Creating Your Own In-House Software Testing Course

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Tutorial at the
Conference of the
Association for Software Testing
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Source Materials on the Disk

- *Video lectures*
- *Activities*
- *Assignments*
- *Sample exam questions*
- *Some readings*
- *A little additional instructional support material*

- *James Bach, Scott Barber, Tim Coulter and I are creating a site like this at www.satisfice.com ("Satisfice University") that will host supervised courses. (Some will cost money, others will be free.)*
- *I have a closed moodle site at Florida Tech but expect to open a public one in mid-summer.*
- *Both of these will provide access to reusable content.*

Today's Key Assertions

1. *Testing is evolving slowly because there is so little educational support for it.*

2. *University support will continue to be inadequate for the foreseeable future. Companies will therefore have to develop their own training strategies.*

3. *Commercial short courses are often ineffective because they*

   - *try to cover too much,*

   - *at too shallow a level,*

   - *without application to the learner's specific situation,*

   - *with too little opportunity for practice,*

   - *and less opportunity for assessment and feedback.*

- *You can develop a suitable training program that integrates into your work environment at a low net cost.*

- *The full curriculum might be broader than you first suspect.*

Meet & Greet

- *Who are you?*
- *What are the most important three things we should know about your background?*
- *Why are you here?*
- *What do you hope to leave with?*

Initial task: Connect to Moodle

- *Your card has your user ID and password*
- *Router is bedbug*
- *Encryption is WEP:*

  603a96b7e7

- *Please update your profile by personalizing it in some way.*
- *This task is complete when you have:*
  - *Updated your profile*
  - *Downloaded and viewed one piece of content from any topic in the testing course*
- *I'll do a quick tour while you're setting up.*

Group Assignment

- *Work in N (TBD) groups on the following questions:*
  - *What have been the big new ideas in testing in the past N years?*
  - *Have they really been new or are we looking at slow propagation?*
  - *How does this compare to the rate of change in*
    - *programming?*
    - *technical support?*
    - *technical training?*
    - *project management?*
  - *Why do you think this is?*
- *Please report your conclusions back to the main group.*

Content Discussion of the Assignment

- *Consider the answers and their implications for training*

Process Discussion of the Assignment

- *What potential objectives did this group activity serve?*
- *What potential objectives did this activity not serve?*

- *In the classroom, we have a vast range of available activities.*
  - *The best choice is the one that serves the educational objectives at hand.*

A degree program in testing?

- *We considered this at Florida Tech*
  - *Certainly a rich enough intellectual problem to deserve a degree. (We'll brainstorm the range later.)*
  - *Serious risk of career stereotyping and lock-in (exactly the opposite to objectives of university-level education)*
  - *Abandoned in favor of a software engineering degree that offers*
    - *black box software testing*
    - *programmer testing*
    - *additional test-relevant courses (e.g. human factors) and testing options.*
  - *This is better than most other places but it still just scratches the surface.*

    (By the way, with pull of U.S. national research funding toward security and away from commercial software, it's not clear that Florida Tech is near a steady state)

Summary so far

- *Testing has evolved slowly compared to related fields*
- *Educational opportunities for testing are limited*
- *University-level educational opportunities will continue to be limited*

- *Conclusion:*
- *You want a good tester?*
  - *Plan A: Hire experienced staff who can demonstrate relevant knowledge, skill and attitudes*
  - *Plan B: Train your own staff*
- *This course is about Plan B.*

Teaching Goals Inventory

- *Take the inventory*

- *If you finish early, start brainstorming an answer to the following questions:*
  - *What courses should testers "have to" take?*
  - *For each course:*
    - *What are its key objectives?*
    - *What is its relevance to software testing?*
- *Over the course of the day, please post your answers to these to the flipcharts*

Teaching Goals Inventory

It is useful to prioritize among goals that fit within 6 categories

- *Discipline-specific knowledge and skill*

  e.g. Develop skill in using materials, tools, technology central to this subject

- *Basic academic success skills*

  e.g. develop listening, reading, and speaking skills; develop appropriate study skills, strategies & habits

- *Higher order thinking skills*

  e.g. develop problem-solving skills

- *Liberal arts and academic values*

  e.g. develop an openness to new ideas; develop an informed historical perspective

- *Work and career preparation*

  e.g. develop ability to work productively with others; improve ability to organize and use time effectively.

