children. With changing times and interests, the computer is often not used and then becomes a source of stress within the family. Rosa has found that children adapt easily to different computer models and formats. If Herb is working on a special writing project that needs to go back and forth between school and home, it's possible to use the library's computer to translate text that has been saved as an ASCII file from one computer system, such as an IBM, to another, such as the Apple. Rosa agrees to speak to the parents and help Herb's mother decide what models will meet both her needs and Herb's.

Issue #2. Rosa has enjoyed watching Kathy teach mini-lessons on how to strengthen your writing by adding descriptive detail, getting rid of extraneous information, and reorganizing the sequence of ideas so they flow and make sense to the reader. However, she has noticed that many *students are using the computer's revising features inefficiently*, by backspace erasing and/or rewriting whole chunks of text when they could be inserting/deleting/moving text. Rosa agrees that students' need some help in this area, but asks for suggestions in how to teach these skills in the context of students' own writing.

Recommendation. Joe suggests that he and Kathy team teach a few lessons on these more advanced word processing skills, using examples from students' own writing. They can use a large screen monitor to model how to use a specific revising feature (e.g., block move) to accomplish a particular writing goal (e.g., I want to move this part to the end). Then students can practice it in their own writing.

January

This month's consultation focuses on revising.

Issue #1. Kathy sees most of her students using the word processor's editing features appropriately. Revising is less of a chore than it is with paper and pencil writing. Joe, however, reports that the *students he sees in the resource room have not made the transition to electronic revising*. Aside from correcting spelling errors, they seem to expect the first draft to be the final draft.

Recommendation. Joe and Rosa turn to Kathy for help with this problem. Kathy acknowledges that not all students spontaneously apply the strategies they learn in the writing workshop mini-lesson to their own writing. After outlining a peer editing strategy she uses to help students respond to each others writing, she and Joe decide the LD students need more structure and teacher instruction in how to carry out a conference successfully. Joe describes a peer editing method developed by MacArthur (1990) that has been successful in improving LD students' revising process and writing quality. Kathy decides to adapt the strategy for use in her classroom, but asks Joe to work individually with each of the LD students so that he can guide them through the process while they are learning this important skill.

February

Issue #1. *There is good news on revising this month.* Kathy and Joe have been working on the project jointly. Kathy worked with small groups to introduce the revised peer editing strategy, while the rest of the class wrote on the computers. Joe taught his students in the resource room. He found it helpful to use a story he was writing about a fifth grade class to show how an author thinks about his writing when revising and to model the conferencing process. He asked students to focus on a particular concern (e.g., I need help with my ending) and then responded to the ideas they generated as a group. As students' confidence has grown, they've volunteered their own writing for this group revision process. Of course, Joe has found that it's crucial that the "author" makes the final decision about whether a particular revision is useful or not. He and Rosa are both excited about the progress thus far, generating additional ideas about how to support students as they discover and build what it is they want to say in their writing.

Recommendation. Kathy and Joe plan to continue using the peer editing strategy, but want to explore other strategies as well. Kathy decides to have some of her most reluctant writers try writing a story on the computer with a partner to see if that will stimulate their thinking and writing.

Issue #2. Rosa also has progress to report. *She has obtained an LCD projection panel for the computer lab that can be used with an overhead projector to show the computer's display on a wall or screen.* Now Kathy can model the writing process on the computer and have students collaboratively respond to a students' writing that is projected on the screen. While Kathy is enthusiastic about the equipment, Joe has misgivings. He has worked hard to build his students' confidence and is worried that they may still be self-conscious about seeing their work held up to the rest of the class for criticism.

Recommendation. Kathy thinks the LCD panel will be an effective tool for most of the class, but agrees to ask children's permission before using any of their work. Joe will continue to work on revising in small groups in the resource room, while letting them know they can volunteer their work to be displayed on the LCD projector when they feel they are ready.

