

Blended Learning: A Software Testing Course Makeover

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What's this course about?

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

It's kind of like CSI

The screenshot shows the CBS.com website for CSI: Crime Scene Investigation. The main navigation bar includes 'EPISODES', 'HANDBOOK', 'VIDEO', 'PRODUCTION', and 'INTERACTIVE'. The 'HANDBOOK' section is active, with sub-navigation for 'EVIDENCE', 'TOOLS', and 'PROCEDURES'. The 'AFIS' (Automated Fingerprint Identification System) page is displayed, featuring a list of tools on the left and a detailed description of AFIS on the right. Below the main content, there are three promotional sections: 'CSI HANDBOOK', 'PREVIOUSLY ON CSI:', and 'CSI: VIDEO'.

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CSI: CRIME SCENE INVESTIGATION
THURSDAYS 9PM ET/PT

EPISODES HANDBOOK VIDEO PRODUCTION INTERACTIVE

HANDBOOK EVIDENCE TOOLS PROCEDURES

AFIS
Agar
Alarm pen
Alginate
ALS (Alternate light source)
Amido Black
Ammeter
Analytical balance
Analytical scale
Anechoic chamber
Angiogram
Autoclave
Ballistic gelatin
Biohazard bag
Bloody print enhancer
Blower brush
Boxed reference ammunition collection
Bromoform

AFIS

Automated Fingerprint Identification System: Computer network that scans crime-scene fingerprints and compares them with millions of prints collected by law enforcement agencies around the state, region, country, and world. A print is traced by a fingerprint expert. The tracing is then scanned by the computer, which assigns values to various features of the print. Those values are compared to other

CSI HANDBOOK
Learn more about tools, evidence and procedures used by CSIs.

EPISODES
Missed an episode? Catch up on previous stories now.

PREVIOUSLY ON CSI:

Room Service
Julian Harper (23), touted as the next Brad Pitt, is taking his bright lights moment to the max. Sex, drugs and a "High Roller Suite" are put at his disposal as he enters the ...more

CSI NEWSLETTER
Be among the first to know. [Subscribe now](#) for email updates

CSI: VIDEO

Behind the Scenes
"CSI" celebrates 100 episodes

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 expensive, so investigators must exercise judgment.
- The investigator must pick what to study, and how, in order to reveal the most needed information.

