Assessment tools for technology

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The Institute on Learning Technology

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This conversation also is available from the Learning Through Technology web site,
http://www.wcer.wisc.edu/nise/cl1/ilt/
Assessment tools for technology

The assessment tutorial of the Learning Through Technology (LT²) web site is intended to help you learn how to gather the kinds of data that can improve the effectiveness of computer and Web use in courses. I've created this section both as part of my Fellowship with the College/Level One Program at the National Institute for Science Education and also as part of my work as Director of the Flashlight Program (http://www.tltgroup.org/programs/flashlight.html). So you'll find this tutorial salted with references to relevant NISE and Flashlight resources.

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Assessment Tools Site Map
Is "IT" Working? What Studies Could Help Make It Work Better?

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There's no one right way to do such a study, any more than there is a single best research tool or method in your discipline. That's why this is a tutorial and not a cookbook. There's no minimum (or maximum) set of skills, or money, or time needed. Our goal is to help you design an inquiry that you can handle and that's worth your effort.

The good news is that it's considerably easier to do a useful inquiry to improve your own course(s) than it is do learn how to do research in genetics or chip design.

The bad news (for me, as primary author of this section of the site) is that I don't know much about who you are or what you need, so this will be a "one size fits all" tutorial.

I know that you could be:
- Someone interested in just one course (which may be 5 students or 500), or a set of courses or experiences; or
- Someone who's motivated primarily by desire to help students learn, or someone whose immediate motivation is more external (accreditation self-study? Pressure from a department head? Desire for a publication? Need for data to help build a budget?); or
- Someone who might work on this alone, or with a team; or
- Someone with a budget for a study, or someone with no money; or
- Someone whose institution already has a site license (http://www.tltgroup.org/programs/flashlist.htm) for Flashlight evaluation tools, or not; or
- Someone whose institution can provide a little skilled help (e.g., in designing a survey, in doing data analysis) or who has to do everything alone; or
- Someone who is interested just in outcomes (if they've mastered the ideas, I'll be happy with the technology) or someone who is (also) interested in figuring out whether the use of hardware, software, or networking is itself working; or
- Someone in any number of disciplines (probably in math, science, engineering, or technology, but not necessarily) and probably in higher education (but not necessarily), and probably from the United States (ditto).

More bad news for me: you don't have much time to look at this web site. So, I've designed the tutorial to give you choices along the way so you can find out as quickly as possible whether you need what I'm offering. If the site doesn't work for you and you still want some advice, please send me e-mail at ehrmann@tltgroup.org and I'll see if there's anything we can do to help.

Why Do A Study?

First of all, maybe the skeptics are right. Many studies of technology use in college courses are a waste of time: for the readers, for the investigators, and especially for the students and others who are asked to respond to badly written surveys and meandering interviews.

You shouldn't take for granted that the study you are contemplating (or already doing) is worth doing. We hope that this site can help you decide whether it is and how to do a study that will be worth your time, your audience's time (if the audience includes people other than yourself), and the respondents who you'll be asking to help you gather data.
Or perhaps someone has asked you to do a study of a course, or courses, and suggested you come to this site. Maybe you are really skeptical about this whole thing, or can't quite make out what they're talking about. You might find it useful to skim this site first, or to take a detour and take a look at this short essay about the scholarship of teaching (http://www.tltgroup.org/resourcesws/Flashlight/Scholarship_What.html).

**Reasonable Goals for a Study**

Not all of the following goals are relevant to every study (and, to repeat, sometimes the wise idea is not to do a study). However, here are some of the more common situations that lead to studies:

- You've already put a lot of work into making something technology-related available to your students (lab software? A web site? Quiz system? New online resources? Discussion site?). However, you're not sure whether students are using it, and whether it was really worth the effort.
- You're concerned that some students in your course(s) aren't getting it, despite (or because of) the ways you're asking them to use technology.
- Technology is changing fast and unfamiliar problems are appearing in courses and colleges more frequently than before, with more at stake if those problems aren't solved.
- Someone is feeling uncertain about a particular group of students, a particular new technology, a particular program, a piece of curricular material...
- Someone has told you, "We have to do a self-study for accreditation (or the state, or the alumni, or someone else) and we thought that we'd focus on technology use."
- To report on a grant, or to increase the chances of getting a grant.
- You like doing research, and it should be fun to learn something about your own course, your own students and (in that light) your own field.

It might help you make a case for promotion, or tenure, or getting a better position if you can discover something interesting about technology use in education in your field, and publish your findings.

Of course you may already be convinced this is a good idea and that the study will actually be worth the effort. If part of your problem is to convince other, more skeptical people to help you, here are some of the frequently made objections to devoting time and money to evaluation, and some responses.

**Directions: What to try next?**

**Four Choices:**

Here are four basic choices, one of which will (I hope) guide you in a useful direction:

1. **I probably need to do a survey or some other sort of formal study.** What sort of study might help me, or us, understand whether our strategies for using technology are really helping students learn? What kinds of facts might help us make those uses of computers, video and/or networking even more effective? Follow this link to the heart of the tutorials on this web site, for help in doing a formal study. Because the outcomes of technology investments are dictated by how users choose to use it, we'll begin by discussing some of the most important educational activities that can be improved with technology.
2. I have a small class (20 or fewer students), no time or interest in doing a survey or creating something fancy. Can you give me some quick and dirty advice on how to gather information from my students that will help me help them use technology?

3. All I really need now is advice on how to assess students' understanding of what I've been trying to teach them. I don't need to know anything more about technology, just whether they're learning. I'd like to look at NISE's Field-tested Learning Assessment Guide (http://www.wcer.wisc.edu/nise/cl1/flag/default.asp; FLAG).

4. I'd like to know more about the study of educational uses of technology. Maybe the articles, case studies, and presentations on the Flashlight Resources Pages (http://www.tltgroup.org/resources/index.html) or information about Flashlight evaluation tools (http://www.tltgroup.org/programs/ftools.html) can help me.

Activities

Before we get to the survey templates, we need to explain some of the underlying ideas to help you use them productively.

Computers and the Web do not, by themselves, cause people to learn differently than before. Of course, neither do paper or electricity. Yet paper, electricity, and (probably) computers are all vital to the way you teach your courses. The point is that the learning outcomes are determined by the choices we make every day about how to use paper, electricity, and computers. Paper used one way can help students learn, while used another way it might confuse them. Because the same thing is true about computers, digital hardware, software, the Web and other modern technologies, we need to focus on the activities that make use of the technology. We've found many technology-supported activities that cut across the case studies and vignettes created for this Web site, such as modeling, simulation, visualization, computer and numerical analysis, locating and evaluating information, and real-world data analysis. The faculty we've interviewed have also praised the value of other, more generic teaching-learning activities such as faculty-student interaction, collaboration among students, attracting students to spend more time studying, and the like.

To make this same point about activities in a different way, it used to be common for people to ask, "If we use this new form of technology, how much better will people learn?" I call that a dyadic question because it has only two elements: the technology and the outcome. But to provide a sensible, useful answer to such a question, you must specify at least three elements:

1. One or more technologies (and possibly other elements of context)
2. One or more activities that happen with the help of the technology
3. One or more outcomes of those activities.

We call this activity-centered view of technology a triad because it has three elements. If you'd like a slightly longer version of this explanation, click here for a narrated slideshow (http://www.tltgroup.org/media/fl/triad.htm); you'll need Real Player to hear and see it.

