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ABSTRACT

Getting real educational benefits from investments in technology requires careful planning. Based on the experience of implementing PLATO[R] at over 5,000 sites, a nine-step planning model for implementing technology was developed. The nine planning tasks are based on the understanding of the factors that are critical to the success of most educational applications of technology, including PLATO[R]. The steps are: (1) Get buy-in from key personnel; (2) Decide on program goals; (3) Decide on instructional applications of technology; (4) Develop instructional models for the applications; (5) Develop an instructional management plan; (6) Plan hardware/software deployment; (7) Plan technical support; (8) Plan professional development; (9) Plan evaluation. For each step, this Technical Paper describes the key concepts and principles involved, and provides suggestions to help with planning. (AEF)

PLATO®

A Guide for Implementing Technology

Or, now that we've got them, what do we do with them?

Technical Paper #5

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Executive Summary

Getting real educational benefits from your investment in technology requires careful planning. Based on the experience of implementing PLATO at over 5,000 sites, we have developed an 9-step planning model for implementing technology. The steps are:

1. Get buy-in from key personnel.
2. Decide on program goals.
3. Decide on instructional applications of technology.
4. Develop instructional models for the applications.
5. Develop an instructional management plan.
6. Plan hardware/software deployment.
7. Plan technical support.
8. Plan professional development.
9. Plan evaluation.

For each step, this paper describes the key concepts and principles involved, and provides suggestions to help you plan.

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Introduction

In deploying educational technology, as in life, there are no guarantees of a positive outcome. Hardware can easily become "shelfware." Software can be forgotten in the backs of countless desk drawers. Without careful planning and implementation, it's likely that the educational return on the technology investment will be very low. There is a generation of research demonstrating the potential of computers to improve learning, but there's much less research on what it really takes to realize those benefits.

Our experience in implementing PLATO systems at over 5,500 sites has allowed us to work first hand with educational organizations who have gotten real, meaningful, measurable results from technology – and those who have not. We have learned that even the best instructional software can be no better than the way in which it is used. Teachers can use technology as an effective lever for meaningful change in their role in the classroom – or the technology can merely act as an expensive alternative to workbooks, overhead projectors, ditto sheets, encyclopedias and board games. Technology can support and strengthen the very core of the teaching and learning experience, or it can be relegated to a role which is peripheral at best, and a distraction at worst. The challenge is to develop a *technology implementation plan* when introducing technology, to make sure that all the critical success factors are in place, when they are needed, to achieve real benefits.

In this technical paper, we'll summarize some of the major "lessons learned" as we have worked with our clients. Our discussion will focus mostly on curriculum, instruction, and instructional management, rather than on the "bits and bytes" of the hardware and software. Our discussion will center on PLATO, of course, but PLATO is an open system which can serve as the "backbone" to help you integrate a wide range of software resources, so we'll talk about the full range of alternatives for use of technology and how they all fit together.[1]

To get the most from your technology investment, there's a lot to do. Begin implementation planning as early as possible; ideally, before the final decisions have been made on what hardware and software to buy, and how much to budget for professional development. But the good news is that our experience has shown that you can start getting some benefits almost immediately, with a simple implementation plan. As you and your colleagues become familiar with PLATO, you can try more sophisticated approaches. Over time – often two or three years, in our experience – the greatest benefits will emerge. As your sophistication grows, PLATO's Education Consultants will be your primary resource for workshops, in-class consultations, and planning. Supporting them is a network of senior education and technical professionals, who can help you achieve your most sophisticated goals for improving learning with technology.

The implementation planning process described in this paper has these steps:

1. Get buy-in from key personnel.
2. Decide on program goals.
3. Decide on instructional applications of technology.
4. Develop instructional models for the applications.
5. Develop an instructional management plan.
6. Plan hardware/software deployment.
7. Plan technical support.
8. Plan professional development.
9. Plan evaluation.

For each step, we will describe the key concepts and principles involved, then provide suggestions to help you plan.

[1] A useful discussion of the full range of educational software types is in *Technical Paper #6.*

Step 1: Get Buy-In from Key Personnel

The first step in planning any change is to identify the key personnel who will be responsible for implementing the change, and to get them committed to the project. Introducing technology to a school or district is no different from any other major change in this respect. In our experience, the key roles at the building level are the *Instructional Leader* and the *Technology Manager*. Backing up these people at the district level are the technical support specialist, key administrator(s), and (for PLATO) the Education Consultant. All of these people must help develop the goals of the technology implementation (see Step 2, below), and must be committed to achieving those goals.

Here's a summary of each role:

Instructional Leader: Our experience parallels the research on innovation in education: for the innovation to succeed, there must be a strong building-level instructional advocate. This person is often the Principal, but can also be a department or program chairperson, or even a master teacher or media specialist. The person must be respected as an "opinion leader" among the teaching professionals in the school who will be using the technology. He or she will play the key role of persuading the teachers to commit to achieving the goal(s) (see Step 2, below), and will help the teachers incorporate the technology into their teaching in the intended way. In any technology implementation, this is the most key role. If there is no strong instructional leader at the building level, the odds are overwhelming that the technology innovation (or any other major instructional innovation) will fail. If the person leaves the project at any point, he or she must be replaced as soon as possible.

Early Adopter: This person may be the same as the Instructional Leader, but often is someone else selected by the Instructional Leader. This person often "leads by example," and is the "early adopter:" the first to successfully incorporate the technology into his or her teaching by demonstrating that it works, and by demonstrating that the risks of adopting the technology are minimal.

Technology Manager. In addition, each building needs to have at least one teacher, media specialist or lab manager who is trained in the day-to-day system maintenance and administrative tasks. This is the person who can help set up on-line curricula and learner records, perform regular backups, clear viruses and maintain system security, help recover from the inevitable computer glitches, and help run administrative usage reports. Since classwork often stops unless these tasks are performed immediately, this person must be available and "on call" for immediate response whenever school is in session. Because availability is so crucial, it's wise to have two or more people trained to perform these tasks.