- *Personal development*

  e.g. develop a sense of responsibility for one's own behavior

See Angelo & Cross, Classroom Assessment Techniques, 1993.

Teaching Goals Inventory

Cluster	Goals in cluster	Percent rated "essential"	Mean rating
1. Higher order thinking skills	1 – 8 (8)		
2. Basic academic success skills	9 – 17 (9)		
3. Discipline-specific knowledge & skills	18 – 25 (8)		
4. Liberal arts & academic values	26 – 35 (10)		
5. Work & career preparation	36 – 43 (8)		
6. Personal development	44 – 52 (9)		

Teaching Goals Inventory

- *How many did you rate essential?*
- *How are you going to find time to cover all of those?*
- *How well do you have to teach them to cover them well enough?*

- *Commercial training appears to cover massive amounts of material. Unfortunately, we are confounding quantity with quality.*

- *Here is my experience report as a teacher (1983-2006)*

The instructional challenge, as I see it

Software testing

is cognitively complex,

requires critical thinking,

effective communication, and

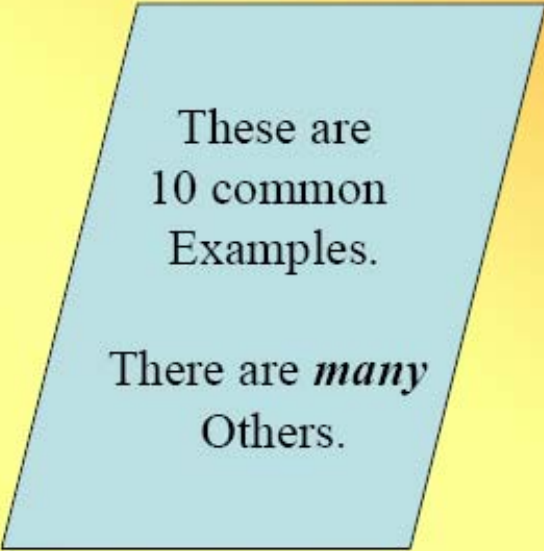*rapid self-directed learning.*

Software testing is a process of empirical, technical investigation of the product under test conducted to provide stakeholders with quality-related information.

What's a test technique?
Ten dominating techniques

- Function testing
- Specification-based testing
- Domain testing
- Risk-based testing
- Scenario testing
- Regression testing
- Stress testing
- User testing
- State-model based testing
- High volume automated testing

These are 10 common Examples.

There are *many* Others.

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http://www.testingeducation.org/BBST/BBST--IntroductiontoTestDesign.html

Test attributes

To different degrees, good tests have these attributes:

- **Power**. When a problem exists, the test will reveal it.
- **Valid**. When the test reveals a problem, it is a genuine problem.
- **Value**. It reveals things your clients want to know about the product or project.
- **Credible**. Your client will believe that people will do the things that are done in this test.
- **Representative** of events most likely to be encountered by the user. (xref. Musa's *Software Reliability Engineering*).
- **Non-redundant**. This test represents a larger group that address the same risk.
- **Motivating**. Your client will want to fix the problem exposed by this test.
- **Performable**. It can be performed as designed.
- **Maintainable**. Easy to revise in the face of product changes.
- **Repeatable**. It is easy and inexpensive to reuse the test.
- **Pop**. (*short for Karl Popper*) It reveal things about our basic or critical assumptions.
- **Coverage**. It exercises the product in a way that isn't already taken care of by other tests.
- **Easy to evaluate**.
- **Supports troubleshooting**. Provides useful information for the debugging programmer.
- **Appropriately complex**. As the program gets more stable, you can hit it with more complex tests and more closely simulate use by experienced users.
- **Accountable**. You can explain, justify, and prove you ran it.
- **Cost**. This includes time and effort, as well as direct costs.
- **Opportunity Cost**. Developing and performing this test prevents you from doing other work

http://www.testingeducation.org/BBST/BBST--IntroductiontoTestDesign.html

Contexts Vary Across Projects

Testers must learn, for each new product:

- *What are the goals and quality criteria for the project*
- *What skills and resources are available to the project*
- *What is in the product*
- *How it could fail*
- *What the consequences of potential failures could be*
- *Who might care about which consequence of what failure*
- *How to trigger a fault that generates the failure we're seeking*
- *How to recognize failure*
- *How to decide what result variables to pay attention to*
- *How to decide what other result variables to pay attention to in the event of intermittent failure*
- *How to troubleshoot and simplify a failure, so as to better*
    - *(a) motivate a stakeholder who might advocate for a fix*
    - *(b) enable a fixer to identify and stomp the bug more quickly*
- *How to expose, and who to expose to, undelivered benefits, unsatisfied implications, traps, and missed opportunities.*

It's kind of like CSI

MANY tools, procedures, sources of evidence.

- Tools and procedures don't define an investigation or its goals.

- There is too much evidence to test, tools are often expensive, so investigators must exercise judgment.

- The investigator must pick what to study, and how, in order to reveal the most needed information.

Commercial Teaching Style

- *Primary communication style was lecture*
    - *Real-life examples*
        - *Motivating*
        - *Memorable*
        - *Illustrate applications*
        - *Illustrate complexity*
- *Lectures can be excellent for conveying basic knowledge, but they are weak for developing higher order cognitive skills*
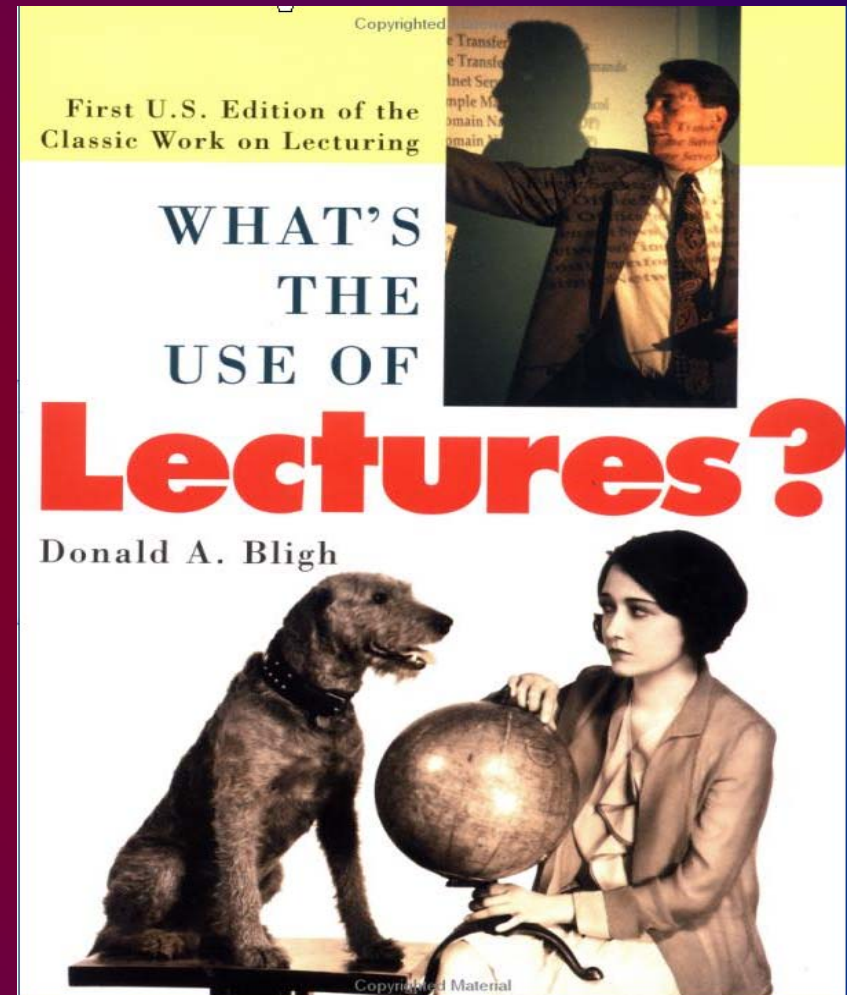
Example Problem: Domain Testing

