



*Florida Institute of Technology*  
*High Tech with a Human Touch™*

## **DEPARTMENT OF COMPUTER SCIENCES**

# **Black Box Software Testing Instructor's Manual**

Foundations in Software Testing, Bug Advocacy,  
and Test Design Courses

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## Preface

We prepared this manual for instructors interested in using BBST materials in their own classes. It explains how to acquire your own copies of course materials; acquaints you with other resources for teaching software testing; and introduces the BBST philosophy, course model, and our pedagogical strategies. In Section One, we emphasize general skills useful for working in a fully or partially online environment. Later sections focus on how to use specific subsets of the BBST materials. Each subset is suitable for a short, professional development course. If you work in an academic environment, you can combine subsets into one or more semester-long courses for undergraduate or graduate credit.

As you proceed through the information in this *Instructor's Manual*, we recommend reviewing the BBST course materials posted at <http://www.testingeducation.org/BBST>.

From time to time, we'll refer you to *Fieldstones*. Instructors often address the same topic many times with essentially the same comments. You can save time by capturing comments like these and reusing them later. If you teach with multiple instructors, the group can create a collection of *Fieldstones* to use together. We provide suggestions, including samples, to help you jumpstart your own *Fieldstones Project*.

Several popular course management systems are available to use in your teaching (e.g. *Moodle*, *Desire2Learn*, *Angel*, *Blackboard*, etc). The systems have similar capabilities including quiz tools, discussion forums, chat tools, and gradebooks. This workbook includes screen shots of the BBST course on *Moodle*, which is open source and available at no charge. If your institution uses another course management system, modify and post the materials to whatever system you have available.

Throughout this book, we share ideas for how you can use resources or teach exercises. We encourage you to modify our suggestions for your specific situation, level of expertise, and teaching philosophy. Section One (Chapters 1-6) offers general guidance to help you adapt and adopt BBST materials for your own courses. Sections Two, Three, and Four offer specific guidance describing exactly how we use the BBST materials to teach the online professional development classes offered through Florida Institute of Technology, Kaner, Fiedler, & Associates, and the Association for Software Testing.

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# SECTION 1

# GENERAL INFORMATION

## Chapter 1

# About the BBST Courses

### The evolution of BBST materials

There is a clear need for testing courses. Up to one-half of the software engineering effort involves testing. Many companies have tester-to-programmer ratios of 1:5 and even 1:1. Despite this evident need, few universities teach any testing courses. Even fewer offer a second or third course in testing. Of the courses taught in universities, many are broad and very shallow as professors cram the testing content listed in the new IEEE/ACM curriculum guide into an already full computer science curriculum. It appears university support for teaching testing will continue to be inadequate for the foreseeable future.

To fill this gap, charismatic experts have developed a variety of popular commercial short courses. Unfortunately, many of these courses cover too much material in too short a time. The courses typically move too fast and end too soon for students to apply what they're learning to their work (and ask the instructor for advice when they find application difficult) or provide opportunities to practice new skills or get feedback based on assessment of their work. This yields little foundation for improving the state of the practice in our field.

The BBST materials originated in this same tradition, but we have evolved a new instructional format that seems more effective with many students. In this *Instructor's Manual*, you will learn about key components of the format and how we apply them when we use the BBST materials in our own teaching—whether for academic or practitioner audiences.

The BBST materials, in various forms, have been used in online and face-to-face instruction: academic courses, professional development courses, commercial training, and in-house staff development.

### What is special about BBST materials and instructional format?

As you become familiar with the BBST course materials and instructional format, you will notice none of the individual ideas are original. After all, teachers have been lecturing and questioning their students for millennia! They've videotaped lectures and asked students to watch the lectures for decades.