Many schools prefer to combine this technology management role with a teaching role, since this person has the most daily contact with teachers and learners as they master the technology. This is often desirable, but in our experience the minimum technical part of the role (as opposed to the teaching part) can be filled by an uncertified teacher aid, or even an extraordinarily dedicated parent volunteer. PLATO training for this person is required.

Technical Support. Our experience also shows that effective and responsive technical support is critical to any successful implementation. No technology innovation can succeed unless the system is available to learners reliably each day. Unfortunately, the technology of networks, the Internet, Windows, and so on, requires periodic attention by trained technicians. For any school or district with a few hundred (or a few thousand) computers, maintaining the technology is likely to be a full-time job for trained and certified computer professionals. For smaller installations, a service contract with a local network specialist who is certified in the network software you are using (Windows NT Server or Novell) may suffice. Technical services are also provided by PLATO's Field Engineers.

Administrators. Timely allocation of adequate resources for teacher training, ongoing support, instructional software, and hardware is critical to the success of any technology implementation. In addition, key administrators must make the success of the technology implementation a priority for all those involved. Administrators must monitor the implementation of the technology. Finally, they must make sure that teachers, and all those involved, receive feedback on their performance in achieving the goals of the technology implementation.

The relevant administrators may be at the building or district level – or both. The one(s) to involve in the project are the one(s) who perform the tasks described above. A common practice among school districts is to administratively separate technology from the day-to-day administration of the district, and from curriculum coordination. This can create the impression among "line" administrators and curriculum coordinators that they "don't have to do technology." It's important for all parties take special precautions to keep the technology function fully involved in the goals of the district.

Education Consultant. The PLATO Education Consultant (EC) has special training in the use of PLATO in the classroom. It's important to involve the EC as early as possible in the planning of the technology implementation—often, before the contract is signed, but in any case before the hardware and software are delivered. The EC's role is to help you think through the implementation plan, to assist as needed with installation of the software as needed, to conduct appropriate teacher training workshops, and to provide ongoing follow-up consultation with all teachers who are using PLATO.

Additional senior specialists are available to back up the PLATO EC. These specialists include both educators and technical specialists in networking and software. They are available to work with the EC and with you to make your technology implementation a success.

For non-PLATO software, it may be possible to fill the role with a consultant who serves the entire district or regional service organization. The importance of this role has been well documented in the change management literature, and is analogous to the "county agricultural agent." This person should be primarily trained as an educator, together with training in use of technology in classrooms, and technical expertise as needed.

Step 2: Decide on Program Goals

It's important to decide first what you want the technology *for*. This decision *should* guide all your decisions about what software and hardware to buy and how to use it. Unfortunately, many schools and districts work the other way: first they let "experts" decide what hardware to buy, with minimal input from instructional staff. When the hardware arrives, the teachers face the task of deciding what to do with it, often with little leadership.

It's important for the key personnel you identified in Step 1 to be committed to the program goals. This is usually best done by involving the program's key personnel in developing the goals, and committing the resources necessary to achieve them.

Sound goals deal with meaningful changes in learning outcomes and/or instructional processes. Unsound goals often deal with technology or simple replacement or augmentation of existing instructional practices. Here are some examples of sound and unsound program goals:

"Improve scores on our 10th grade state competency test."

This is an example of a *sound* goal, because it deals with a measurable learning outcome (scores on the competency test), and states a direction of change (improvement).

"Put 5 computers in every classroom, with Internet access through a wide-band network."

This is an example of an *unsound* goal, because it deals with deployment of the technology without regard to any expected changes in teaching and learning.

"Strengthen teaching of NCTM standards related to authentic math problem solving"

This is an example of a *sound* goal, because it deals with instructional processes and learning outcomes.

"Use the Internet in teaching Science."

This is an example of an *unsound* goal, because it says nothing about a teaching process or a learning outcome, only that a technology (the Internet) should be used in a classroom (Science). An example of a sound goal might be, *"Use authentic data (obtained via the Internet) to provide a context for analysis and interpretation of local environmental measurements."*

"Use the Computer to do Projects."

This is an example of an *unsound* goal, because it does not include a learning outcome – only an output (the project). A learner who builds a PowerPoint file or a Web site doesn't necessarily learn any more about science (or social studies, or literature, etc.) than one who hand-writes a paper—though he or she may show more motivation, and may learn something about teamwork and using the computer tools (which might be acceptable secondary goals). A better goal might be, *"Construct a project which compares at least 3 conflicting positions on an issue, by summarizing and juxtaposing the competing points and providing hyperlinks to supporting arguments and data."*

"Ensure that all entering freshmen are ready to do grade-level work in math and language arts."

This is an example of a *sound* goal, because it describes a learning outcome, implies measurement of the outcome, and implies an instructional process (remediation).

"Enable at-risk students (whether due to mobility/drop out, pregnancy, adjudication, illness, etc.) to earn lost credits and graduate no more than 1 year late."

This is an example of a *sound* goal, because it describes a learning outcome and implies measurement of that outcome.

"Devote 50% of my class time to problem-based activities, by moving 50% of expository teaching to self-instructional formats used in or *out of class."*

This is an example of a *sound* goal, because it describes a teaching process change goal – even though it does not describe a learning outcome (the goal would be even stronger if it did this also).

"Every learner will use the computer for at least 30 minutes per week."

This is an example of an *unsound* goal, because it deals only with deployment of technology, and is not concerned with learning outcomes or teaching processes.

Notice that many sound goals don't mention technology at all – and that if technology is mentioned, it's only as a means to a learning outcome. That's appropriate because the mission of schools is learning, not technology deployment. It sounds obvious, but this basic principle is often overlooked in practice.

A single large-scale technology investment may have many sound goals, of course. Different classes can use the same hardware for different goals. It may even be reasonable for the hardware to be used during the day by the school, in the evening by an adult program, and on the weekends by a community-based program – there's no reason to ever turn off the computers, and such uses could even help cost-justify or pay for the equipment[2]. The point is to make sure all of the technology users have clear, sound and reasonable (feasible) goals for changing learning outcomes and/or teaching/learning processes.

[2] Some of our more entrepreneurial clients purchase PLATO and charge back its off-hours use by hourly or monthly charges to local adult learning, job training and community-based organizations which run weekend homework/tutoring programs.