If we are together on this notion about the centrality of what people choose to do with technology, we can take a look at three types of study that can really be worth the effort for
courses or departments such as yours. The rest of this tutorial is devoted to showing how to do each of them.

**Three Types of Formal Studies: A Summary**

This page links to details about three types of formal study, and also mentions a fourth type (cost studies) not described on this web site. This list of evaluative strategies is a suggestive list, not a comprehensive one. If you would like to suggest additions, please send them to ehrmann@tltgroup.org.

- Scanning Studies
- Proof and Tracking Studies
- Diagnostic Studies
- Cost Studies (not discussed in this web site)

**I. Scanning Studies**

A scanning study looks across a large set of potential issues, looking for clues about strengths and weaknesses, opportunities and problems. Scanning studies rarely contribute directly to the improvement of outcomes but they often can be the first step in that direction by helping focus attention on a particular set of technology-related possibilities.

**Limitation:** because scanning surveys rarely devote more than a question or two to each issue (in order to check on more issues), they rarely prove much about what's going on. Instead they provide hints that certain issues warrant study in depth. Some people do scanning studies in order to spot weaknesses or problems. Others examine the same data in search of potential strengths that, if better understood, could be accelerated or exploited.

[More on scanning studies](#)

**II. Proof (Cause/Effect) and Tracking Studies**

Suppose that you have been encouraging students (many of whom commute) to do their homework together in pairs online, commenting on each other's responses, before they each submit 'their final answer.' Your hypothesis is that this online collaboration will help students master the knowledge and skills required by the homework. Your hypothesis has (at least) three elements:

1. **Technology** - the systems used for communication and exchange of files
2. **Activity** - students doing the homework, and exchanging ideas and notes about it
3. **Outcome** - mastery of the ideas and skills required by the homework.

We call these three elements a *triad*. (For more information on why triads are so important in designing studies to improve educational uses of technology, you may want to watch this [narrated slideshow](http://www.tltgroup.org/media/fl/triad.htm))
A proof (or cause/effect) study would focus on questions such as:

- Was the e-mail system used successfully to support collaboration on homework?
- Did collaboration on homework help improve student mastery of the material?

A tracking study asks these and other questions over time, for example:

- Is the e-mail system being used more successfully to support collaboration this year than it was last year?
- Are we learning more about assignments and coaching so that collaboration this year is doing a better job in helping mastery than it did last year?

Tracking studies can help focus attention and resources on a triad for enough years to make real gains in the outcomes. (If you've watched academic reforms and technology investments long enough, you know that a short attention span is one of the primary reasons why we've achieved surprisingly little with computers. Digression: Here's a more detailed discussion (http://www.tltgroup.org/resources/Visions/Improving_Outcomes.html) of how evaluation could help end the cycle of failure in educational uses of technology.)

More on proof (cause/effect) and tracking studies

III. Diagnostic Study
Diagnostic studies gather data about the incentives and barriers that influence the ways users use, or fail to use technology for the activity. Continuing with the same example we mentioned above, a diagnostic instrument might check on the most common reasons why students fail to collaborate online. There are perhaps 60 such factors worth attention because they happen often enough, can make a real difference for at least some students in a course, and can't readily be detected by the faculty member unless the information is purposefully gathered. Some examples are closely related to technology, training and support, such as:

- Speed of connection/bandwidth
- Skill with newsgroup management
- Skill in attaching and detaching attachments

Others are not, such as:

- Students believe the course is graded 'on the curve' so that assisting others could hurt their own grades;
- Students don't see the need to collaborate in order to do an adequate job on the assignment;
- Student believes real-time collaboration is needed but can't arrange times to meet with teammates.

Many of these factors are relatively easy for the faculty member or institution to solve but only if they know in time that someone has the problem. That's the function of the diagnostic tool: to spot the solvable problems in time and make sure the right people know what needs to be done.

More on diagnostic study
IV. Cost Studies
This web site doesn't address studies designed to reduce the stress and other costs associated with technology use. Flashlight does have a separate handbook developed especially for that purpose.

"Cost study" is often a misnomer, for two reasons:
1. Such studies often deal more with other resources, such as time and space, than with cash.
2. For many people "cost study" means "Threat!" Cost studies (goes this worry) about always done by someone else in order to come up with an excuse to reduce my budget or cut my job.

The Flashlight Cost Analysis Handbook describes how to do your own studies, for your own benefit: to 'unstretch' time, money, and space, and to reduce stress in your work. The hope: reduce stress while actually improving results by rethinking the processes by which the work gets done. The new edition of the Cost Handbook (due later in 2002) includes a case study about the redesign of undergraduate engineering laboratories at Penn, resulting in both improved lab experiences and lower costs per student.

More information is available in the Flashlight Cost Analysis Handbook (http://www.tltgroup.org/programs/fcai.html). Institutions subscribing to the Flashlight Tool Series or that are members of the Flashlight Network get one free copy, discounts on additional copies, and the right to legally print their own copies for their own use. You can find out if your institution has already purchased that site license (http://www.tltgroup.org/programs/flashlist.htm).

More information about other resources that can be useful in studying costs is available (http://www.tltgroup.org/resources/farticles.html - Studies of Costs; Methodology of Cost St).

Scanning Studies: Introduction

What is a Scanning Study?
In order to help users decide which few issues most deserve more attention, research, or action, a "scanning study" asks one or two questions about each of a large number of issues. A scanning study can also be used for other purposes, such as providing more context for discussions of the program and its improvement.

Why do a Scanning Survey?
A faculty member might do a survey that scans student use of many readings and assignments, asking (for example) whether the resource was used and whether it was appropriate and useful for its purpose. A department might scan across a variety of educationally significant activities (time spent studying, design work, student-faculty interaction, ....) to see how prevalent each one is and whether available technology is being used to support them. A distance learning program might ask dropouts, continuing students, and graduates about each of a large number of technology-based services.

To repeat: a scanning study takes a broad, shallow look at lots of issues, looking for hints about which of those issues deserves a closer look.
Imagine, for example, that your engineering department does a scanning study that takes a quick
look at many different educational uses of technology in your program. Suppose that the
findings hint that few students are doing much design work and that relatively few of those
students believe that computers aid them in doing more ambitious designs.

This finding might alarm some people, especially if a major reason for buying computer design
software and hardware in the last three years was to help students do more creative design or
research. Conceivably, the scanning study might have misled them. Because it was a scanning
survey looking at a dozen uses of technology, it only asked one or two questions about design,
and it only asked students, not faculty.

Nonetheless the scanning study did its job. It alerted the department that 'design' deserves more
attention. Next, for example, the department might do a proof study to check on the
appropriateness of the infrastructure for design work or on whether design practice is actually
helping graduates become better designers. Or the department might develop diagnostic surveys
to understand the barriers that are discouraging design work and student use of design
software.

In other words, the goal of the scanning study is simply to help you decide where to focus your
attention. If you think you already know where the issues are, you may not need to do a scan.