What is special about the BBST materials and instructional format is the combination of factors we've successfully implemented with this course, including:

1. Strong content
2. Story-based teaching
3. Detailed examples
4. Video lectures
5. In-class activities tied to the lecture
6. Application to a real product under test
7. Orientation exercises
8. Open book quizzes
9. Study guide based exam
10. Challenging but focused assignments
11. Task scaffolding
12. Peer review
13. Explicit discussions of learning issues in the course design
14. Open discussion of the employment value of the material and the work
15. Enthusiasm and ongoing renewal of the course
16. Instruction on test-taking skills
17. Extensive student feedback via the Student Assessment of Learning Gains (SALG) instrument

We'll highlight specific roles of some of these factors in this *Instructor's Manual*, illustrating implementation with a four-week format which worked well for us. Format is not mandatory — we've had success with other formats too. We encourage you to develop a format that meets your instructional needs.

## **The testing philosophy espoused in BBST materials**

This course is not about best practices, standard definitions, or other universal truths about testing. We don't believe in those.

Rather, the BBST courses reflect a context-driven approach to software testing (see Kaner, Bach & Pettichord (2001), *Lessons Learned in Software Testing; Pettichord's Schools of Software Testing* ([www.io.com/~wazmo/papers/four\\_schools.pdf](http://www.io.com/~wazmo/papers/four_schools.pdf)) and Kaner's *Schools of Software Testing* at <http://kaner.com/?p=15>).

Context-driven testers choose their testing objectives, techniques, and deliverables (including test documentation) by first considering details of the specific situation, including desires of stakeholders who commissioned the testing. The essence of context-driven testing is project-appropriate application of skill and judgment within a humanistic social and ethical framework.

To understand a project's context, the skilled tester must learn:

- 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;
- consequences of potential failures;
- who might care about which consequence of what failure;
- how to trigger a fault generating the failure we're seeking;
- how to recognize failure;
- how to decide what result variables to monitor;
- how to decide what other result variables to monitor in the event of intermittent failure;
- how to troubleshoot and simplify a failure to:
  - motivate a stakeholder who might advocate for a fix;
  - enable a fixer to identify and solve the problem more quickly; and
- how to expose, and to whom, undelivered benefits, unsatisfied implications, traps, and missed opportunities.

The conditions under which we test are so diverse that context-driven testing ultimately is about doing the best we can with what we get. Rather than trying to apply "*best practices*," we accept very different practices (even different *definitions* of common testing terms) will work best under different circumstances.

We hope you will encourage your students to critically engage with the ideas and materials presented in the BBST course materials and to participate in thoughtful discussion about when specific ideas and techniques covered in the course should be used and when they should not. We encourage you to invite students who hold honest and well-considered opinions different than those promoted in BBST materials to express those opinions, as well as to consider the ideas presented in the BBST materials.

## Sample course structure and course components

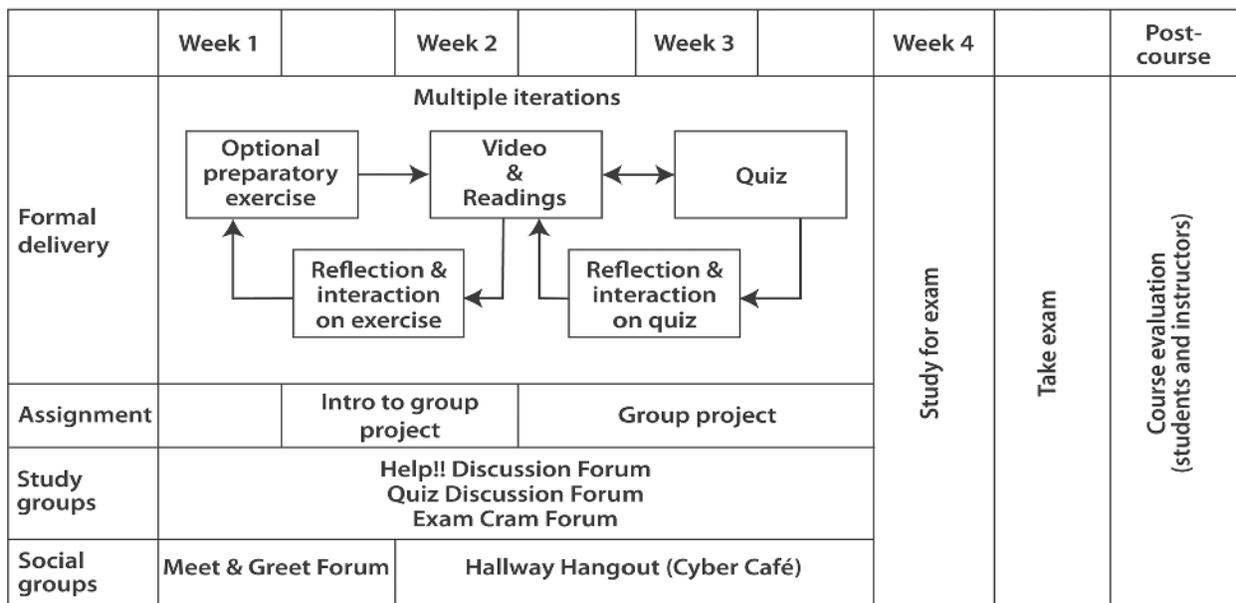
The BBST course materials provide a variety of resources to teach software testing. You may use them as presented or modify them to suit your context and purposes.