- *Most widely taught testing technique*
  - *For details, see http://www.testingeducation.org/BBST/Domain.html*
  - *Easy to explain the basic concepts*
  - *Classic examples widely taught*
  - *Students quickly signal that they understand it*
  - *But when you give them exercises under slightly new circumstances*
    - *They blow it*
      - *And then they blow the next one*
        - *And the next one . . .*

Brilliant (?) idea

- *Lots of practice exercises*
- *Like we used to do as math students*

I Tried This With Commercial Students

- *Many (often, most) of them needed a lot of practice under changing circumstances*
- *But the perceived slow pace of the course made them anxious*
- *And the shorter topic checklist created a marketing disadvantage for my courses.*

So I Became a University Instructor

- *Big pay cut, but a clear goal:*

  Improve the state of the practice in software testing by improving the test-related education of software testers

- *This responds to my belief that the most significant cause of the slow pace of change in testing, compared to programming, is the weak educational support for theory, practice, and experimentation in testing.*

Commercial   vs.   Academic

Commercial	Academic
• *Drive-by teaching*	• *Local teaching*
– *2-5 days, rapid-fire ideas, visiting instructor*	– *Several months, a few hours per week, students get to know instructor*
• *Broad, shallow coverage*	• *Deeper coverage*
• *Time constraints limit activities*	• *Activities expected to develop skills*
• *No time for homework*	• *Extensive homework*
• *No tests*	• *Assessment expected*
• *Familiarity*	• *Mastery*
• *Work experience helps to bring home concepts*	• *Students have no work experience, need context*
• *Objective: one applicable new idea per day*	• *Expect mastery of several concepts and skills*

The idea is to develop courses in an academic environment (where I can learn more about what works and why), with the goal of providing an alternative model for commercial (in-house) training and professional self-study

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Back to that Brilliant (?) idea

- *Lots of practice exercises*
- *Like we used to do as math students*

- *It was impractical in commercial training*
- *Now, at last, we can try it on university students.*

Padmanabhan's Thesis:
# Practice on Domain Testing

- *15 classroom hours of lecture plus examples plus practice, practice, practice. Lots of procedural instruction and drill*

- *Students mastered every procedure*

- *Final exam*
  - *Applied what they knew to similar questions (near transfer)*
    - *They aced them*
  - *Applied what they knew to a problem that was beyond their practice (not beyond the lecture) (a little bit farther transfer)*
    - *They all failed miserably*

- *Successful transfer of learning requires more than procedural training and practice (This is a what-else-is-new result in science education.)*