**Scanning Studies: Activities**

**Scanning Study: Identifying Activities on Which To Focus**

Earlier in this tutorial we discussed some of the reasons for focusing on what students do with
technology - focusing on activities that rely wholly or partly on their use of technology. If the
focus of your scanning study is, "Where are the best success stories and/or the most
worrisome problems in the ways we use computers, video and telecommunications to improve
learning?" then that suggests some pretty basic questions for a scanning survey. Once you've
listed the technologies you think are most important and the activities you think are the most
important ways of getting educational value from those technologies:

1. How often are those activities happening?
2. How often is technology being used to help them happen?
3. How appropriate and valuable do the users see the technology when used for that
   purpose?
4. If the educational value of the activities isn't obvious, you should also ask whether the
   people engaging in the activity see it as helping them achieve the outcomes you've (or
   they) have in mind.

For example, your program may be encouraging students to do their homework together by using
e-mail because you expect that collaboration should help them master the subject matter. So you
might ask:

1. How often do you do your homework with other students?
2. How often do you use e-mail (etc.) to do your homework with other students?
3. How appropriate and valuable is the e-mail for that purpose? For example, if you didn't have e-mail would that make it harder, or impossible, for you to do homework together this often?

4. On a scale of 1-5 (5 being extremely valuable) how would you rate "doing homework together" as a way of mastering the skills taught in your courses?

The Fellows who created the case studies and vignettes on the Learning Through Technology Web site have created a list of activities that you might find helpful in devising your own scanning study; you also should take a look at the seven principles of good practice outlined on the site. I relied on those resources as well in creating my draft scanning study, which you should feel free to use as a template.

**Scanning Studies: Draft Example**

**Study of Teaching-Learning Activities, Computer Use, and Their Contributions to Learning in This Major**

Please give us a few minutes of your time. We are trying to discover whether certain learning activities are helping student academic performance. We are also investigating whether computers and the Web are helping faculty and students with those activities.

This survey should take you only xx minutes to complete.

[You should pretest your draft survey and discover how many minutes it takes a typical respondent to complete it. The lower the response time, the more people will usually complete a survey.]

**Academic Preparation for Your Future**

1. What do you think you will do in this field (sooner or later) after graduation?

____________________________________________________.

   If you do not plan to do graduate work or to seek a job that relates to what you have been studying, skip to the next section.)

2. How would you rate your course of study as preparation for this job or graduate work? Very well prepared - well prepared - adequately prepared - not well enough prepared - poorly prepared - don't know

3. What is your GPA?

   [If you have the student's name and ID number and if you get appropriate permissions, can you get the student's grades in the major from the university's database rather than by asking the student.]

**Teaching-Learning Practices in Courses in Your Major**

In order to discover which instructional practices are helping students learn, we need to ask which of the following practices were common in many of your courses and, of those, which most helped you learn.

**Column 1** lists a teaching-practice
Column 2 on "frequency" deals with how often you have been involved in this activity in your major (courses, clubs, competitions, internships, etc.) Enter a number between 5 and 1:
- 5 if the practice has been used frequently in your major
- 1 if it was used little or not at all in your major. If you enter "1" skip to the next item; you don't need to fill in columns 3 or 4

In column 3, enter a number between 5 and 1:
- 5 if the practice has been extremely important to helping you master the concepts, techniques, ideas or values you need for your future work and life
- 1 if the practice has not helped you learn what you need
- NR (no response) if you have no opinion

In column 4, enter a number between 5 and 1
- 5 if computers or other technology were used frequently to make this activity possible or helpful
- 1 if computers were never, or almost never used, for this activity.
- NR if you don't recall
<table>
<thead>
<tr>
<th>Teaching-Learning Practice</th>
<th>Frequency of this activity in your major (5-1)</th>
<th>How helpful was the activity in preparing you for life after graduation (5-1, NR)</th>
<th>Frequency of computer use for this activity in your major (5-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures, textbooks or software that helped me visualize abstract, complicated phenomena and ideas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructional software that explained something, tested our understanding, and then taught us something else</td>
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<tr>
<td>Assignments or discussions that were valuable because of the differences between the ideas and approaches of different students</td>
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<tr>
<td>Assignments that could required me to create a problem and then solve it</td>
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<tr>
<td>Assignments that required me to predict what would happen, observe what did happen, and then explain what did happen</td>
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<tr>
<td>Assignments that required us to create our own models or simulations of phenomena or ideas</td>
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<tr>
<td>Simulations where we learned by changing settings or parameters and observing the results</td>
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</tr>
<tr>
<td>Laboratory work or assignments that showed us carefully what to do at each step and sometimes even showed us what was supposed to happen next (for example, in a laboratory experiment)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Laboratory or assignments that required us to investigate, explore, create or think in other ways</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis of data from laboratory experiments or real world observation</td>
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<tr>
<td>Use of the Web, library and/or other sources to locate data, research or explanations not available through regular instructional material</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Projects so large that they were only possible because students collaborated (e.g., gathering different types of data; doing different parts of the analysis or design)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working on homework with other students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working on homework with people who are not students or staff at this institution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work on projects of academic value outside the institution (e.g., internship, co-operative program, outside job)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using experts from the real world to help us do assignments or to assess our work</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Technology Availability and Support
How strongly do you agree or disagree with the following statements.
1=strongly agree, 3=don't agree or disagree  5=strongly disagree

"When I need to use computers, video, telecommunications or lab equipment to do an assignment for the courses in my major, access to that sort of technology is not usually a problem."

"When I need to use that sort of technology for an assignment in my major, I usually already know how to use the equipment or software to do that kind of work or, if not, I know there usually will be instructions or assistance to learn how to use it."

"To do at least some of the work in my major, I need to be able to use college equipment like this at night or on weekends."

Scanning Studies: Suggestions

Scanning Surveys: Suggestions For Doing a Real One
In the prior section, I sketched a rough draft of a scanning survey. Feel free to use it as your own rough draft if you’d like to go ahead and create your own real study. Whether you use it or not, you might find the following suggestions helpful in developing your own study. (If you do use it, please let me know where it was useful, misleading, a waste of time, etc. - send e-mail to ehrmann@tltgroup.org.)

Converting the Draft into a Real Survey
The draft needs a lot of work before it would be usable with real students. Among other things:

- Do you want to alter the list of issues? This list is longer than it should be - long enough that it might reduce the fraction of students answering all the questions and returning the survey. You should shorten the list to items of greatest interest to your program.

- In that process, however, you may want to add items to the list. The items in the current draft were included because the author believes they each meet two criteria: a) they can sometimes help promote better learning outcomes, b) computers and other technology can be used to make these practices more common

- Add questions you need for your own purposes (e.g., if you are working with the academic computing or technology support unit, you might want to add a few questions about technology access or support).

- Test your resulting draft with real students.
  - After they complete it, ask them to describe what they thought each question meant. Did they understand the meaning correctly? If not, the question needs to be rewritten.
  - Do they think that this study would be of value to them and their friends? If not, you either need to come up with a better explanation, more respected backers (student honorary society? student government?), pay the students to respond, or consider not doing the study. For more on increasing response rates, see, for example, this Flashlight essay on participation (http://www.tltgroup.org/resources/Flashlight/Participation.html).
**Steps for Using a Scanning Survey**
- Have faculty fill in this survey first with their predictions of how students will respond. Do faculty members immediately identify areas where they’d like to do a study in depth?

- Then gather information from students. Are there issues where their responses were substantially different from predictions? These areas may deserve some study in depth.

**Analyzing the Data**
- Scanning surveys can be done just once. But if you’d like to get a sense of whether practices and issues are changing, do a scan every year or two. Try to keep at least most of the same questions.

- Scanning surveys also help you to see where technology might be paying the biggest dividends (those educationally important activities for which the technology is most frequently used).