In Kaner’s face-to-face university courses, students often reported the most valuable parts of class happened outside of the lecture, when students met with him to work on group assignments or to puzzle through some of the same exam questions. In response, he reversed the traditional course structure and assigned videotaped lectures students watched before class. He and the students used class time for more challenging activities, labs, and exercises. This hybrid style worked well, easily using the materials described here with that approach.

This manual describes our next design iteration, which adapted the courses to a fully-asynchronous, web-based instructional approach.

This approach organizes the materials into distinct four-week courses with duration reflecting a tradeoff. The course should run long enough to allow students to do meaningful work (including trying ideas at their workplace) and get detailed feedback. But the course also has to end soon enough to fit in working professionals’ schedules. We chose four weeks based on the experience of other online educators.

The following illustration shows the four-week professional development online course structure.



*Figure 1: Four-week professional development course structure*

Notice the course has both formal and informal aspects. In face-to-face classes, informal aspects of courses develop on their own; but in online courses, instructors must provide space and encouragement for this to happen. In this model, we put a specific structure in place to help students participate in ways we believe will be productive.

In the four-week model, introduction to new content occurs in weeks one through three. Students complete a group project applying their new knowledge and skills during weeks 2 and 3. They study for their final exam during week 3. In the fourth week, students complete their final exam and course evaluation.

## Instructional unit

The main part of each course is one or more instructional units delivering *course content*:

- In traditional courses, the textbook and lecture have been the primary sources of course content.
- The BBST course materials use a combination of videotaped lectures, course readings, and open-book quizzes to form an instructional unit on a specific topic (e.g. domain testing).
- If it is appropriate to your context, and if you have a good textbook, we encourage you to form your own instructional units by integrating BBST materials with readings from your text.

## Course components

Let's take a closer look at the components in this model. In subsequent modules, we present a bit of theory supporting our ideas for implementing the components.

**LECTURE**—Lectures convey basic knowledge. A speaker's examples and stories illustrate the complexity of topics being presented and offer useful illustrations about how ideas and techniques presented in the lecture are applied in industry. Told well, stories offer a human interest element, making them more motivating and memorable. Videotaped lectures in the BBST materials seek to do that. Videotaped lectures have the additional advantage that students can replay them as necessary. This is especially helpful for students whose first language is not English. We also have gotten feedback that students like to speed-listen to the lectures. Surprisingly, research suggests students comprehend material better at the faster speed.

**READINGS**—Course readings present examples and case studies that are relevant to the course content. When possible and practical, course readings provide competing views on a particular topic to introduce students to the variety of perspectives in the field and illustrate how approaches vary depending on context. We urge you to embrace and acknowledge the diversity of opinions in the testing field and encourage your students to engage with them critically.