Instructional Implications

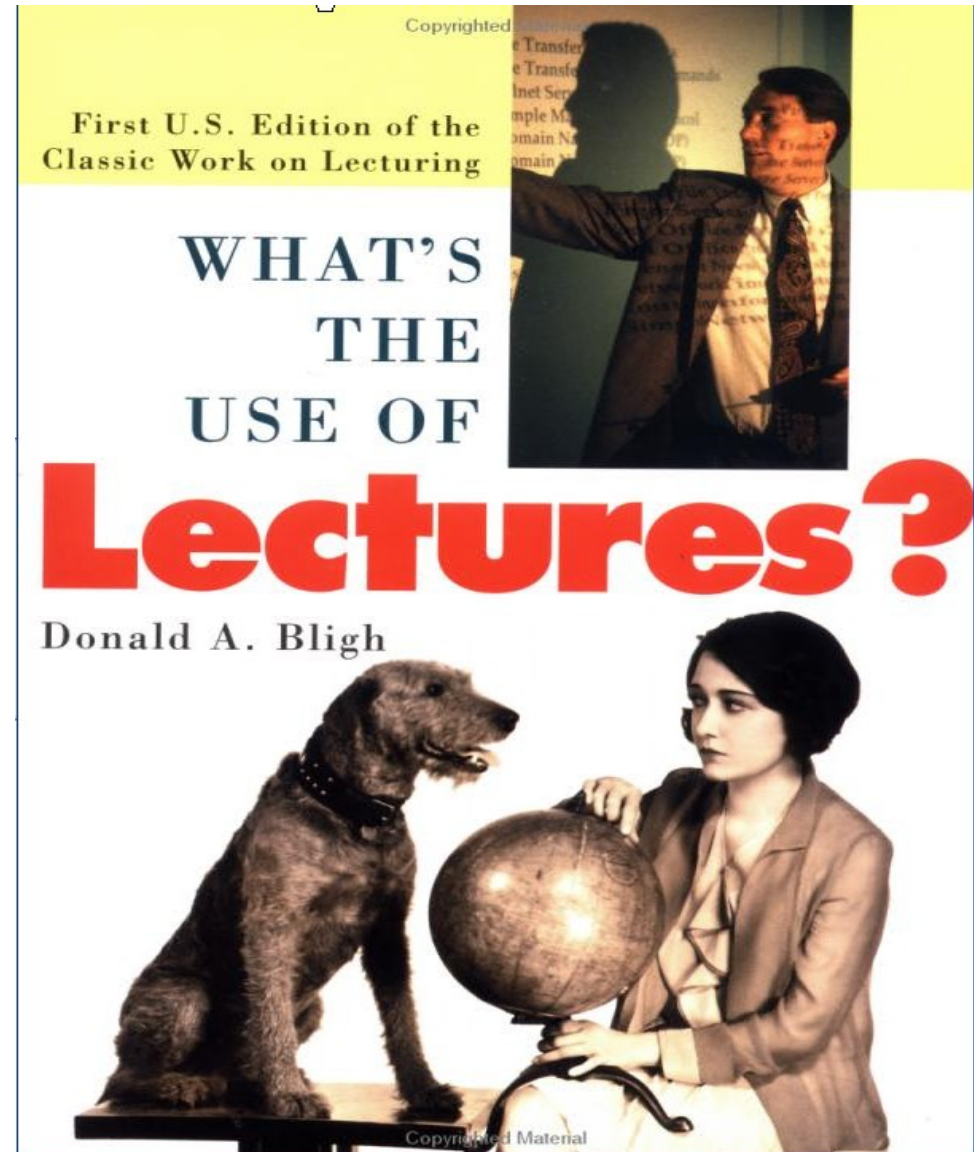
- Software testing is a cognitively complex task
 - We might or might not consider it **as important** to teach as traditionally difficult science / math courses, *e.g.*, Calculus
 - But it is **as difficult** to teach because the cognitive issues are similar

Moving From Commercial to Academic

- Broad, shallow coverage
- Time constraints led to resistance to activities
- Familiarity
- One new idea per day
- Few days to a week
- No homework or tests
- Work experience to understand concepts
- Deeper coverage
- Activities expected to develop skills
- Mastery
- Extensive homework
- An entire semester
- Assessment expected
- Inexperienced novices in the field

Before the Makeover

- Heavy reliance on lectures
- Used an open source project as object of test
- Detailed study guide, drives exam preparation
- Constraint: No textbooks address the field in the ways we want to cover it, so lectures were hard to give up



Problem: Not doing well on HOTS

	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

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Rethinking the Course

- Angelo & Cross: Teaching Goals Inventory
 - <http://www.uiowa.edu/~centeach/tgi/background.html>
- Their broad categories include:
 - "Higher-order thinking skills
 - Basic academic success skills
 - Discipline-specific knowledge and skills
 - Liberal arts and academic values
 - Work and career preparation
 - Personal development"

So We Developed 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

Now What?

- Practice is important (without it, students make boneheaded mistakes)
- Good lectures are important (they present material that isn't available elsewhere, and in *we think* better ways than textbooks)
- But lectures and practice are insufficient
- So where do we go from here?

Classroom Support for Cognition

- Students reported that their most valuable learning experiences were their out-of-class collaborations
- So let's bring the collaborations into the room, where we can coach them
- Drive 'every' class (well, most classes) with a coached, group activity that encourages students to think about what they're learning (apply / evaluate / create)
- So how do we make room for lectures?

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
- Study guide stayed
- Open source testing project stayed

What did the students think?

- 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.