- This particular draft scanning survey should enable a crude analysis of the relationship between activities and student performance. You might also try including the qualifications of incoming students (e.g., SAT scores) because they are a powerful predictor of academic performance. The survey could also provide hints about the answers to other questions about your program. For example, do well prepared students value different instructional activities, or the same instructional activities, as less well prepared students?

**Proof-Tracking Studies: Introduction**

What is a Proof-Tracking Study?

Proof-tracking studies deal with questions such as these:
- Is the technology being used for an educationally significant teaching-learning activity? (Proof)

- Over several terms or years, is the activity gradually increasing or improving? (Tracking the activity)

- Over several terms or years, is technology helping to increase or improve the activity (Proof and tracking)

- Is that activity helping improve a learning outcome? (e.g., increased skill, retention, cost saving) (Proof)

In contrast to a scanning study which looks for hints about what might be going on by glancing at many technologies, activities, and outcomes, a proof-tracking study usually gathers information in depth on one triad in order to create convincing evidence for taking action.

Limitations of proof-tracking studies: We’ve never seen a cause-effect study that was definitive - it's rather difficult to be certain about any cause-effect relationship involving human minds - so, no matter what you do, the results will be suggestive, not absolutely conclusive. That same 'uncertainty principle' goes for tracking change over time - our instruments are necessarily crude. It’s usually sufficient, however, if a proof-tracking study gives us some valid hints about what's been going on. Studies can't eliminate the risks associated with big decisions, but their findings can reduce those risks.
Rather than continuing to describe proof-tracking studies in the abstract, let's use an example: the Houston case study on this site. The following pages describe one way to gather evidence about whether available technology is helping students learn algebra at the University of Houston Downtown. Please keep in mind that there are almost as many (good and bad) ways to assess the use of technology in an algebra course as there are ways to paint a picture of the scenery outside your window. What follows represent one person's choices during approximately two hours of making a preliminary sketch of a study. Let the reader beware!

**Proof-Tracking Studies: Activities**

In the activities section earlier of this tutorial we introduced the concept of a triad:

1. technology
2. the activity for which it's used, and
3. the outcomes of the activity.

Any case as normal (complex) as the algebra course at the University of Houston, Downtown, has many potential triads that each could provide the focus for a proof-tracking study. Here are just a few candidates that I've drawn from a quick reading of the Houston case. Because I'd like to demonstrate how to collect proof about whether technology helps improve student learning, I focused my attention on the subsection of the Houston case entitled "The Learning Environment."
<table>
<thead>
<tr>
<th>Triad #</th>
<th>Technology</th>
<th>Activity(s)</th>
<th>Outcome</th>
</tr>
</thead>
</table>
| I.     | Computer and calculator | 1. Reduce math errors, increase calculation speed, increase speed of creating graphs, and thereby  
2. Increase student time spent hearing about, and discussing, the nature of functions | Better, lasting student understanding of algebra concepts |
| II.    | Graphing software on the instructor's computer; projection equipment | 1. Faculty can easily display graphs of varying representations and values of the function, to  
2. Help students visualize mathematical ideas in the classroom, and  
3. Engage students' interest so they put more attention and time into the course | Better, lasting student understanding of algebra concepts |
| III.   | Graphing software on the instructor's computer; projection equipment | 1. Faculty can easily display graphs of varying representations and values of the function, and then  
2. Ask students to explain their thinking about the function | Better, lasting student understanding of algebra concepts |
| IV.    | Graphing software on student computer in lab | Student explores properties, graphs of functions | Better, lasting student understanding of algebra concepts |
| V.     | Software, data available on or through lab computers for doing calculations that enable students to work on more complex, realistic problems than they could handle with paper and pencil | 1. Students are given more complex real world issues that they translate into mathematical problems and solve  
2. When discussing these issues and problems it's more likely that there will be important conversations (faculty-student, student-student) that can help students learn | Better, lasting student understanding of algebra concepts |

Several of the triads have more than one activity. In most cells, the first activity is intended to encourage or support the second activity; both activities contribute to the outcome.
Think of each triad as a hypothesis about how this course, or a set of sections of the course, are intended to work. The "proof" part of the study checks on questions such as these:

1. Is the technology in the triad being used at all?
2. Is it being used for this activity?
3. If there is a sequence of activities, are they all happening?
4. What's the state of the activity? For example, in triad I, is it true that students who use computers are spending less time on calculations and drawing graphs than they would have using paper and pencil? If so, is it true that they used that 'saved time' to talk and think about the meaning of the function? Or are they doing problems as thoughtfully or thoughtlessly as before, just faster?
5. What's the state of the outcome: their ability to understand and use functions and graphs?
6. Is there a relationship between the extent or quality of each activity and the extent to which that outcome is achieved? For example, in triad I, if you can look at more than one section (simultaneously or over a period of years), is there a relationship between time spent talking and thinking about the meaning of the function and the scores of students in those sections on good tests of conceptual understanding? Do students who score higher on the tests also report spending more time in class and at home thinking about the functions? Do they value the technology for giving them the time to do so?

Focusing
Every question we'd like to ask about what faculty and students are doing in a course, and about what students and faculty are learning from the course, takes time, energy, and (often) money to answer. The trick is to ask as few questions as possible, as cheaply as possible, while getting the most valuable answers.

That suggests several criteria to use in translating some or all of the triads above into a study design:

- Which activities are mostly likely to contribute to substantial improvements in the outcome?
- If this is an investigation of a course by a faculty member and if the faculty member is the user of the information, an investigation may well be more valuable if it illuminates important phenomena that the faculty member wouldn't otherwise observe. To put it another way, studies are most likely to be valuable when their findings provide direction and energy for making decisions, usually by reducing uncertainty. (This criterion often points my attention to learning activities by students, because the faculty member can't always see what students are doing and thinking, even when they are in the classroom).
- Where would the findings be most valuable? That often depends on who can take action and what they're feeling anxious and uncertain about. The Houston case study itself isn't very informative on this point, but it does hint that student teamwork is an area of concern. If so, a study of teamwork might be more likely to draw attention and action than a study of something else where faculty are already comfortable that they know what is happening and what to do.
Keep in mind that what you're reading is a quick sketch, not a real study. In reality, I'd have talked with the faculty and administrators in order to work out a plan of inquiry together. However, because this is simply an exercise whose purpose is to help you think about your own program, I haven't actually talked with the people in Houston.

So, pretending that I've talked with the faculty and that these are our joint decisions, here they are:

1. I'm pretending that the Houston people have told me that the board and future funders want some evidence about whether the technology has been of value in improving algebra learning before making a decision on funding for more equipment. These folks are neither true believers nor hostile to begin with; they'd just like evidence that could help them make up their minds.

2. We decided to focus on the activities in triads III, IV, and V. Each one is closely related to the technology, involves student activities, and seem to the faculty to have special promise for improving learning outcomes.

3. For outcomes we decided to assess student skills not only at the end of the term but, even more important, in later courses. After checking the FLAG web site (http://www.wcer.wisc.edu/nise/cl1/flag/default.asp) and finding little of direct relevance to functions and algebra, we decided to ask our colleagues teaching later courses in which these students enrolled to come up with a test of their understanding of functions and graphs that could be used as a diagnostic early in their classes, and which could also feed us information about how our students were doing. Our interest was in the adequacy of their lasting, useable understanding of functions. That news, even if good, wouldn't tell us much directly about the value of the technology, however.