Dealing With the Transfer Problem
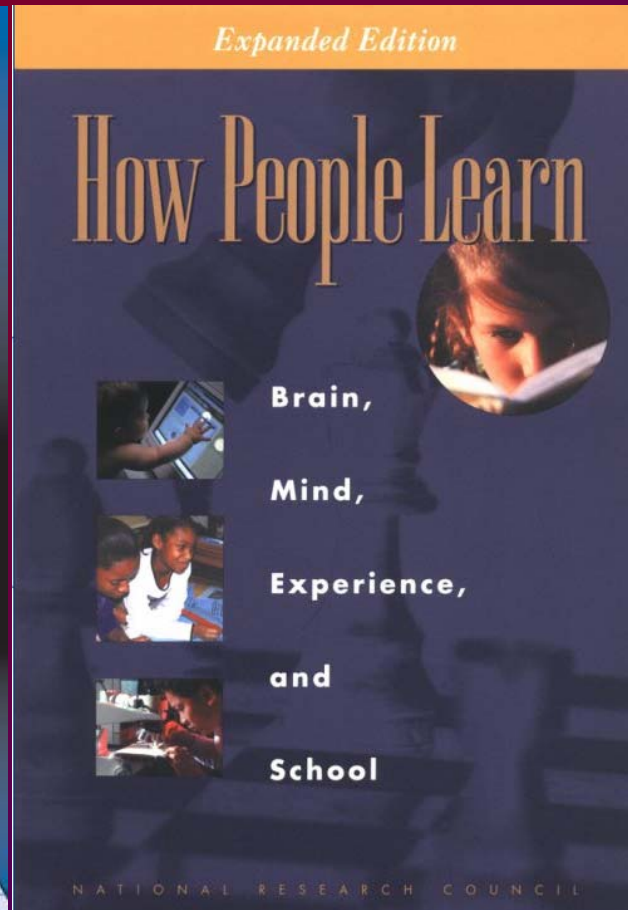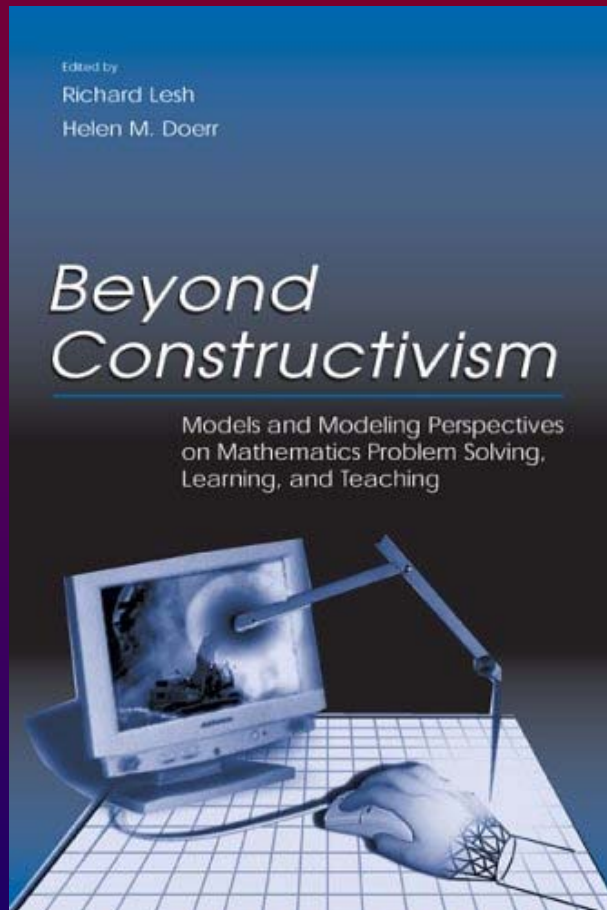
- In science / math education, the transfer problem is driving fundamental change in the classroom

- Students learn (and transfer) better when they discover concepts, rather than by being told them
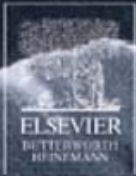
Andragogy

- Pedagogy: study of teaching / learning of children

- Andragogy: study of teaching / learning of adults

- University undergrads are in a middle ground between the teacher-directed child and the fully-self-directed adult

- Both groups, but especially adults, benefit from activity-based and discovery-based styles