Results

- Data is from a pilot only; this is formative assessment
- N=13
- Results given in percentages
- Ordinal data
 - 5 means Very Much Help or A Great Deal
 - 4 means Much Help or A Lot
 - 3 means Moderate Help or Somewhat
 - 2 means A Little Help or A Little
 - 1 means No Help or Not At All

Dimensions & Context of Testing

	5	4	3	2	1	NR
Test Oracles	38	38	23	0	0	
Impossibility	85	15	0	0	0	
Test Design	27	45	27	0	0	15
Psych Issues	15	38	31	15	0	
Trade-offs	31	31	38	0	0	
Conceptual Relationships	31	54	8	8	0	
Choosing Strategy	0	77	23	0	0	

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Some sections of the course are stronger than others:

Impossibility of Complete Testing is very strong

Students are confused about the psychological issues of testing. Cem and I talked about this one. He wants them to recognize the complexity of the task. He says he wouldn't mind if they reported less confidence in this area.

What do the students say?

"I know this stuff. I've been spouting it at work. People are impressed.

"I feel like I learned a lot about test techniques and how to use them to achieve the best testing possible given the constraints of projects. We learned a lot about the concepts of test documentation but the implementation of this is very job specific so we had little practice at it. Likewise, psychological issues can be understood deeply only after they have been experienced first hand but we received a good exposure to them so we can be prepared."

Test Techniques

	5	4	3	2	1
Open Source Project	46	42	8	8	0
Individual Test Techniques	54	31	15	0	0
Basic Test Techniques	62	38	0	0	0

We're pleased with these numbers. The students say the Open Source Project contributes to their learning. They report having a good grasp of the techniques. We're happy.

The students?

“The main strength of the course is the real world examples that are worked into the various techniques. With out them much of the impact would be lost and it would be difficult to distinguish between the various techniques if they were presented as theoretical only.”

We couldn't summarize any better

Strategic Thinking

Prioritization

No questions

Requirements Analysis	5	4	3	2	1
Test Template	15	23	31	31	0
Requirements Analysis	15	31	46	8	0
Test Automation	15	38	46	0	0

The numbers in this section deserve a closer look. Time constraints force trade-offs in terms of what the course covers.

Requirements analysis and test automation aren't covered as well as other topics. Low numbers aren't surprising.

“The main weakness seems to be that there is such an enormous amount of data on the field that needs to be covered in the course. It seems as though an entire class could be devoted to any of the topics that we covered. I strongly believe that there could be a great benefit to developing this area into a full blown degree program. Especially since it is a emerging field and relatively young field. “

The test template was an activity to alert the students that templated approaches might not be a good idea. Student comments let us know that a lot of students didn't like the template and wouldn't use it. Mission accomplished, but low ratings.

Ratings on Reading skills are more troubling It's something to work on for future revisions.

Investigative Skills

	5	4	3	2	1
Critical Thinking	23	38	31	8	0
Reading	8	23	38	31	0
Technical Investigation	0	85	15	0	0
Think thru Problems	8	31	54	8	0
Discover & Eval Risks	15	85	0	0	0

These broad skills are difficult to impact. Students reported they would use much of what they learned about Discovering and Evaluating risks after the class.

Their comments indicated they didn't think reading and critical thinking were impacted or, alternatively, they explained some low ratings on skills they believed they already had.

Communication

Writing	5	4	3	2	1
Bug Reports	46	31	15	8	0
Bug Advocacy	54	31	15	0	0
Quality Cost Analysis	31	54	15	0	0
Communication Skills	15	23	46	15	0
Writing Essay Answers	54	46	0	0	0
Reading					
Critical Thinking	23	38	31	8	0
Analyzing Specs	8	23	38	31	0

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The writing portion of Communication is interesting:

Clearly, they appreciated the instruction in writing essay answers, but ratings on overall communication skills look a little low. For the most part, the components are much higher.

We've already seen the reading scores. Active reading skills are essential to specification analysis and students need more practice in this.

Students?

“The hands on experiences gained with OpenOffice were invaluable to the class. They gave students real world experience in the testing field while staying in an academic setting.”

“The bug report assignments were useful, they gave us a flavor of real-world testing. Also, it made the work fun - to work on and test a real project.”