March

Issue #1. *The use of word processing in other content areas is discussed again.* The students will soon be preparing exhibits for a science fair. Kathy is looking for ideas.

Recommendations. Rosa recommends that this would be a good time to teach the students how to make templates. Templates are similar to forms. They give an outline with headings and allow the users to fill in content. These would be useful in reporting science experiments. Kathy and the students can design a form that will contain a basic outline of the elements of an experiment. One standard template will be saved on each student's data disk. Students can then "fill in the blanks" on the computer after they have finished their experiments. Completed templates may be displayed along with the student's exhibits at the science fair.

April

Issue #1. With the basics of word processing now in place, Kathy is thinking about a writing project that would allow students to publish their work in a professional magazine or journal format. *Could a computer be of further help in producing an attractive literary magazine?*

Recommendation. Rosa tells Kathy about a publishing program that allows users to choose different styles and sizes of type, make different-sized columns, and import graphics. The program has the convenient feature of accepting files from the word processing package Kathy is using. Rosa gives a quick

demonstration to Joe and Kathy, who decide to use it. The next issue is artwork. Rosa tells her colleagues about a good computer graphics program. All three agree that hand-made student art work is also effective and appealing and should be included in the final product.

May

Issue #1. Kathy's class and their work in the lab have attracted attention throughout the school. *The principal has asked Kathy to present some of her students' work at a meeting of the Board of Education. Joe recommends using a multimedia presentation package*, Slide Shop (Scholastic, 1991). This package combines text and graphics with sounds. Used with the LCD panel or a large monitor, it can effectively show what the class has been doing. Students can work individually and in groups to design and save a series of computer screens. The package shows the screens in a slide-show format. Rosa mentions that the district has just gotten a video-overlay card that allows students to integrate video into the Slide Shop program. Students could use the school's minicam to film segments, in addition to the graphics, sound effects and text. Joe, Rosa and Kathy are excited about using the program.

Recommendation. Since Joe is already familiar with the Slide Shop program, he and Kathy agree to team teach this special unit. While Rosa focuses on designing the instructional supports, Joe will prepare his resource room students to be "slide shop experts" so that they can help their classmates learn how to use the program. Rosa volunteers to help out with the video filming and production of the final project. She will also be present at the Board of Education meeting to ensure there are no technological glitches!

June

This month's session is devoted to reviewing the year's progress and planning for next year. As the three colleagues look back, they recall their feelings in September.

Final Thoughts

Rosa thinks that the computer program in Kathy's class has been a success. In fact, she's surprised at the number of technological applications Kathy tried (word processing, Time Liner, and Slide Shop), and wonders if the explanation lies in the fact that Kathy began with a strong writing process program and also had a strong partner in the school. Joe not only provided expertise concerning the students with special needs, but had prior experience using computers. Rosa is also pleased with the non-technological accomplishments. She fulfilled her goal for the year by giving technology the emphasis it deserves, but not at the expense of the writing curriculum. In this case, technology enhanced Kathy's instructional goals, and made it possible to do some things in new and different ways. As a last

note, Rosa thought about all the things she had learned about process writing — that would definitely help her do a better job next year!

Kathy remembers worrying about the number of available computers. The lack of a computer for each child was the least of her problems — actually not a problem at all! Ancillary activities constructively occupied more than four students. She is pleased with the results of the class writing project and already has ideas for next year's program. She's intrigued with the idea of using multimedia as a way of developing her "at risk" and special needs students literacy skills. Some of their best work emerged in their final slide shop presentation! She also is thinking about other ways to team teach with Joe next year. His help was invaluable!

Joe reflects on the progress made by "his" two students. Although not superior students, they have held their own, especially in the computer lab. He is confident that Lynn and Patrick are on the road to full integration into the mainstream. Like Kathy, he is also pleased at the success of his team teaching and wants to expand it next year.