Step 3: Decide on the Instructional Applications of Technology

There are many different types of software, and they are designed to serve many different purposes in an instructional program. Clever teachers can adapt an even broader array of software to instructional uses, even when that was not part of the software's original intent. But all classroom applications of software are not created equal: different types foster different uses, and have different learning outcomes. It's therefore important to think carefully about what kinds of software are best suited to the goals you've identified. As you do so, you'll also be thinking about the instructional models you'll want to use, and even the instructional management system you'll need.

In the next section, we'll provide a brief overview of kinds of software with educational use. A more detailed dicussion is in *Technical Paper #6*.

Instructional Software Types

It may be useful to think of three general types of educational software:

- *Supplementary*: Software which adds little or no new content, and parallels teaching already done in other modes. Electronic alternatives to textbooks, lectures, workbooks, etc. Examples include skill and memory games and exercises; on-line references and informational Web sites, and many on-line tests. PLATO's Vocabulary Builder, practice lessons and on-line tests fit here.

- *Complementary:* Software which adds new content to the curriculum, often in ways for which there is no non-computer alternative. Examples include simulations (such as PLATO *Problem-Solving Activities*) and games designed to teach problem-solving; Web-based "expeditions" and "projects." Tools which automate low-level tasks (such as word processors, data graphing tools, web page authoring systems, search engines, etc.) also fit, if they are used as part of a learning activity which adds some new topic to the curriculum; by themselves, the tools (and most Web sites) have little or no support for specific learning activities other than learning to use the tool itself.

- *Primary:* Software which acts as the main source of initial teaching, as a replacement for non-electronic modes of instruction. The purpose is to allow the teacher to work in a "guide on the side" mode, instead of "sage on the stage." PLATO tutorial lessons are examples.

A given software product can often be used in more than one of the three ways, so notice that these definitions characterize the *way* in which software is used as much as *how* the software is designed.

There are a number of tradeoffs associated with the three uses. The tradeoffs concern learning gains, teacher training, ease of implementation, and hardware deployment:

- Our experience is generally consistent with the research finding that supplementary uses have the least potential for producing large learning gains, though incremental improvements are possible. Complementary and primary uses have much greater potential, if they are applied broadly across an entire curriclum or program.

- Teachers seem to find that the supplementary uses are the easiest to implement and require the least training, in comparison to the other two types of uses.

- Supplementary and complementary uses can be added to existing classroom routines and ways of teaching fairly easily. Primary uses for a whole class are often difficult to implement within a conventional school structure, and are much more common in special programs, alternative and charter schools, etc.

- Supplementary and complementary uses of many kinds (but not all) can be implemented using a student:computer ratio of 4:1 or so. The common recommendation to place 4-6 computers in every classroom seems to be based on an unstated assumption of supplementary or complementary use. By contrast, most (but not all) primary uses require a student:computer ratio of 1:1 or 1:2 (for the portion of the classes being taught this way). This leads to decisions to give each learner a laptop computer, or to place 12-30 computers in a classroom, or to set up computer labs. Thus, deciding on what type of software uses you want can give you a rough estimate of the number of computers you will need.

Step 4: Develop Instructional Models for Applications

The next step in your planning is to work with your instructors to plan in greater detail how the technology will be integrated into the curriculum. To do so, you need to answer these questions:

1. What is the learning goal of the technology application?

You answered this question in Step 2 (above). However, at this stage you should have additional details of exactly what parts of the curriculum will be taught to which learners using technology, based on your analysis of general goals in Step 2, and the kinds of software you want, based on your analysis of software types and resource requirements in Step 3 (above).

2. How will we assign learners to use the technology?

Some instructional models assume everyone will be doing the same thing at the same time. Others require sophisticated individualized learning plans (ILP's) based on an assessment of individual needs. In these cases, placement of the each learner in the right assignment, on a daily basis, should be an important factor in your planning.

3. What will the learner's role be?

Instructional models vary widely in how much and what kind of decisions the learners make about their own learning. Some models require solo, self-paced work, while others require collaborative study with everyone studying the same thing at the same time. It's important to work out in detail what the learner's responsibilities will be and how they will be fulfilled.

4. What will the instructor's role and program structure be?

Once the learner's role is defined, then it's necessary to plan the role for the instructor, and the overall program structure, so that both will lead the learners to fulfill their roles.

5. How will we manage the resources?

In Step 3 (above), you worked out a rough estimate of resources required. With the decisions made about curriculum and instruction, it's possible to develop a detailed plan for how to schedule and manage the hardware and software resources.

6. How will we assess the learners?

You also need to decide how you will assess what the learners have learned as they have used the technology. For example, PLATO has a range of powerful assessment options built in. Other software leaves assessment as a task entirely for the instructor.

Technical Paper #6 presents four "generic" instructional models for PLATO. The four models are:

Review/Reinforcement (Supplementary)

The goal of the review/reinforcement instructional model is to reinforce the knowledge and skills of the learner using any PLATO curriculum.

Primary instruction is assumed to be done in the classroom, without use of PLATO. PLATO lessons are assigned (often as seat work or out-of-class work) before a given classroom lesson to review prerequisite concepts, or after a classroom lesson to provide additional reinforcement, review and practice of the topics taught in class. The PLATO work can occur immediately following the classroom instruction, or after a delay (such as for end-of-unit review or review before a unit test, final exam, or competency test).

Enrichment (Complementary)

The goal of the enrichment instructional model is to add to or deepen the knowledge and skills of the learner through use of any relevant PLATO curriculum.

Primary instruction is assumed to be done in the classroom, without use of PLATO. PLATO lessons and other on- and off-line materials are assigned (often as seat work or out-of-class work) by the instructor or selected by the learner. Study is usually after a classroom lesson, and is used to provide additional knowledge and skills for learners who want more depth, background, or advanced work in a subject. The computer work can occur immediately following the relevant classroom instruction, or in support of an independent research or learning project.