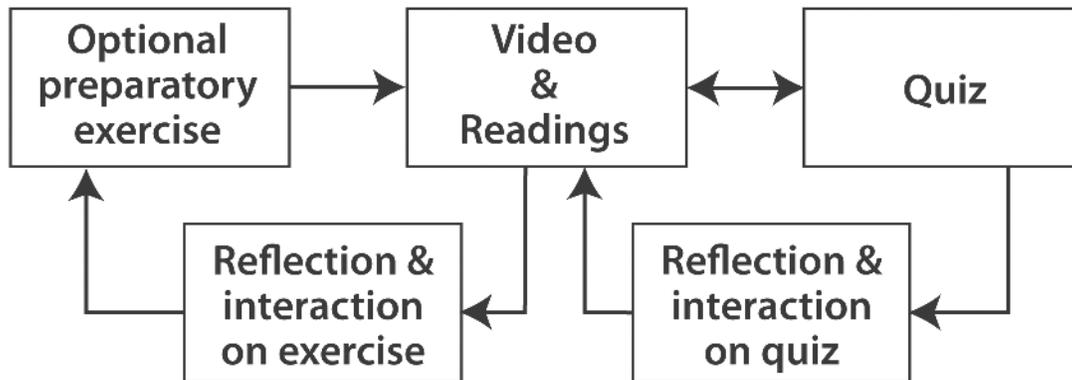
**QUIZ** — We recommend using the quizzes as open-book, open-lecture quizzes. In Kaner's university classes, quizzes count very little toward the final grade. In our professional development courses, quiz grades don't count at all. The quizzes are intended to highlight important aspects of the lecture materials (i.e. key concepts and definitions), clarify distinctions between concepts, and help students monitor their own understanding of the lectures by raising a gentle alarm when a student watches a video or reads a text without comprehension.

We recommend providing a discussion forum for students to talk about quiz questions and answers to build a deeper understanding of course materials. In face-to-face classes, this kind of discussion may occur in a classroom or between students in hallways. Offering the discussion forum is an important strategy to make "space" for this type of discussion among online students.

**PREPARATORY EXERCISES**—In the ideal case, instructors will use or design a preparatory exercise focusing on particularly challenging aspects of any new topics. Preparatory exercises give students a chance to confront challenges inherent in the topic, better preparing them for

the new material presented in lectures and readings. After instruction, students return to the original task with new insights, new skills, and (hopefully) new appreciation for the goals of exercises and content of the lectures and readings. Practically speaking, time constraints will prevent you from using preparatory exercises for all instructional units. You will almost certainly need to limit your use of preparatory exercises to new topics and the most challenging content.

The cycle of preparation, instruction, and reflection is illustrated in this graphic.



*Figure 2: BBST instructional cycle*

In the four-week professional development model, you will probably use one or two instructional units with full iterations of the preparation - instruction - reflection cycle and several more instructional units without associated preparatory exercises. University classes following a traditional calendar have time for many such iterations. Commercial training formats vary widely and the number of instructional units presented in a course will vary widely as well.

**GROUP PROJECT**—A group project is intended to provide an authentic task, giving students an opportunity to apply what they have learned in lectures, readings, and exercises. (An “authentic” task or example is representative of real-life work.) In online courses, groups often include people from several different time zones, giving students experience in managing the challenges of operating in a multi-national work team.

**FINAL EXAMS AND STUDY GUIDES** — When teaching BBST courses, we provide a pool of potential exam questions at the beginning of the course. The practice allows you to require better-organized and more thoughtful answers than “surprise” tests where students see a question for the first time. Providing an advance study guide fosters strategic preparation and deeper learning as students discuss and debate possible answers. Study guides also benefit limited-English-proficiency students by allowing them time to craft their answers as part of their exam preparation. The cooperative learning tasks of a study group also help these students improve their language skills.

In university courses, the study guide contains no more than 100 questions for mid-term and final exams. For shorter courses, the study guide is proportionally smaller. Throughout the

course, students are encouraged to prepare potential exam question answers together and assess each other's work. In face-to-face classes, study groups sometimes form to meet outside of class.