4. So, for studying activities, we decided to focus on whether technology was actually being used in ways of great value to:
   - Encourage students to react to functions and graphs displayed in class. Were we and our colleagues really taking consistent advantage of the power of the technology to stimulate a "what-if" dialogue with, and among, our students. "What if we were to change this parameter - how would the graph change?" "Here's a graph. What function could produce it?"
   - Help students explore the characteristics of functions and their graphs while working in the lab
   - Introduce problems that are a) more complex than before, b) more exciting for students, c) able to help students see functions in action.

To sum up, here are the triads we decided to study over multiple sections and over several years to see if we could provide evidence that technology was being used to gradually improve algebra learning. (Note that these are the same triads from up above.) The boldfaced words and phrases indicate components of the activities where we'll focus our data gathering.
The next step is to use this rather complex triad to create suggestions for the kind of data that could help prove whether technology is in fact helping students learn algebra by these mechanisms. The same data could be useful in tracking whether the program's use of these technologies and activities is becoming more effective in fostering understanding of functions over a period of years.

**Example: Houston Proof-Tracking Study: From Triad to Data**

For our (fictional) development of a (hypothetical) study of the University of Houston Downtown algebra course, we'd selected a triad. The next step was to consider what sort of data to collect.

We kept several considerations in mind when making our plan:

- There wasn't much money or time to spend on gathering data.

- The more straightforward the data were, the more persuasive they could be (because the faculty and administrators using these findings are not trained social scientists)

- Having two or three types of data bearing on one question is more likely to provide something like the truth than relying on just one type of data (e.g., a survey).

Here are the types of data we decided to collect, grouped by their position in the triad:

<table>
<thead>
<tr>
<th>Triad #</th>
<th>Technology</th>
<th>Activity(s)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>III.</td>
<td>Graphing software on the instructor's computer; projection equipment</td>
<td>1. Faculty can easily display graphs of varying representations and values of the function, and then 2. Ask students to explain their thinking about the function</td>
<td>Better, lasting student understanding of algebra concepts, as measured toward the end of the term and in later classes requiring an understanding of functions</td>
</tr>
<tr>
<td>IV.</td>
<td>Graphing software on student computer in lab</td>
<td>Student explores properties, graphs of functions</td>
<td></td>
</tr>
<tr>
<td>V.</td>
<td>Software, data available on or through lab computers for doing calculations that enable students to work on more complex, realistic problems than they could handle with paper and pencil</td>
<td>1. Students are given more complex real world issues that they translate into mathematical problems and solve 2. When discussing these issues and problems it's more likely that there will be important conversations (faculty-student, student-student) that can help students learn</td>
<td></td>
</tr>
</tbody>
</table>
I. Technology Used for the Activity?

<table>
<thead>
<tr>
<th>Technology Used for the Activity?</th>
<th>Data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphing software on the instructor’s computer? Being used? projection equipment being used by faculty to support conversation with students during class hour? Does the software seem to support added flexibility, spontaneity, adaptability to circumstance? And/or does it create new rigidity to the classroom conversation?</td>
<td>• Interview faculty members  • Survey of students includes at least three questions about classroom conversations about the images of functions and graphs on screen</td>
</tr>
<tr>
<td>Graphing software on student computer in lab being used by students to explore the properties of functions and their graphs?</td>
<td>• Survey of students includes at least three questions about how they use the computers in the lab when doing math assignments and projects  • Student assistants in the math labs will be taught how to observe and record notes on how students are using the computers to explore functions and their graphs (we think this will help them help the students too).  • Interview faculty  • Compare the problems in sections using computers in this way with problems assigned several years ago. Show the problems to faculty teaching the courses that these students take next (without telling them which sections the problems came from) and ask them to rate the problems for realism and complexity</td>
</tr>
</tbody>
</table>

Is appropriate software, data available on or through lab computers for doing calculations that enable students to work on more complex, realistic problems than they could handle with paper and pencil? How much is it being used?

On this web site, the last step we’ve taken in designing a study for Houston is to do a rough, partial draft of a student survey.

Proof-Tracking: Questions for a Student Survey

We've listed several data sources for this study, each of which was to be gathered once a term, in order to get a sense of whether the courses were improving in their ability to use technology to improve algebra understanding:

**Outcome: Data Sources**
- A test of the conceptual understanding of functions and the ability to graph and analyze them (to be designed)
- Interviews with instructors teaching later sections (alternative that takes more time but is more revealing: have instructors of later sections give oral exams to students from these courses and rate their ability to work with functions and graphs).

**Use of Technology to Improve a Key Activity: Data Sources**
- Interview the instructors for each section. We might also want to interview instructors for sections to which these ‘experimental sections’ might be compared.
- Use faculty who teach courses that require algebra to analyze the assignments and tests of this course
- Train lab assistants who know math to observe students in the lab, and then interview them and summarize their observations
- Survey students
Because the purpose of this Web site is to help you think about studying your own course(s) rather than to actually do an evaluation of the Houston algebra program, we'll conclude by focusing on the draft student survey and illustrating the kinds of questions that might be included.

**Draft Student Survey (Proof-Tracking)**

**Introduction**
We need your help. The instructors, the department and the University are all working to make this course even better, this term and in future terms. We have worked with administrators, faculty and students in this class to develop this survey. In this survey, we ask for your description of some of the teaching techniques used in this course — not all instructors teach alike and to help us interpret what you learn, we need to know more about how you were taught — and for your description of the ways you personally have learned about functions in this course.

By helping us get a sense of how students learn, you can help make the course better. Your grade will not be affected by this survey, unless you don't turn it in, in which case two points will be subtracted from your score for the term. That's because students, as well as faculty, determine whether a course is poor, or good, or great. You help influence the quality of this course by whether you do homework, by the quality of your discussion, and in other ways, such as by helping us improve the remaining weeks of the course through your feedback on this survey.

**Questions about classroom projection of functions and graphs, and resulting discussion**
1. How often did the instructor use a computer to project functions and graphs?
   a. Usually several times each time the course met
   b. Usually at least once per class meeting
   c. Several times during the term
   d. Three times or less
   e. I don't remember

2. To what extent do you agree or disagree with the following description of the class this term?

"When the instructor used the computer to project a function or graph, there was usually there was a lot of discussion. The instructor would ask questions and, based on what students said, the instructor would change something about the function or graph."
   a. Strongly agree
   b. Agree somewhat
   c. No opinion
   d. Disagree somewhat
   e. Strongly disagree
3. Which of the following statements is a good description of the class discussions about the computer projections of functions in the class this term? Check all that apply.

☐ The instructor asked questions because he really wanted to know what we thought.
☐ The discussions would usually go too fast; often I couldn't follow what was going on.
☐ The instructor asked questions but always knew the answers better than we did.
☐ The room was too dark.
☐ Sometimes, because of our discussion of the functions or graph shown on screen, I would suddenly realize something. Those moments were exciting.
☐ The instructor would ask us how to change the graph or function and then would do what someone had suggested.
☐ Students didn't want to discuss math in our class, not just about what was on the screen, but at any time.
☐ The discussions often made me feel good.
☐ The discussions often made me feel bad.

4. Whether you liked or disliked the way the instructor used the computer projection of functions and graphs, please tell us what was most important about it to you.