Problem-Centered (Complementary)

The goal of this instructional model is to make problem-solving the central strand of the curriculum. Development of knowledge and skills is done in the context of problem-solving, as a pre- or co-requisite. The intended results include deeper understanding, greater transfer to non-school tasks, development of learning skills, and greater motivation.

At the center of each unit is a problem-solving activity which can be a PLATO Problem Solving Activity (PSA), or other case problems implemented on the computer or offline. Knowledge and skills development is done in the context of the problems, as a pre- or co-requisite. This establishes a context for the learning of facts, concepts and skills.

Skill Development System (Primary)

The goal of this instructional model is to develop, remediate, and/or enhance the knowledge and skills of the learner using PLATO.

This is a competency-based, mastery instructional model. It is completely individualized, and is based on three principles: (1) learners should study a topic only when they have fully mastered its prerequisites; (2) learners should study a given topic until they have fully mastered it, before going on; (3) learners should study only topics they have not already mastered (further discussion of these principles is in the next section of this paper).

This is a particularly success-oriented model. In principle, anyone who is ready to learn can work until they have mastered each skill, in privacy. There is no comparison with peers—only with progress toward personal goals. In principle, in this model failure is impossible—only non-completion.

For each of the four models, *Technical Paper #6* answers the six questions above. Of course, there are many different instructional models using many different types of software, and not all models are equally effective in meeting your needs. The four models summarized above are intended to serve as a starting point for you to develop instructional models which meet your needs.

Step 5: Develop an Instructional Management Plan

Instructional management may be an unfamiliar term, but it's not an unfamiliar set of activities. Each day, instructors and administrators decide

- who is going to go to which classroom and instructor
- what learning activities will occur
- which texts and resources they will use
- how the resources will be scheduled, how long each activity will be
- who will be assessed and how
- how the assessment will guide future work
- how all these decisions will be communicated to learners, parents, staff, and others who need to know

One of the big advantages of technology is the ability to do instructional management much more precisely and flexibly than is possible using conventional methods. Using conventional methods, many of these decisions are dictated by century-old custom and by what's feasible in a paper-and-pencil world. For example, the convention of the 25-person class in secondary schools is probably due more to practical limitations of paper-and-pencil instructional management than to any research on class size. Even fixed class schedules, "one size fits all" curricula, and practices such as relatively infrequent and large tests (rather than frequent small ones) are probably artifacts of a paper-and-pencil instructional management system. In that system, highly individualized instruction almost always creates an unacceptable work load for instructors, and leads to "burn-out" within a few years.

Used appropriately, technology can change these things. Large-scale and fine-grained individualization becomes possible, with precise alignment to curriculum standards and frequent (daily, or even hourly) progress assessment with immediate feedback. "Just in time" delivery of individual instructional prescriptions, any time and anywhere, can be routine. Learners really can work at their own rate, and follow their own interests and needs, without concern for appearing to be a "nerd" or a "dummy." The critical social context for learning can be based on success in a goal-oriented community, rather than being based on individual competition and fear of failure. And, these advantages can be obtained while freeing instructor time to work as a "guide on the side" with each learner (one instructor using PLATO in this way recently commented that for the first time in 25 years of teaching, he felt he could really teach; another commented that for the first time she thought of her learners as individuals, rather than a class).

PLATO's instructional management capabilities are built into the *PLATO Pathways* computer-managed instructional system, and are founded on the basic modular and open architecture of the system. You can use Pathways to prescribe and track the day-to-day work by your learners, whether or not PLATO courseware is involved, and whether your system is based on a local area network, the Internet, or even a single work station.

Planning An Instructional Management System with PLATO

To plan your instructional management system, you will have to make a number of practical decisions which need to be consistent with the type(s) of software you have chosen and the instructional model(s) for their use. The following table outlines some of the most common decisions you will need to make, and briefly mentions some of the options available to you through PLATO.

Decision	Discussion	PLATO Options
Which learners will use the computers ?	A common error is to try to spread computer use evenly across all learners in all classes. This usually results in so little computer time per learner that little or no improved learning results. Better is to choose learner groups based on the goal(s) you decided upon in Step 1.	If you use PLATO on your Local Area Network (LAN), or on the Internet, you can make it available throughout your school, district, and even in the learners' homes and in the community.
How	A common error is to give all learners	PLATO's centralized

Decision	Discussion	PLATO Options
should we schedule computer use?	an equal amount of time on the computer, even if this only works out to 20 minutes a week or so. This practice virtually precludes significant improvement of learning for any learners. It makes more sense to plan for at least 1 hour daily, at least 2 days per week, per subject (3-5 days/week preferred), at a learner:computer ratio determined by the type of software you plan to use. Depending on your program goals, this level of access may not be needed for the full year, so different classes may be able to share computer facilities without undue interruption of their curriculum sequence. To reach this level of access, you may need to abandon some program goals and focus computer use on certain high-need learners or high-priority uses. If you are using mastery learning (the skill development model), then plan to accommodate a 6:1 ratio of completion times (see Appedix A, "Mastery Learning and PLATO"). You may be able to do this by having slower learners continue work out of class, before or after school, or at home via the Internet. There is no reason ever to turn off the computers. Make them available as continuously as possible.	management and prescription over LAN and Internet systems gives you maximum flexibility in scheduling. Since PLATO will run via the Internet on many home computers, you may be able to supplement computer time at school with computer use at home.
What should the instructors do while the learners	A common error is to assume that when the learners are on the computers, there is nothing for the instructors to do and they can be assigned to other tasks. It's important for instructors to be	Research on computer learning shows that learning approximately doubles when an instructor is effectively involved. PLATO is

Decision	Discussion	PLATO Options
are on the computers?	actively involved in a "guide on the side" role. Instructor activities vary depending on the goal, the type of software used, and the instructional model in use. Training usually is necessary to acquire the skills for this role. This involvement does not always have to be in "real time," however, especially with more mature or self-directed learners. In distance education settings, instructor involvement can be done through asynchronous communications such as e-mail and chat groups.[3] Note that it is frequently reported that the instructor workload in distance education courses is about double that of comparable classroom teaching.	designed for solo use, but our evaluation data are consistent with the general research: active involvement of an instructor in the "guide on the side" role greatly improves learning, across all instructional models. PLATO Pathways provides a powerful system to provide usage and progress reports to instructors on learner progress in class, in specific groups, or even by exception to "flag" those who need extra attention. PLATO includes e-mail in LAN and Internet systems, and chat groups are available as well on the Internet.
How should we group the learners?	Learning is a social experience. It's important to create a positive, success-oriented experience for all learners. For learners with poor teamwork skills or a history of negative group interactions, solo work on the computer can bypass this problem and provide a positive learning experience. At the same time, software types which support collaborative learning and peer teaching can help build teamwork and interpersonal communication skills. It's also important not to group learners so as to create the impression	PLATO's mix of solo tutorials and collaborative learning software can support a mix of peer teaching and small-group collaboration. PLATO Pathways also allows you to integrate non-PLATO activities such as tools and web sites which are useful for inter-group communication.