In online courses, we provide an *Exam Cram* forum to replace face-to-face group meetings. Throughout the first three weeks of class, students use the *Exam Cram* forum to practice and discuss their answers to prepare for the final exam which takes place during the fourth week. Review detailed timelines of how this works in later sections of this *Instructor's Manual*.

**COURSE EVALUATION**—Industry “smile sheets” and university course evaluations rarely capture the detailed feedback course designers need to improve their courses. (See <http://reliablesurveys.com/smilesheets.html> ) Early drafts of the BBST commercial course were extensively peer reviewed. We have also heavily used the Student Assessment of Learning Gains (SALG) (<http://www.salgsite.org/> ) to capture detailed student feedback about how individual course components contribute to student learning.

**STUDY GROUP FORUMS**—In traditional face-to-face courses, students regularly congregate in hallways and at vending machines to talk about their courses, progress, and thoughts about quizzes, exams, and assignments. In many cases, they form informal groups to study together. Online instructors can build similar types of opportunities into their courses. In our courses:

- The *Help!!! Discussion Forum* gives students a place to ask for clarification of an assignment, challenge the instructor's published grading standard, or seek technical support from their instructor or peers. As an instructor, you should monitor this forum each day or subscribe to the forum using an email account you read frequently. Often problems raised in this forum prevent students from working on other aspects of the course. The sooner you (or one of the students) can resolve a problem, the sooner the student can refocus on the course content. Encourage students to route as many of their questions to this forum as possible. This public space becomes the first place students check for solutions to problems they encounter, instead of sending private email to you.
- The *Quiz Discussion Forum* fosters discussion of quiz questions and challenges in a low-stress environment where the focus is on fixing misunderstandings and exploring alternative perspectives.
- Finally, the *Exam Cram* forum helps students prepare and discuss course content with the goal of preparing for exams.

**SOCIAL FORUMS**—In face-to-face classes, instructors frequently ignore social aspects of the course and social needs of the students. In most cases, students informally build relationships and a social structure to complement the more formal aspects of the course. In online classes, social structure develops more haphazardly. Online instructors should build social opportunities into their courses because students who are connected to each other are more likely to complete the course.

In the BBST courses, we typically give students two social spaces. In the *Meet & Greet Forum*, students introduce themselves to each other and begin to form friendships based on common interests. This is a very active forum for the first week and should taper off as students focus

their attention on course content. Sometimes, we have to remind students to pay less attention to the *Meet & Greet* and more attention to the course in subsequent weeks! In the *Hallway Hangout*, students share news they might share if they saw each other on campus. It's a great place for students to discuss something on their minds but not directly relevant to this class: anecdotes; success stories; and hobbies. If students think their classroom colleagues might be interested, this is the place they use.

## **Course management systems**

There are several course management systems. Instructors at a college or university will likely have some degree of institutional support if they choose to deliver their classes using the institution's preferred course management system. We will not review the many commercial course management systems in this manual, although from time to time, we will show screen shots from some we've used.

*Moodle* is one of the popular open-source course management solutions and the one we use for the BBST course series. Please visit the *Moodle* web site, [www.moodle.org](http://www.moodle.org), for the latest downloads and news. *Moodle* provides pointers to a variety of demonstration courses to help you understand how others have used the *Moodle* tools. If you are not familiar with configuring a course management server, several companies offer *Moodle* course hosting at reasonable prices.

## Chapter 2

# An Instructor's Tasks

As an instructor, you will face many tasks before, during, and after a course. These include setting and enforcing policies, managing the classroom, monitoring student work, communicating feedback, and reporting grades. The course-specific chapters within this *Instructor's Manual* offer detailed guidance on running specific exercises outlined in the BBST courses. This chapter focuses on skills involving communication and control that will be useful no matter what courses you teach.

## Course formats

In face-to-face classes, your students usually find you at the front of the classroom. You are often the center of attention as you deliver lectures, answer questions, question students, facilitate discussions, and mediate disagreements.