Lynn, Patrick, and Herb have also learned a lot this year. Lynn is especially proud of the appearance of her written work. Her word processing assignments look as neat as the other kids. Patrick is still not a fluent writer. However, by the end of the year he had begun to write more complete pieces and was feeling more confident about sharing his writing with others. He also did a terrific job designing computer graphics for the slide shop presentation. Herb had found a way to communicate more easily with adults and with his peers. All three of these students have made progress this year, and technology, in combination with good teachers, rich curriculum and effective instruction, made it possible.

SECTION THREE: SOME GENERAL, BUT IMPORTANT FINDINGS

Researchers and practitioners developed the preceding case study to highlight some general, but important findings about technology and teaching. This knowledge verified that good instruction and good teaching continue to be cruicial, the computer is important in teaching special needs students, computers can be used effectively with groups of students, and students like computers but need skills to use them.

Technology alone is rarely the answer.

Simply providing the 'right' hardware and software is unlikely to have a dramatic effect on mildly handicapped students' learning. For example, the early research on computers and writing yielded somewhat disappointing results. Despite the capability of the word processor to ease the generating, revising, and editing aspects of writing, most students continued to write as they always had, composing a single draft and then cursorily editing mechanical errors. The importance of the larger instructional context emerged as teachers and researchers learned that students could make meaningful revisions in their writing, if they were taught specific writing strategies and if they learned how to operate the revising functions of the computer efficiently.

Helping teachers make good decisions about how to use technology depends on understanding their specific educational context—the classroom, the teacher, the child, the curriculum, and the technology resources. It is the interaction of the variables that is key. Unfortunately, we don't have many studies that examine the use of technology with special needs students in mainstream, naturalistic context, and particularly in regular education classes, despite our goal to use technology to help these students participate more fully in mainstream education.

Technology, in combination with good instruction, can improve students' learning.

The match between effective teaching practices and technology is particularly important in the case of tool software such as word processing, database, and graphics programs, but is also important in computer-assisted instruction (CAI). Teachers must establish the context, prepare students for usin[illegible]e technology, make links between the computer application and the larger in[illegible]ictional context, and monitor students' performance on and off the computer. N[illegible]erous studies have shown that mildly handicapped students learn more when [illegible]AI is used as a supplement to teacher-directed instruction than when CAI is used alone.

The principles guiding effective instructional design and teaching practice apply to technology-based instruction as well.

As Carnine, Gleason, Woodward and their colleagues at the university of Oregon have shown, effective CAI reflects many of the same design principles underlying curriculum design and teaching practice. Some of the design characteristics relevant to CAI include:

- direct teaching of strategies
- careful selection and sequencing of examples
- scaffolding (e.g., the student is provided a variety of prompts and supports that are gradually withdrawn as s/he develops concepts and skills)
- ongoing assessment
- immediate correction of errors, with linkage to previously learned strategies or steps
- many opportunities for practice
- chunking of new information into small sets
- cumulative introduction and review of information
- frequent, corrective feedback

Studies of tool-based software, such as word processing, show that the teacher's philosophy and approach to teaching determines how the software is used with students.

For example, in the EDC Writing Project, teachers who viewed writing as a series of discrete skills and emphasized the mechanics of writing had their students use the computer as a fancy typewriter, while those who viewed writing as a thinking process in which the text evolves over time taught their students specific strategies for developing and elaborating their text in several, non-linear encounters.

The effectiveness of graphics and sound effects depends on the specific design and purpose of the software and the characteristics of the learner. Research on computer drill and practice software indicates that 'bells and whistles' can interfere with learning, particularly if repetitive or if reinforcing an incorrect response. The issue has become more complex, however, with the increased sophistication of programs and the gradual increase in multimedia programs, simulations, and hypermedia environments that by their very nature depend on graphics, video and/or sound as a means of representing and building students' concepts and skills.

The computer can help special needs students develop automaticity.