Characterizing Cognitive Complexity
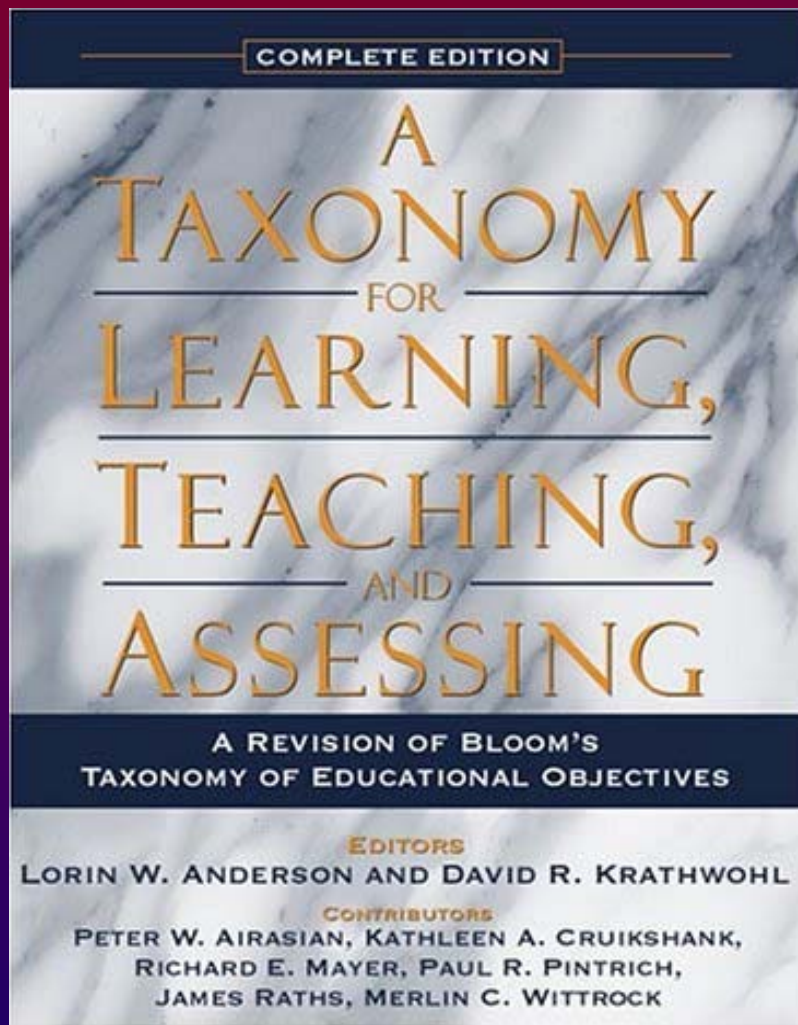
- *Anderson & Krathwohl (2001) provide a modern update to Bloom's (1956) taxonomy*

Characterizing Cognitive Complexity

		Cognitive Process Dimension					
		Remember	Understand	Apply	Analyze	Evaluate	Create
Knowledge Dimension	Factual	**lecture**	**lecture**				
	Conceptual	**lecture**	**lecture**				
	Procedural	**lecture**	**lecture**				
	Meta-Cognitive						

Anderson & Krathwohl, 2001

We Start Over

- *Cognitively complex material*
- *We need to develop skill, judgment, and attitudes, not just knowledge of facts and definitions*
- *We face the usual (for science education) transfer problems*
- *Set a few explicit learning objectives*
- *And assess against them*

My Learning Objectives

- *Learn many test techniques well enough to know how, when, and why to use them*

- *Foster strategic thinking--prioritization, designing tests/reports for specific audiences , assess the requirements for complex testing tasks (such as test automation, test documentation)*

- *Apply (and further develop) communication skills (e.g. for bug reporting, status reporting, specification analysis)*

- *Improve and apply teamwork skills (peer reviews, paired testing, shared analysis of challenging problems)*

- *Gain (and document) experiences that can improve the student's chances of getting a job in testing*