[3] For further research on distance education and PLATO, refer to Perez, S. and Foshay, R., *Adding Up the Distance: Critical Success Factors for Internet-Based Learning in Developmental Mathematics*. Monograph and multimedia CD-ROM published by the League for Innovation in the Community College, March, 2000.

Decision	Discussion	PLATO Options
	that the computers are for the "geeks" or the "dummies." If you use the individualization capabilities of your software, you can intermix groups of varying abilities without creating problems with learning rates. Group by common learning goals. Encourage groups to communicate among themselves and with the instructor(s), and even with peers in other locations or cultures. Of course, testing should be done in a solo, secure environment.	PLATO Pathways allows you to monitor individual progress when learners are in groups, as long as testing is in a solo, secure environment. Pathways also allows you to import and export data from and to your school administrative software. This can include not only learner names, but important demographic descriptors which may be useful for grouping and tracking performance.
How will we integrate computers into our curriculum ?	A common error is to underestimate the degree of planning needed to effectively integrate technology. Steps 2 through 4, discussed above, will help you make the decisions you need to effectively integrate technology. Simply having learners "working on the computer" will not lead to meaningful gains. Be particularly careful to maintain close and precise alignment of all learning experiences, both on- and off-line. For example, it can be profoundly disorienting to learners to rapidly switch from study of one math topic in a large-group class, to another math topic on the computer. Concern over this issue is often a major reason why instructors don't individualize. It's also important to see that all of your curriculum standards are taught by appropriate learning experiences (whether on- or off-line), and that they are in a logical sequence with no "gaps."	PLATO's modular structure, large coherent curricula, and custom learning path capabilities in Pathways are designed specifically to support curriculum alignment to your state and local standards. PLATO's flexible assessment options may allow you to perform many of your assessment requirements on-line, on-demand and automatically without instructor paperwork. You can use Pathways to add in non-PLATO computer and non-computer learning activities, and track usage and results. When you do this, Pathways becomes the primary classroom instructional management tool.
How will	In any individualized system, it's	PLATO uses module

Decision	Discussion	PLATO Options
we track and assess learner performan ce?	important to keep a close watch on learner progress, so you can intervene immediately when a learner encounters a problem. Choose a computer system which can assess learner progress frequently (daily or even more often), and which can report that information to the you in a convenient form which makes it possible to identify "problem learners:" those who are floundering or not trying. Also: make sure the tests are tied closely to the curriculum and to your curriculum standards, so the information on learner progress will be meaningful. For more complex and higher-level learning objectives, you may wish to use a *portfolio assessment* approach. Make sure your software can generate the information you need for this purpose. Many PLATO Problem Solving Activities (PSA's) can do so.	mastery tests (small quizzes which accompany every 45-minute module) and cumulative course-level tests, which can be assembled on a custom basis. You can even add your own tests if needed. The tests communicate with PLATO Pathways, the management system, to provide real-time progress data in convenient and efficient formats.
How will we report learner progress?	Instructors are used to end-of-unit and end-of-semester grades. The computer can provide specific details on progress for individual learners, and do it daily. This can be very motivating for some kinds of learners, as well as allowing instructors and parents to intervene quickly when a problem occurs. In the "Skill Development Model," it's feasible for the computer to use skill profiles rather than just cumulative % scores or letter grades. This can be much more diagnostic, and it can recognize the different kinds of intelligence your learners have.	PLATO Pathways can generate skill profiles based on your curriculum's design, and report on daily or weekly progress.

Step 6: Plan Hardware/Software Deployment

Closely related to the instructional management plan is your plan for deploying the technology. A common error is to make decisions about hardware, software and support before the goals and instructional plans for use of the technology are decided. In this section, we'll discuss some of the instructional considerations which should affect your technology plans. Details of the technologies themselves are beyond the scope of this discussion.

How many computers and software licenses do we need?

You can use the taxonomy of software types presented in *Technical Paper #6* to decide on:

- the type(s) and quantity of software and hardware you need
- the student:computer ratio you must provide
- the professional development you must plan and budget for

We'll discuss the first two decisions here, and the last one under Step 8.

Some Program-Based "Rules of Thumb" For Budgeting

Use this procedure as a general guide to make your decisions about the type of software, the range of topics to be covered, and the number of computers you will need to attain your learning goals:

Step	Example
1) For each goal, decide if it requires a supplementary, complementary or primary strategy (refer to Parts 2 and 3, above).	A High School decides to improve pass rate on its state competency test of mathematics. The school decides on a primary strategy.
2) For each strategy, decide on the software type(s) which you think should be the main one(s) for that goal.	The school decides to use a combination of tutorial and problem-centered software.
3) For each software type, look up	Tutorial software: 1:1