Many students with learning disabilities have great difficulty automatizing basic skills and processes such as reading recognition, spelling, and math facts

computation. Hasselbring and his colleagues at Vanderbilt have explored how the computer can help students develop math facts automaticity. They found that the drill and practice math software available on the market is only marginally successful because it does not differentiate between those facts the student can recall from memory (albeit with difficulty) and those that s/he cannot. After hours of practice, the student generally increases his or her retrieval of facts previously known, but makes little improvement in relation to unknown facts. *CAMS – Cronometric Assessment of Math Strategies* (Hasselbring and Goin, 1986), is a drill and practice software that successfully develops learning handicapped students' math automaticity by directly instructing new facts and drilling on previously recalled facts. Their specific instructional design principles are relevant to automaticity work generally, and include the following:

"1. determine learner's level of automaticity
2. build on existing declarative knowledge
3. Instruct on a small set of target facts
4. Use controlled response times
5. Intersperse automatized with targeted nonautomatized facts during instruction"

Additional work on automaticity shows that students' can improve decoding skills by learning word analysis skills and that they benefit from CAI spelling programs that use a voice to present the target word, rather than a visual presentation.

Computers can develop special needs students problem solving skills.

Too often, special needs students are restricted to drill and practice software that focuses on skill building in isolation. Several researchers have been exploring how technology-based instruction can help students develop skills, conceptual knowledge and critical thinking in problem-solving contexts. Carnine and his colleagues have carried out a series of studies focusing on direct instruction of concepts and strategies within a specific content area, such as math or science. For example, Kelly, Carnine, Gersten and Grossen (1986) found that students taught basic fraction concepts through a traditional basal program made four times as many strategy errors as did students taught through a videodisc program, *Mastering Fractions* (Systems Impact, 1985). The videodisc program reflected many of the effective instructional design features discussed previously, including demonstrations and guided practice that focused on potential misconceptions and strategy confusions. The effectiveness of these design principles was further illustrated in a study comparing a traditional basal approach to teaching ratios and a videodisc program (Mastering Rations, 1987).

Hasselbring and his colleagues at Vanderbilt have taken a somewhat different approach to developing students' problem solving skills, designing and testing JASPER, a hypermedia learning environment that combines graphics, text, video and sound to engage students in constructing math concepts and problem solving skills. They capitalize on the videodisc medium to provide an interesting, and sometimes quite dramatic common experience that will "anchor" the instruction for teachers and students and help them connect what may be inert knowledge with experience to generate and solve 'real' problems. For example, students view Jasper as he motors down Cedar Creek to look at an old cruiser he wants to buy. They must use embedded information and strategies to figure out how Jasper can get his cruiser home before dark without running out of gas. Preliminary results suggest that fifth grade students working collaboratively in small groups in a complex learning environment such as Jasper are able to formulate problems and solve them successfully, and that these skills transfer to other similar tasks.

The computer is a collaborative tool.

Research on computers in the classroom has shown that technology can have a profound influence on the social organization, learning, and teaching that takes place. The computer supports collaboration in a number of ways. As students work together in small groups or pairs, they exchange ideas, information and strategies, ask questions, explain their point of view, negotiate conflicts, and alternate various roles. Collaboration fosters students' learning, as well as increasing their awareness and acceptance of others.

But collaboration poses challenges, as well as benefits, for students with special needs, and the interaction and learning that takes place varies depending on the task, and the size and composition of the group or pairing. Research from general education suggests that pairing students who have somewhat different achievement levels promotes learning for both students. Lieber and Semmel (1987) suggest that mildly learning handicapped students benefit from working with a nonhandicapped peer on a math problem-solving computer game. In any case, it's likely that students will need to learn how to work effectively in cooperative pairs and groups, in addition to learning how to use the specific software and hardware.

Special need students LIKE using computers.