__________________________________________________________________
__________________________________________________________________

Questions about use of computers for exploratory problem solving
5. How often did you usually use a computer to work on homework or projects for algebra?
   a. More than once a week
   b. About once a week
   c. Sometimes but less than once a week
   d. Never or almost never

How strongly do you agree or disagree with the following descriptions in Questions 6-11 of how you use computers to solve algebra problems involving functions and/or graphs?
   1 = strongly agree
   3 = neutral
   5 = strongly disagree
   6 = doesn't apply to me.

6. I solve the problem on paper first and then use the computer to check my answer.
   1  2  3  4  5  6

7. I usually don't use the computer to do math homework.
   1  2  3  4  5  6

8. I use the computer to try many different ways of solving the problem.
   1  2  3  4  5  6

9. I rely more on the graph than the equation when solving problems.
   1  2  3  4  5  6

10. For me, the equation and the graph are equally helpful in solving problems.
   1  2  3  4  5  6

11. It's been hard for me to find a computer to do my homework.
   1  2  3  4  5  6
Questions about the realism and engaging power of problems in assignments and classroom discussion.

How strongly do you agree or disagree with the following descriptions in Questions 12-15 of how you use computers to solve algebra problems involving functions and/or graphs?

1 = strongly agree  
3 = neutral  
5 = strongly disagree  
6 = doesn't apply to me.

12. Math problems in this course didn't relate to things I know about.

1  2  3  4  5  6

13. If instructor and students didn't have computers in this course, we might have had to skip some of the most interesting math assignments.

1  2  3  4  5  6

14. When the coursework involved computers, the math problems and assignments were more likely to be the kinds of problems you see in real life.

1  2  3  4  5  6

15. When we used the computer, I was thinking more about the problems I have with computers than about the math.

1  2  3  4  5  6

Diagnostic Study: Introduction

Diagnostic Study: What is it and Why do it?
The third type of study described in this tutorial is a diagnostic study.

Diagnostic studies explore how and why students use technology as they do. Because benefits of technology use depend on how the technology is used, this information can be crucial in improving both the power of the technology and the outcomes of the course or program. For people with experience in computer programming, it might help this explanation to say that the process of educational diagnosis is akin to "debugging." The goal is to discover and fix barriers (and increase incentives) so that all students learn. Some diagnosis involves factors that affect everyone in the class but more often the aim is to deal with barriers and incentives that may each affect only a few students. In a class of 25 students, 12 may be having technology-related problems that are impeding learning but it is unlikely that all 12 have the same problem. Instead the task of diagnosis is to discover, student by student, whether there are fixable problems that have been blocking learning with technology.

Diagnostic studies are not always needed. Sometimes the people involved (for example, the faculty member teaching the course) can see what's going wrong in time to fix things, without the need for formal gathering of data. Take a look at the example below, where I've tried to think aloud about whether and how to design a diagnostic study.

Earlier in this tutorial we began a hypothetical study of the University of Houston Downtown's algebra program, using the LT^2 case study as our source of data. This study is a thought experiment, intended to illustrate several different useful approaches to evaluation. In this
section, we'll begin creating a diagnostic study that might help improve technology use in the program.

Diagnostic Study: Activities

Diagnostic Study - On Which Activities Should the Study Focus?

From here on we'll work on an example, so you can see the kind of thinking needed to create a diagnostic. As I did with the proof-tracking study, I'll focus on the Houston algebra case study (but you can do a diagnostic study without first doing a proof-tracking study - it simply depends on what kind of information you need most or first.)

After studying the Learning Environment section of the Houston-Downtown algebra program case study, I decided to focus on three technology-dependent activities in the course, the technologies used to carry them out, and one goal for their use. This is the triad on which our studies are focusing.

Which of these should be the subject of a diagnostic, if any? Let me think aloud about this, to help you understand the issues involved.

A diagnostic is meant to help you do something by gathering data that you wouldn't otherwise see. It's just the same as a doctor ordering an X-ray of a painful leg: you gather information so you can decide what to do. Obviously you don't waste energy on this if: a) there's no problem, b) there is a problem, but there are only one or two conceivable reasons for it, or c) you have no educational equivalent of an X-ray - no way to diagnose the problem.

So in using this triad to decide what we might diagnose, I ask myself which facet of the triad is most likely to pose a problem with many conceivable causes -- causes which we could relatively easily diagnose by looking beneath the symptoms. I first considered the faculty's use of projected functions and graphs to stimulate class discussion. But many faculty are already pretty good at facilitating discussion and diagnosing potential causes of student silence in class. So I looked at the second activity: use by students of graphing software on computers in the lab. I hesitated here, too, because (perhaps because I don't teach algebra and haven't taken it for over 30 years) I wasn't sure what sorts of 'bugs' could derail this learning process, or how to detect them.

Ultimately I decided to focus on the faculty's hope that students would use software on assignments involving real world issues and data. Faculty hopes in Houston are described in the section of the Learning Environment called "Connecting to Real World Data." They hope that students will use computers in the labs to work (often together) on issues in a process that involves framing a math problem in the context of a real world situation and solving that problem, probably relying on numerical and graphical representations of the functions.

Are all students using computers to think and learn in this way? Probably not. If many students aren't thinking in this way, some of the problems are probably not easily fixed. But isn't quite possible that some students may be facing barriers every week that, if the faculty member only knew about them, could be dealt with more easily? A misconception blocking a few students? Lack of a key computer skill hindering others? Inability to find a computer outside class that has been slowing a few others? And so on. If that's the case, then a quick diagnosis might conceivably make a huge difference for many students individually and for the tone of the course as a whole. The key guess I was making at this point was that there were enough such potential problems that recurred - so that if you discovered the problems in week 2 and fixed
them in week 3 that students would be able to learn faster and better in week 4 and thereafter. (If the problem were specific to week 2, and week 2 only, then discovering it in week 3 doesn't help anyone except students in the next offering of the course when they get to week 2. That's OK but there's more of a payoff in dealing first with problems that affect students every week.) Anyway, with my attention now fixed on this particular learning activity, I decided to try sketching a diagnostic survey. That's on the last page of this section.

**Diagnostic Study: Data**

**Diagnostic Study - What Kinds of Data Should be Collected?**

Because you're probably not facing the same issues as Houston, I've not taken the time to create a well-honed diagnostic survey. Instead I've simply constructed a table suggesting the kind of questions Houston might ask students, and what action Houston might take as a result of each type of answer. (In this type of study, by the way, it's especially important to explain to students the purpose of the data and then to get their names along with their answers. If you find out that 4 of 25 students are having problems with using the software, you can help them more quickly if you know who they are!