Here's Where We Are Now

- *We created a variety of out-of-classroom activities, such as homework (with application to real products) and group study sessions*

- *Students praised the (by now, well polished) lectures*

- *But they often told us that they learned the most from the out-of-class activities*

- *In many cases, the most effective (our subjective assessment) student-and-instructor interactions happened out of class, such as discussions at the local cafe.*

- *So we turned the class inside out*
  - *Lectures out of the classroom*
  - *Activities (including discussion) in the classroom*

Tour de Course

- *The BBST main page*
- *The first instructional segment* (later ones are similarly structured):
  - *Video lecture*
  - *Lecture slides*
  - *Worked examples such as this one*
  - *Review quizzes*
  - *Activities*
    - *Soon to be applied to a product under test*
  - *A set of study guide questions*
    - *From a much larger pool*

Lectures On-Line

- http://www.testingeducation.org/BBST
- Video lectures
  - Students watch them before class
  - Take simple quiz that checks that they watched the video and paid attention
  - Then we do in-class activities
- The results seem good
  - Good student satisfaction
  - Exam results aren't as different as I expected
  - Not enough time for the activities
    - In an in-house course, time is not constrained by the same type of schedule. It is constrained by value to the project and the staff.

Application Under Test

- *Like service learning, but not as heavy a commitment for the students or for me*
  - *Facilitates student learning (application level and above)*
  - *Facilitates student transfer of skills / knowledge to the workplace*
  - *We pick a well-known product*
  - *Students apply what they learn to that product*
  - *Typically, I use an open source product because it avoids NDA problems, students can show their work at interviews*
- *In an in-house course, the AUT is your product*

Study Guides

- http://www.testingeducation.org/k04/BBSTreviewfall2005.htm

- 100 questions, include all candidates for mid-term and final exam

- Students prepare answers together, assess each other's work

- I can require well-organized, thoughtful answers

- Fosters strategic preparation

- Reduces disadvantage of students whose native language is not English

- Creates cooperative learning tasks that should help limited-English-proficiency students improve language skills

Study Guides

- *Study guide results*
  - *Students inexperienced with these, often blow the first test*
  - *Make-up mid-terms*
    - *Replace grade, not average, not best 1 of 2 results*
    - *Students who take it improve more (1st test compared to final exam) than students who did not take it*
      - *Practice effect, motivation confound*
  - *Writing is better, answers are better, I have greater freedom to grade less forgivingly*
  - *Many students told me this was the most valuable learning experience in the course, and the most time-consuming*

Assessing student reaction

- Chose the Student Assessment of Learning Gains http://www.flaguide.org/cat/salg/
- Measures student perceptions of their 'gains' in learning
- Customizable
- Administered online
- FREE
- Beats the standard course evaluation form!
- Students each spent over an hour providing their evaluation.

Let's play with Moodle

- *Multiple choice review questions*
- *Submitting assignments*
- *Peer review of assignments*
  - *Forums*
  - *Wikis*
  - *Workshops*

Example of a useful group activity:

- *Heuristic test strategy model applied to Firefox specification*
  - *Compared student results*
  - *Compared results of using different tools*

More playing with Moodle

- *Creating clone courses*
- *Using Moodle as a broader purpose, password-protected, content management system*
- *Q & A freeform*

How would you structure your course?

- *One vision of the in-house course*
  - *Meet weekly for a year*
  - *Watch 10-25 minutes of video in advance*
  - *Discuss the lesson and its applicability*
  - *Over the next week, try to apply it on the job to the current project(s) in test*
  - *Discuss the application results in the next week or move to the next segment.*
- *At the end of the course, students know how things fit into their environment, and have multiple examples (from multiple student colleagues).*

Discussion in groups

- *Develop at least two additional course models that would work in your environment*

If we have time ...

- *Let's come back to curriculum*
- *What are the key topics*
  - *And what courses do we need to develop to meet them?*
- *How can we create such a series of courses?*