School is often a frustrating and difficult experience for students with special learning needs. It's important to remind ourselves that the majority of these students, like their normally achieving peers, enjoy working on computers. This increased motivation often translates into more time spent in learning, and in some cases, an increase in self-efficacy. While some researchers have found that students' motivation declines as the novelty wears off, others have found that students maintain their interest over time, and that the motivational effect of

working on the computer extends to non-computer activities, as well. However, students' enjoyment and continued involvement is likely to interact with their capabilities and interests, the particular content area, the task, and software design.

In a recent literature review, Bialo & Sivin (1990) point out several factors related to students' enjoyment of computers. While these results may not directly apply to students with special needs, it seems likely that they are relevant. Students enjoy the active involvement, the feeling they have of "being in control" as they navigate a particular program, and the fact that they can make mistakes and obtain corrective feedback without embarrassment or penalty. They also enjoy the graphics and sound capability of the computer and game formats.

Access to technology makes a difference.

Teachers' decisions about how to use technology will be constrained by the technology resources available to them. Effective TRPs encourage teachers to develop immediate, or short term goals that match their instructional goals and students' needs with the available technology. At the same time, they help them develop and pursue intermediate or long range goals that may require additional technology resources, such as purchasing hardware and software, as well as other school resources, such as staff development and training opportunities in curriculum areas and in technology.

While one computer lends itself well to collaborative story writing among small groups of students, and can be an effective supplement to the writing students are doing off the computer, a single computer is not sufficient for a full blown computer-supported writing process program where students need to be able to compose frequently on the computer. A TRP working with these teachers might not only provide teaching suggestions and strategies for using one computer in the writing classroom, but might also work with teachers and administration to explore options for expanding their computer writing program by investing in additional hardware, software, and teacher training.

Students need basic machine skills.

All students, and particularly those with learning difficulties, need general instruction in how to use the computer and keyboard, as well as specific instruction in how to operate individual programs. Lacking this basic competence, students will use programs inefficiently and/or inaccurately. Ineffective habits are often difficult to overcome and frustrating for students. Machine skills are particularly crucial for students writing on the computer. If students aren't able to at least "hunt and peck" efficiently, they become frustrated with writing for any length of time on the computer. Unfortunately, while teachers want their students to be able to operate the computer independently, many feel

ill-prepared to teach these skills, or are reluctant to add yet another subject to an already crowded curriculum.

Developing students' 'machine skills' is a worthwhile investment. It's important, however, that this instruction is linked to real opportunities to use the technology and that training be maintained and reinforced over time. Teaching fourth-graders how to word process during a six-week computer class is not particularly useful if they're not allowed to write on computers until the sixth grade! While many schools rely on game formats to teach students' keyboarding, this format is no more effective than drill-and-practice, and may in fact, have a negative effect on students' willingness to continue 'unsupervised' typing practice.

An important caveat ...

There are no "final" answers!

The field of special education technology is characterized by change - change in the technology, change in our understanding of the effects of technology on students and their teachers, and even change in the questions we think are important to ask about technology and special education. For example, in the early 1980's many of us were delighted to add computer arcade games that drilled students on math facts to our repertoire of teaching tools. Not only did our students enjoy "blasting" math facts on the computer, but research indicated LD students benefited more from the computer game format than from paper and pencil practice.

However, as discussed above, Hasselbring and his colleagues at Vanderbilt University have found that the relationship between computer drill and practice and math fact automaticity is in fact more complex. While drill and practice software improves LD students' fluency on those facts that can already be recalled from memory, it does not help them become fluent on new facts. Using more advanced technology and different instructional design principles, Hasselbring et. al., developed software that assesses students' math facts performance, provides direct instruction on 'new' math facts, and drills to build fluency on 'old' math facts. In addition, Hasselbring and his colleagues have moved on to exploring math skills in complex hypermedia problem solving environments like the Jasper program.

So don't get locked in! Our understanding of the problem(s) and the solution(s) will change (and change again) as the field develops. As we learn about how to use technology in special education, we are also learning more about how children and teachers work and learn together in that special place, school.

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