the suggestion for ideal learner:computer ratio.	Problem-centered software: 4:1
4) Divide your total student population using that software type by the numerator of the student:computer ratio.	400 learners who failed the test in the first year will be remediated. 400/1=400 computer work sessions needed in each daily "cycle".
5) Multiply the product of (4) by the number of computer work sessions per week each learner is to have. • For primary applications, assume 2-5 work sessions per week (3 is often optimal). • For complementary applications, assume 2-5 work sessions per week (usage patterns vary widely depending on the project) • For supplementary applications, assume 2-3 work sessions per week (usage patterns vary widely depending on scope of the curriculum)	3 x 400 = 1,200 computer work sessions needed per week.
6) Calculate the total number of class periods (including after school time, lunch time, etc.) during which the computers are to be available for study on this topic.	9 50-minute periods in a day, counting lunch time and 1 after school session. 5 days per week. 9 x 5 = 45 periods of use (minimum available)
7) Divide the product of step (5) by step (6).	1200 / 45 = 27 student work stations needed (assuming 100% scheduling efficiency).
8) Decide what fraction of 100% the computers will actually be scheduled for use by learners working on this goal (no scheduling system is 100% efficient, so the computers will be idle some times). Reduce the fraction further if self-pacing is planned, to allow for the 6:1 ratio of completion times. Multiply the product of step (7) by this factor. • In computer labs, scheduling efficiency can be very high	Assume 80% scheduling efficiency, to allow for scheduling flexibility and additional use by learners who need it. Multiply number of student-periods needed by 1.25. 27 x 1.25 = 34 student work stations needed.

(perhaps 80%). • In classrooms, scheduling efficiency rarely exceeds 30% or so. For a discussion of tradeoffs in deploying computers, see Step 9, below.	
9) Add work stations for administrative and teacher lesson planning, and to allow for maintenance, and unscheduled use, as needed.	3 computers added to faculty offices, 5 added for unscheduled use and maintenance. Total work stations needed = 34 + 8 = 42 Maximum software licenses needed=40.

In our experience, the hardware/software requirements you calculate by this procedure often exceed "one size fits all" recommendations such as 5 computers per classroom. This procedure provides a sound basis for justifying a hardware and software budget based on program goals. If the decisions have already been made, then it's important to set priorities among the goals, so that you will be held accountable only for achieving the ones for which resources are available.

Where should we put the computers?

A common error is to put a few computers in each classroom without considering how they will be used. There are tradeoffs in both directions for putting computers in classrooms, centralizing them in labs, or giving each learner a personal laptop computer. If the budget allows, you may be able to do more than one kind of deployment.

In addition, remember that many of your learners may already have computers at home. Through the Internet, these learners may be able to use some kinds of software, such as PLATO. A number of innovative programs have pioneered easy financing of home computers and laptop computers for educational use by families and by instructors. This kind of access can greatly increase the options you have for scheduling flexibility.

4-6 Computers/Classroom	**25+ Computers/Lab or** **Personal laptops for each learner**
Advantages	**Advantages**
• Supports small-group instructional models • Allows spontaneous use and integration into other activities	• Supports 1:1 instructional models as well as small-group models • Useful for planned professional development activities

4-6 Computers/Classroom	25+ Computers/Lab or Personal laptops for each learner
easier • Makes it harder for instructors to ignore the technology; facilitates experimentation.	• Lab Manager can provide instantaneous technical and instructional support • Can be implemented by networking only the lab • Power and cooling upgrades need only be done to one room • Security is higher (including avoidance of theft, damage, "hacking," misuse) • Access before and after school hours may be possible
<u>Disadvantages</u>	<u>Disadvantages</u>
• Prevents the entire class from engaging at one time in activities which require a 1:1 or 2:1 learner:computer ratio (see Step 3) • Actual computer use may be limited to a few computer-literate learners, unless instructor encourages others to use the hardware • Instructors must be self-sufficient both technically and instructionally in use of the technology • May require networking all classrooms • May require upgrades to power and/or cooling for all classrooms • Security more difficult • Access before and after school hours often not feasible	• Usage must be planned and scheduled; access may be limited to scheduled times • Instructors may be tempted to "leave it to the lab manager" and not actively work with learners while in the lab • Instructors may not develop their own technology skills, but may "leave it to the lab manager" • Learners "pulled out" to go to the lab may be stigmatized

How will we make the software available when and where it's needed?

A common error is to purchase dozens, or even hundreds of CD-ROM's with software which must be installed and used on individual computers. This rapidly creates an overwhelming logistical nightmare for instructors, learners and administrators: CD's and learner records get lost, and they are never in the right place. For any but the smallest and simplest installations, delivery of software through local area networks (LANs) or the Internet is strongly recommended. The additional investment in networking, network management and instructor training is more than offset by the increased access to software, and its more efficient use.

Use of a management system such as *PLATO Pathways* also is strongly recommended to ease access to software, as well as to maintain central records of use and achievement. This "just in time" network delivery allows you to maximize use of your software portfolio and prevent loss or damage.

PLATO Pathways can create simple menus to launch any PLATO or non-PLATO Windows software, including access to specific Internet Web sites. PLATO LAN licensing limits only the number of simultaneous users, not the number of work stations or total users. While they are using PLATO software, learners can float among work stations on the network (or at home over the Internet) and still have access to assigned software while maintaining central data collection and administration.

If your plans include the Internet, networking is all but mandatory. Individual learners and instructors working at home for distance education can cost-effectively use telephone lines and modems for Internet connections (though modestly priced broadband connections to homes are becoming available). However, as soon as simultaneous connections are needed by more than a handful of computers at a given site, a high-speed network connection will prove less expensive to operate, faster, and more reliable. Such connections are now common in schools. Most use telephone wire-like connections, but some are wireless (which makes it easier for learners to carry around laptop computers, or for teachers to rearrange classrooms).

For best performance, reliability and security, add a central computer called a *file server* to your local area network, and use it to run the software you purchase. Some school districts network all their buildings together in a wide area network (WAN), and centralize the file servers for maximum efficiency of software use and network administration.

If a LAN or a WAN is too complicated to be justified for your use, then you can use a network solely for Internet access. In this case, you can run PLATO on the Internet and still have private and secure access to learner records.

Step 7: Plan Technical Support

Unfortunately, computers are neither as reliable nor as simple to use as other familiar technologies such as telephones and automobiles. Computers require knowledgeable setup and frequent attention to keep them running reliably. Failure to provide adequate and timely technical support is often cited in surveys of instructors as the greatest barrier to increased use of technology.

The table below summarizes the typical levels of technical support required in an academic computer installation.