Teamwork

	5	4	3	2	1	NA
Team Activities	38	23	31	8	0	
Student Presentations	23	0	23	8	8	38
Study Sessions	31	46	23	0	0	
Outside Collaborations	38	23	23	15	0	
Teamwork	23	38	31	8	0	

Working on teams was a mixed bag. It is not required of anyone.

However, students get incentives to work on teams. They report mixed results:

"Working with other people was very constructive, helped me get different views for same problem."

"The study sessions before the exams were extremely helpful. Working on group assignments is always hit or miss depending on the individuals in the group.

"I may have been unlucky (or stupid) in group selection, but I felt like the work quality of people in my group(s) was not good. I ended up doing more than my share of the work."

Employability

	5	4	3	2	1
Real-world Relevance	23	69	8	0	0
Confidence	38	46	15	0	0
Insight into Testing in Industry	15	54	23	8	0
Getting a Job in SWE	0	62	31	8	0

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These scores aren't bad. Cem expected higher scores on the “getting a job” dimension. Some big-name employers target Florida Tech for hiring because the testing program is so strong. Some use his test questions in interviews because they find the questions so interesting. They also tell us they look at the students' bug reports on the Open Source project in interviews.

“I have already seen professional benefits from this class. I am already able to communicate problems with the software better to my development and test teams. My new understanding of what is involved in software testing has allowed me to foster a better relationship with our testing manager and we are currently working to improve the testing of our software and the impact that it has on my department. This is partially due to him finally having someone else in the organization who seems to understand the challenges that he faces on a daily basis”.

“As for the subject of testing I think I learned a great deal and it has already started improving the quality of my testing activities at work. As primarily a developer knowing how to test has already helped my program design skills and my code testing abilities a great deal.”

Important Components

	5	4	3	2	1
Study Guide	69	15	15	0	0
Open Source Project	42	42	8	8	0
Lecture Slides	31	54	15	0	0
Lecture Videos	62	38	0	0	0
Way Class Taught Overall	64	36	0	0	0

The study guide and open source project had been used before. Anecdotal evidence suggested we keep those components. Student feedback confirms this.

Lecture videos took a massive amount of time to create.

"The video lectures are a very good idea, but they shouldn't be quite as rushed as they were this semester. That is no one fault really, but the longer this method of teaching is done, the better the videos will become. It also allows more time for activities while the instructor is around for questions and to give students feedback on their work."

"The time required out of class to watch the lectures was quite difficult to come by sometimes since I found they often took two or three times their running time to watch. However, this was likely made worse by the erratic and often last minute delivery of them, something that is less of a problem for future classes."

"I really liked the way the material was presented to be viewed on my own time, where I could view several times, replaying where needed. It will really be great when the movie making process is perfected and streamlined. The in class activities were good but it always seemed kind of stressful to get them done in the time provided. Maybe the class exercise could be posted in advance so that preparations can be made. The student presentations were very helpful. I think the idea of presenting to the class made people really think things through."

Discussion

- Communication: Mismatch between what they believe they learned and other indicators.
 - Try changing SALG to persuasive writing
 - Testing students perform exceedingly well on comps
- Investigation and active reading: Area needs work.
 - Made some changes in Fall 2005 semester, but still not right
 - Specification Analysis: Looking for the right activities. The Spring 2005 test template was a step in the right direction.
- Extremely happy with the videos and overall direction.

Creative Commons Licensing

- Available on the Internet for free
- Goal to serve as catalyst to improve practice of Software Testing worldwide
- An entry to the field for newcomers
- Competitive environments for those charging \$\$\$ for 20-year-old commercial courses
- Support & model teaching at other universities
- Mailing list with 130 members
- More info on Creative Commons licensing at <http://www.creativecommons.org>

Contact Information

Course available at:

www.testingeducation.org//BBST/

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Nuts and Bolts

- Cem tapes and edits the videos himself
- Adobe Premiere on a Dell XPS Gen5 system
- 2–10 hours of tape for an hour of edited lecture
- Several hours of slide formatting / preparation for integration with video
- Several hours of preparation of lecture notes (tradeoff from scripted versus unscripted: spontaneous and active but hours more tape)
- Several hours editing, for a total of about 25–35 hours work per hour of taped class