<table>
<thead>
<tr>
<th>Question about possible reasons why some students aren't using technology as expected in the lab</th>
<th>Source of Data</th>
<th>What Houston Might Do with the Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Specialized software is to be used in the lab but some students don't know how to use it, or at least can't easily use key features (e.g., they are expected to use spreadsheets, but these students don't know how to create a graph).</td>
<td>Survey question: Ask the students about their confidence in using this feature of the software, or how often they use it this way. Test: if students can't accurately judge their own skills or if the skill is key, you might actually ask the students to use the feature.</td>
<td>Help the students with problems. Figure out the source of the problem. For example, a study at Mount Royal College several years ago traced some such problems to the fact that some students had so little experience with computers they had missed the fact that help was available in using the software; other, more experienced students were so over-confident in their ability that they too had not heard (or ignored) the messages about the availability of help. At Mount Royal, in other words, the help was adequate but certain groups of students weren't using it. When the method of publicizing the help was changed, the problems in using the software largely disappeared.</td>
</tr>
<tr>
<td>2. Some students can't find machines available when they need them: lab closed at that hour or long lines, for example</td>
<td>Survey question Observer at the lab (long lines)</td>
<td>If technology services is co-sponsoring this study, they might be able to use this data to ask for the budget needed to help fix the problem. In the meantime, there may be other labs on campus open at other hours.</td>
</tr>
<tr>
<td>3. Some students don't find the real world situations described in the assignments to be very engaging or perhaps understandable</td>
<td>Survey question Discussion with students (see the methods outlined in the &quot;Quick and Dirty&quot; section of this site.)</td>
<td>Try changing the explanation of the problems. Find out more about the students' &quot;real world&quot; and begin with situations that do relate more directly to their experience.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---</td>
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<td>---</td>
</tr>
<tr>
<td><strong>4.</strong> Some students don't understand the math ideas well enough to work on the problems (e.g. what is an unknown; what is a graph over time)</td>
<td>Diagnostic tests of the math ideas.</td>
<td>Some instructors will use additional tutorial materials and peer assistance to help students learn these ideas in the context of the real world problems. Others may assign special work on the basic ideas before sending the students back to work on the real world problems.</td>
</tr>
<tr>
<td><strong>5.</strong> Some students report that they don't have the time to spend on these ambitious problems.</td>
<td>Survey question</td>
<td>Some students really don't have the time. Perhaps some of them shouldn't be in this course. Perhaps some need help in time management. For others, this explanation may mask their lack of understanding that this type of math problem (and other real world uses of math) do require more time than cookbook drills. If so, find ways to teach and persuade them to budget the needed time. Peers and recent graduates of the course or college might provide some useful testimonials.</td>
</tr>
<tr>
<td><strong>6.</strong> The lab's design is too cramped to allow students to collaborate easily</td>
<td>Survey question</td>
<td>Rearrange the lab or find another that has more room for students to cluster together around one computer.</td>
</tr>
<tr>
<td><strong>7.</strong> Poor reading skills or other types of learning disability make it difficult for students to understand the problem statement</td>
<td>Survey question might provide a clue. Diagnostic testing would be needed to pin this one down.</td>
<td>Work with the college's learning center to provide help. Encourage students to work in teams so that these students can get some peer assistance in understanding the problem.</td>
</tr>
<tr>
<td><strong>8.</strong> Student's native language isn't English. Student often works alone because it's hard to understand other students, especially in the buzz of the lab.</td>
<td>Survey questions.</td>
<td>Try having students work online - the slower pace of written online conversation can help students with differing languages or accents. Find smaller, quieter labs Group students with similar linguistic backgrounds</td>
</tr>
<tr>
<td><strong>9.</strong> What obvious potential problems have I missed?</td>
<td>What data could detect them?</td>
<td>Once detected, how could they be solved or at least reduced?</td>
</tr>
</tbody>
</table>

This completes the tutorial on diagnostic studies! Well done!
Quick and Dirty Advice

Here’s a strategy for inquiry if you meet some or all of the following conditions:

- You want something you can do quickly and cheaply
- You’re interested in making the use of computers, video, or networking (e.g., the web or threaded discussions) more effective in your course.

I’ve adapted the following idea from the "Paideia Project", developed in the 1970s by Mildred Henry and Joseph Katz.

**Goal:** Help all students succeed in your course if at all possible, no matter how different they are in abilities, needs, and learning styles. It's important to teach for all students, not just the majority or just for the students who are most like you. But what works for some students in a course may not work for others (and sometimes for surprising reasons). Ordinarily students who are 'different' may be relatively invisible to you, especially if there are only one or two of each kind of 'different.' Use this interview approach to help you see how things are going even for these 'invisible' students, so you can invent ways to teach that will work for everyone, or almost everyone in your course.

**Method (summary):** In order to adjust your teaching and course materials so that all students can learn, (1) select a few students who are different in ways that are likely to affect their experience in the course, and (2) ask them periodically about what in the course has worked for them since your last conversation, and what has given them problems.

**Method (detailed):** (1) Selecting students to interview. Select a small group to interview regularly (weekly?) as the course unfolds. If your course consisted of 11 type X students, 2 type Y students, and one type Z, you would select an interview group of three students: one X, one Y and one Z. From your later weekly conversations with them, you’d be trying to get insights to help assure that the course works for all three types of students, not just the majority (X) or the ones most like you (Y).

What kinds of variation among students are important enough to consider when picking the group of students to interview?

- **Comfort with technology.** There are sometimes surprising differences among students with little computer experience, students with a moderate amount of experience, and students who are so experienced that they are (over?) confident.

- **Students who value right answers versus students who are comfortable with ambiguity, exploration and creative work.** This variation could be important in an engineering design course, for example.

- For a course where students will work in teams, **students who experienced in making teams work, students who are inexperienced, and students who have had bad experiences with teams and don't like them.**

- **Students who vary in their ability for mathematical reasoning**

How can you discover how students vary in these or other ways, without spending too much time? There are at least three ways to get such data:
1. Diagnostic data already collected about students by the institution, including test scores and grades in prior courses.

2. Tests of their ability to perform

3. Ask them to rate themselves, after explaining why you want the information. Be as precise as possible in your questions, and try not to let one option sound like the one 'good' students would pick. Ideally a student of each type would say about one option, "That's me" and feel quite comfortable in describing themselves that way.

However you do it, select a group of about four to seven students who represent the most important variations of learners and learning in your courses: personal characteristics that might affect their encounters with your technology-related teaching or assignments.

Once you've selected your group of interviewees, arrange to talk with them. You might do this just once, but it seems more useful (if more time-consuming) to do it every week or two. You'll need to convince them that you're going to use these conversations to make the course better for students like them. When talking with them, just listen to what they say and take notes. Try not to be defensive. Here are some questions you might ask:

- Since we last talked, what has happened in the course (class meetings, readings, assignments, etc.) that you liked the best?

- What has happened that was the most confusing or unpleasant?

Suppose you're trying to improve a particular use of technology. For example, you teach biology and you've asked students to do simulated breeding experiments.

If time is short, you might just ask "What did you think of the simulated breeding experiments?"

If you've got more time, you might get some basic information from them first?

- What has been your previous experience in the lab and/or with simulated lab experiences in your science courses? (If students have a history of great experiences, or bad experiences, in labs, it's important to find out why because their past will usually influence the way they use the new simulation, and what they learn from it.)

- Did you try the simulated lab in this course? If not, what got in the way?

- If you've done this lab, what were the best aspects of it for you?

- What was most frustrating or confusing about it?

If you have a suggestion for rewriting this page, please send e-mail to Steve Ehrmann at ehrmann@ttltgroup.org.
Frequently Made Objections (FMO’s) to Spending Time and Money on Evaluation, Plus Some Suggested Responses

Stephen C. Ehrmann, Ph.D.
NISE CL-1 Fellow
Director, The Flashlight Program of The TLT Group

1. **Studies are a waste of time.** Either the findings confirm what people already believe or, if findings contradict beliefs, decision-makers still don't believe the findings. Instead they assume that there was a flaw in the methods. And there is always a flaw in the methods!

   This is too often true. That's why, if you have a choice, you should focus studies on issues where decision-makers really are uncertain. For more on this, see "Finding a Great Evaluative Question: The Divining Rod of Emotion" (http://www.tltgroup.org/resources/F_divining_rod.html).