Source of Technical Support	Description	Response Time Require-ment
Instructor	• Enrolling learners in groups • Locating and Assigning software • Generating reports on progress • Simple "troubleshooting" work station problems with mouse, locked-up computer, e-mail, etc.	Immediate, ongoing On site
Network Administrator (may be same or different from instructor)	• Enrolling classes • Exchanging data with central school administration system • Maintaining security settings • Routine backup copies of important data	Daily, Ongoing On site

Source of Technical Support	Description	Response Time Require-ment
	• Installing new instructional software • Erasing old data and unused software • Simple troubleshooting of common network operational problems • Assists remote users (distance education learners) in resolving simple technical and use problems	
Network Manager (may be a contractor in small systems)	• Designs and sets up network • Designs and sets up security system • Maintains network speed/reliability • Maintains speed/reliability of network-wide services such as Internet access and e-mail • Applies periodic software upgrades and maintenance • Troubleshoots network hardware and performance problems	Weekly and on-demand, on site and via network
Hardware and Software Suppliers	• Provides regular software upgrades and maintenance • Consults with your technical support to resolve operational problems, incompatibilites, etc.	On-demand via web site, e-mail and hotline; on-site consulting

Step 8: Plan Professional Development

There is a growing concensus that a school technology budget should be allocated in the range of 1/3 to hardware, 1/3 to software, and 1/3 to professional development of instructors.[4] Adequate. timely and continuous professional development is absolutely key to effective technology implementation.

In our experience, educators seem to progress through four levels of sophistication in the instructional use of technology. The levels are:

1. ***Struggling with the technology.*** Simply learning the complexities of user interfaces, operating systems, how to use a given software system for productive work, and how to use the resources of the local network and/or the Internet is usually a major challenge. While this kind of learning is an ongoing process, mastering the basics is a requirement before any productive work in classrooms is possible.
2. ***Supplementary Use.*** Once they're past the basics of using a computer, it's natural for instructors to approach the use of the new technology from the frame of reference of what they are already doing. This tends to lead instructors to use the technology to directly replace previous classroom activities on more or less a 1-for-1 basis. Thus, instead of workbooks, learners work on computer drill-and-practice exercises. Instead of reviewing with the textbook; learners review with computer tutorials.

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[4] For example, see: Panel on Educational Technology, *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States*. Washington, DC: President's Committee of Advisors on Science and Technology, March, 1997.

Instead of paper tests, learners work on computer tests. Instead of flash cards, learners work on computer memory exercises games. Instead of paper-and-pencil reports, learners use word processors and multimedia production tools, and create Web sites. Instead of researching the reports in the library, learners search for Web sites.

3. ***Complementary Use.*** Sometimes, instructors go on to seek specific technology-based learning activities which are new to the curriculum, and which could be done by conventional means only with unacceptable cost, time or risk. Examples include use of simulations designed to teach problem-solving; use of computers for gathering and handling complex, "messy" data from real-world problems; use of the Internet e-mail, chat and multimedia capabilities to collaborate with classrooms and workers in other parts of the state, nation, or world.

4. ***Primary Use***. Some instructors take the technology further. They use it to fundamentally change their role, the structure of their classroom, or the structure of the school. These instructors often use technology to replace large-group instruction with highly individualized, self-paced study. They may completely restructure the curriculum into a problem-centered, interdisciplinary approach. They may exploit the distance education capabilities of the Internet to build community-based programs. In conventional secondary and post-secondary environments, these uses are most commonly found in learning labs for special needs (remediation/developmental studies, advanced work, etc.). With increased availability of technology, however, examples of these applications are growing in "mainstream" classrooms, as well. They are also found in a wide range of non-traditional settings, such as alternative schools, charter schools, home schools, workplace learning, lifelong learning, job training, etc.

PLATO has components and features designed to be used in the top three levels. For example, PLATO problem-solving activities (PSA's) are often used by instructors working at the complementary and primary levels. PLATO tutorial modules are often used by instructors working at the supplementary and primary levels, and they may play a supporting role at the complementary level. PLATO assessment capabilities are often used at all three levels (after the first).

Appropriate professional development is critical to advancement from one level to the next. In our experience, without substantial training most instructors never progress beyond the first or second levels. Plan the training just before and in tandem with the introduction of new technologies, and should progress over a period of years as instructors develop experience with the technology.

Types of Training

There are many types of software training available. Some of the training can best be done in workshops, while other types are best done in less formal settings.

Workshops

To plan workshops, you can use these "rules of thumb" to plan for professional development training your faculty and staff may need. These should be "hands on" experiences, so keep the learner:computer ratio at 1:1, and limit class sizes to 10 per instructor. All of the training types below, except for the last two, are needed by instructors.

Level and Type of Training	Estimated Training Days per Person
Level 1: Basic introduction to computers, Windows, Networks	1-2 days per operating system
Level 1: Productivity tools (such as word processors, spreadsheets, multimedia production tools, etc.)	3-5 days per tool
Level 1: Internet overview for educators	2-3 days
Level 2: Supplementary software and its use	½ to 3 days per software package, depending on size and complexity.
Level 3: Complementary uses of software	1-3 days per type
Level 4: Primary uses of software	3 days introduction/overview, plus ½ to 5 days per curriculum, depending on size.
Level 1: Administration/management of the system/network (for the system administrators/managers; not needed by instructors)	Basic: 3 days Advanced: 2-4 days
Level 1: Technical support of the system (for trained and certified computer professionals with network certification as needed)	3-5 days per software system type

Consultation

Research on change management reinforces the importance and effectiveness of ongoing informal consultation as a follow-up to formal training experience. Instructors need to have easy access to expertise in both the technicalities of the software and the subtleties of educational use.

For PLATO, this role is handled by the Education Consultant (EC). We strongly recommend that you budget EC consultation time on a regular basis throughout the first 2-3 years of use of the system, and again whenever new software is introduced or new instructors start using it. Typical consultation budgets include 3-7 days per site in the first year, gradually declining to 1-3 days per site in the third year.

You may also have access to experts within your own district or region. If so, be sure to arrange for their active involvement in your program.