2. **We're just now investing in technology X. We should wait until it's running well before we put time and money into evaluation of its contribution to better educational practice or outcomes.**

   If you're just about to make a new investment in technology, or just did make one, now is an ideal time to begin a series of studies. The value of using technology stems from how it's used, not just whether it's available. So for example, two classic ways of using technology to improve learning outcomes involve improving student-faculty interaction and active learning. So now is a good time to begin assessing student-faculty interaction and active learning (including the roles played by current technology). Later, when the new investments are in place, another evaluation can help you discover whether and how much that investment is indeed helping to improve faculty-student interaction and active learning (or whatever other educational activity or outcome is to be aided).

3. **People might say it's virtuous to study educational uses of technology. But no one around here has seen a single study that produced findings useful enough to justify the time and money needed to do the study.**

   That's often true, and a little puzzling because many useful studies have been done. [See for example, the lists of articles and case studies on the Flashlight (http://www.tltgroup.org/programs/flashlight.html) web site.]

4. **It's not possible (or especially important) to do a study of costs. Everyone will just think it's an excuse to cut jobs or make them work harder.**

   That may be true. Most institutions would benefit in the long term by doing fewer (but more carefully chosen and designed) studies. As for cost studies, the chief element of costs in education are the ways people use their time. So a "cost study" is often a study of how people can use their time (and their budgets, and space) in more productive and satisfying ways. The most successful cost studies are usually done by a group of individuals and units and focus on a process in which they all participate and whose costs no single person understands, e.g., the costs of helping faculty use technology in their courses. Cost studies can be helpful because so many of the costs are ordinarily hidden. If the cost study helps people understand the total activity in which they all have been taking part, including the ways in which that activity may be sapping their energy
and budgets, it can be the first step toward redesigning the process so it works better while taking less of a toll on people and budgets.

5. **Our board (or donors, or legislature) don't understand what we're doing with technology, and don't want to. At most they want to know numbers: how many machines do we have, and the like. No evaluation is necessary.**

That also may be true. But it's likely that at least some of them would like help in understanding the real benefits for students and alumni of the money. And it can be in the institution's long-term interest to use evaluative findings, including case studies, to help them understand. Good results can help fuel enthusiasm. Equally important, a track record of using studies to find problems and make improvements can help build confidence that, when you seek the next big infusion of capital, that you're not flying blind.

6. **Our faculty will object to evaluation. They know more about good teaching than any course evaluation instrument can tell them. Anyway we already have a course evaluation system. (Although it can probably be distorted by being a "nice guy" and giving mostly high grades!)**

Flashlight was designed to help faculty, their departments and institutions conduct studies of teaching-learning strategies and support services. Flashlight studies of courses are usually done by faculty members in order to improve their own courses, and to contribute to the scholarship of teaching. Institutional studies using Flashlight tools are aimed to help create a more successful academic program.

7. **By the time the data come in, the findings will be obsolete - we'll have changed technology, or the courses will be different, or both.**

Flashlight studies focus on activities (e.g., student-student collaboration, "library-type" research, time on task). These activities were important twenty years ago and they will be important twenty years from now, no matter what the discipline, level of education, type of technology, or details of teaching-learning strategy.

8. **Flashlight Online would help us gather information from students but that's just anecdotal information and can't be trusted.**

Flashlight Online (and other Flashlight tools) focus on descriptive information ("how often did the respondent do something) and expert judgment ("when you tried to use this software to do that task, how well did it work?"). If an institution wants data about how often students interact with one another using technology, students provide the single best source of data. To complement the student data, the Flashlight Faculty Inventory provides some parallel questions to ask faculty members about student-student collaboration and other educationally important activities.

9. **Studies like this are inappropriate. They apply models from fields like physics (controlled studies, quantitative data) to education and that just distorts education while not proving anything.**

Flashlight tools and items can be used for many kinds of study designs. It's most common to begin with interviews and searching discussions, in order to focus the study. Investigators then often use designs that derive more from the discipline of history than physics: they use interviews and discussion to describe a chain of events describing how the technology is to be used, and how that use may lead to hoped-for or feared
outcomes. For example, a study of a course may begin with the hope that students will work together, face to face and online, in doing homework and projects and that this collaborative learning will increase student interest in the course. This interest and energy are meant to lead to more time spent studying and better test scores. A Flashlight-type study might scan this whole chain of events, to see if any of the links are "weak," e.g., one of the early "links" is student use of e-mail to do homework. But if students don't do this, then perhaps the chain breaks. A deeper investigation might focus on why so few students are using e-mail to do homework together: problems with Internet access? lack of training in using attachments? Have they had bad experiences with "freeloaders" so that they are now reluctant to team up? Do they think that the course is graded on a curve so that helping others may harm their own grades? Feedback like this can help fix the problem and make it more likely that the end of the chain - improved learning outcomes - will be reached.

10. **We don't have the staff to carry out studies or help others**

   This is a very common problem but increasingly institutions are assigning this duty to current staff and/or hiring new staff. If you don't have people who taking leadership responsibility, it is extremely difficult for the institution to carry out studies that affect practice.

11. **We only have a half-time person available to do this.**

   Even a half-timer with a budget can help many other people do studies, so long as the work is really shared, especially if the half-timer can occasionally help the researchers get released time. A half-time person can organize brown-bag lunches among people doing studies and interested in doing studies, make sure that support services are available and help publicize findings. A half-timer is even more effective if supported by a TLT Roundtable or other leadership unit in the institution.

If you have other "Frequently Made Objections" or Responses to add to the list, please share them with us by sending them to ehrmann@tltgroup.org. We've recently added another article to this site on this topic, "Diagnosing and Responding to Resistance to Evaluation."

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Triad for the Houston Case Study

It was once common to ask "If we use computers, how much better or faster will students learn?" and "If we use computers, how much money can we save?" These are dyadic questions: they refer only to technology and outcomes. The last thirty years of research agree with common sense: you need to refer to at least three things if you want to connect technology and outcomes:

1. Some technology (e.g., e-mail)
2. Some use for the technology (e.g., students doing their homework together)
3. Some result of that activity (e.g., students mastering the central limit theorem in mathematics)

The Flashlight Program has coined the term "triad" to refer to this minimal framework needed for research on technology and outcomes.

Here’s a somewhat more complex focus for studies of the algebra program at the University of Houston Downtown, created using this "triad" concept.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Activities</th>
<th>Outcome</th>
</tr>
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<tbody>
<tr>
<td>Graphing software on the instructor's computer; projection equipment</td>
<td>1. Faculty can easily display graphs of varying representations and values of the function, and then 2. ask students to explain their thinking about the function</td>
<td></td>
</tr>
<tr>
<td>Graphing software, data on student computer in lab</td>
<td>Student explores properties, graphs of functions</td>
<td></td>
</tr>
<tr>
<td>Software, data available on or through lab computers for doing calculations that enable students to work on more complex, realistic problems than they could handle with paper and pencil</td>
<td>1. Students are given more complex real world issues that they translate into mathematical problems and solve 2. when discussing these issues and problems it's more likely that there will be important conversations (faculty-student, student-student) that can help students learn</td>
<td>Better, lasting student understanding of algebra concepts, as measured toward the end of the term and in later classes requiring an understanding of functions</td>
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</tbody>
</table>