Where to Find Professional Development Training

Sources of training include:

- Expertise within your own staff
- Local colleges
- Local education support agencies or district specialists
- National conferences and workshops
- Major software vendors

PLATO provides professional development services, including workshops and consultation for teachers and technical support personnel, through its large field organization of Education Consultants and Field Engineers.

Step 9: Plan Evaluation

Feedback on how your instructors and learners are doing is a basic requirement for continuous improvement. It's likely that you will want to know how well your technology investment is paying off. If there are problems, you'll need to know quickly so you can intervene. And, it's likely that other stakeholders who provided the funding for your technology investment will want you to demonstrate a return on the investment. The time to plan for the evaluation you need is at the beginning of the project.

Evaluation models and guidelines are discussed extensively in PLATO's *Technical Paper #2: Guidelines for Evaluating PLATO*. Be sure to obtain that paper as you plan your evaluation.

Here are some answers to common questions on evaluation.

What should we evaluate?

The main purpose of your evaluation should be to measure progress toward achieving the goal you identified in Step 1, above.

It is also often wise to evaluate how extensively and how well the technology plan was implemented. And, you may need to track program cost as well.

Administrators often assume that an evaluation should compare classes using technology with those that don't. Unfortunately, that's rarely practical. Presumably, the purpose of such a comparison is to judge the impact of technology. But to attribute results to the technology, you would have to take special precautions to be sure that the "experimental" and the "control" classrooms *differed in no other way*. So, you would have to make sure they taught exactly the same content, in exactly the same way, with the same (or matched) instructors, randomly assigned learners, etc. Creating such an experiment often would be unacceptably disruptive and would have such an artificial situation that the results wouldn't necessarily be applicable to your "normal" environment. Therefore, it's usually best to concentrate the evaluation on how well the goal(s) you identified were achieved in your "real world" setting.

When should we evaluate?

At the beginning of the program, expectations are very high, but your organization has yet to climb the "learning curve" to successfully implement the technology. We often find that the best results occur in the second or later iterations of the curriculum. In academic settings, this usually means that evaluation for results should occur in the second semester or year of the program. Evaluations before then should monitor success of the implementation compared to the plan. Only when the implementation is going smoothly and according to plan should evaluation focus primarily on results.

What data should we gather?

The data you gather depends on the goal of the evaluation. Here are some commonly-used sources of data:

- **Pre-tests:** a test administered just before the program starts should verify the entering skill levels of the learners and their readiness to learn what is planned. A placement test usually screens for prerequisite skills and will allow you to verify readiness of the learners. A parallel form of the *post-test* (see below) will allow you to verify that your learners didn't already know what is to be taught, but may not be detailed enough to verify mastery of prerequisites.
- **Post-tests:** your program may require an exit test such as a state-mandated competency test or a standardized test. Alternatively, you may wish to use the PLATO Custom Assessment Test tool to construct a "final exam" from PLATO questions. Or, you may choose to write your own test.

  Depending on your goal, the post-test results may be an adequate measure of how well you achieved it. However, if the goal involves a performance improvement (rather than a knowledge gain), then a post-test can serve only as a measure of program implementation, not as your ultimate "criterion" measure.
- **Performance measures:** if your program's goals focus on performance, then you will need to measure that performance. Examples include reduction of dropout rate, employment rate, reduction of error rate, or improvement of a productivity measure.
- **Demographics:** it may be important to track specific subgroups of learners, or to otherwise characterize the profile of the learners in ways that are significant to you or to other stakeholders. If so, be sure to figure out the identifiers before learners enroll, so you can gather the data and enter it into the PLATO Pathways management system, to use it to generate reports specific to those groups. Common demographic data include age, years in school, ethnicity, free/reduced lunch, program type, referring institution or instructor, primary instructor, total years of education or experience, etc.

Additional measures are often useful for monitoring successful implementation. Some common ones include:

- **Number of modules tried and mastered:** PLATO Pathways tracks the number of modules a learner enters, how often they have tried a given lesson, and whether the learner passed the module mastery test.
- **Time on task:** PLATO Pathways tracks total time spent on each activity, as well as when the activity occurred.

- **Subjective reaction of learners:** research has shown consistently that a learner's subjective reaction to a learning experience is virtually unrelated to how much they learn from it. However, overall satisfaction with the learning experience may be a useful indicator of program implementation success. It may also provide some suggestion of how likely learners are to persist in the program.
- **Subjective reaction of instructors:** instructors' reactions are strongly influenced by a wide range of factors, such as ease of use, level of their training, availability of technical support, etc., as well as instructional effectiveness. Therefore, assessment of subjective reactions can be a useful indicator of program implementation success.

Note that sample learner and instructor questionnaires are included in *Technical Paper #2.*

- **Cost:** you may need to monitor program costs, both for initial set-up and for ongoing operation of the program. Issues involved in cost modeling and cost comparison are discussed in *Technical Paper #2.*

Conclusion

The nine planning tasks described in this paper are based on our understanding of the factors which are critical to the success of most educational applications of technology, including PLATO. Our intent is to help guide you toward a successful technology implementation. We recognize that PLATO is often only one part of a much larger technology plan, and we have designed the system to help you in this kind of use. Similarly, in this paper, we have attempted to discuss the issues generally enough so you can apply them to your entire technology plan, not just the PLATO portion.

For small implementations, these eight planning tasks can be very simple and need not consume much effort. Often, in such cases, we find that they can efficiently be discussed in a single implementation meeting of an hour or two. For large implementations, of course, the planning process is much more complex and may require months of work with many individuals.

Regardless of program size, however, in our experience it is important to address all nine of the planning tasks identified here.

PLATO's professionals are trained and committed to support your planning process at each step. Consult with your Account Manager and Education Consultant for advice, at any time before or after your decision to purchase PLATO. Before you buy, your Account Manager can help you make some of the key decisions described here, in order to be sure you are buying what you need to achieve your goals. After your purchase, your Education Consultant will help will the remaining questions during implementation planning. Both the AM and EC have at their disposal the full resources of technical and educational specialists at TRO Learning, Inc., and can call on them to help you at any time.