In an online classroom, your presence is less obvious but still vitally important to overall student satisfaction. The challenge in teaching online is to make your presence known without dominating the class and the course discussion forums.

In addition to fully-online and fully-face-to-face classes, many teachers use “hybrid” formats that combine traditional and online approaches. We use the BBST materials both ways, teaching both hybrid and fully online courses.

Throughout this manual, we'll highlight how ideas presented can be used in different formats.

## Establishing instructor presence

In this section, we present ideas on how you can establish your presence without going overboard.

### Communicate regularly using *Instructor Announcements*

In a face-to-face classroom, instructors often use a few minutes of class time to remind students of upcoming deadlines, offer guidance and caution about tasks for the coming week, provide feedback about class performance, or initiate discussions of current events relevant to the class. In an online classroom, you are not so obviously “there.” Unless you make students aware of your presence, they will not know you are working with them in the course. Periodic messages help establish your online presence to students; help them stay engaged with course materials; and connect the instructional tasks with the “real” world.

Consider setting up a discussion forum specifically for *Instructor Announcements*. Explore how your course management system allows you to automatically email course announcements to your students. Advise students that they should consider your posts in that area to be “required reading” and essential to successful completion of the course. If you do that, limit your posts to things essential for students to know. When we teach online, we typically send two posts for each instructional unit: *Weekly Feedback* and *Highlights of the Coming Week*.

## Highlights of the coming week

This gives students an overview of the coming week and highlights particularly interesting or difficult areas. If the workload is heavier than usual, warn students to plan accordingly. Making this post also gives you a chance to remind students how to correct persistent problems that you have noticed in previous weeks or to tell students what aspects of their performance you will be watching closely. You might also share additional resources relevant to student efforts for the coming unit.

## Weekly feedback

In the weekly feedback post, you can point out broad themes identified over the past week; draw attention to particularly insightful or noteworthy individual contributions; or invite further participation in an especially engaging thread. Use this post to identify and correct any broadly held misunderstandings you've noticed (but never in a way that would embarrass individual students). To correct misunderstandings, you can ask students to review a particular chunk of course content; point them to additional resources; or create another resource for them. If at all possible, start and end this post on a positive note.

Depending on the capabilities of your technology, you might decide to email *Instructor Announcements* to students or to require them to subscribe to the posts in some other way.

## Creating a welcoming online classroom

A face-to-face classroom holds many visual cues for the new student to get settled. Often, the instructor in face-to-face classes has prominently displayed the course and instructor name somewhere in the room. Students in face-to-face classes can usually tell at a glance whether they are in the right place at the right time and whether there is a friendly face greeting them. The student knows, if he or she is the first one in the classroom, which seats are still available, or whether a friend is in the class.

## Set up a welcoming online space

If your class is fully online—or mostly online—it is important to provide some of these same visual clues to the student logging in to your class for the first time. Generally speaking, students new to online learning—or new to the course management system—will need some extra instruction to orient them to the layout of the classroom so they can easily find things. Give enough information for students to know which documents and areas with which they should first familiarize themselves. Choosing what to post will depend on your unique situation, but consider including some or all of the items on the following list:

- A greeting
- A brief explanation of the course layout and where students can find important information
- Directions on what students should do first
- A pointer to your biography
- A request for students to introduce themselves to each other

Be careful not to include too much information on the front page of the online classroom. It can easily look cluttered and overcrowded. Instead, include a pointer to more detailed documents somewhere else.

Figure 3 is a screen shot from the *BBST Foundations* course we co-taught for the Association for Software Testing. Notice there is an expression of welcome, a clear indication of where students should start, and convenient access to each lesson.

The screenshot shows a Moodle course interface for 'FDNS\_101A'. The top navigation bar includes 'Main Menu', 'Start Here', 'Lesson 1' through 'Lesson 6', 'Exam Prep', 'Exam', and 'Exam Grading'. The course title is 'Moodle V1.9.9+ > Archive > FDNS\_101A'. The left sidebar contains sections for 'Activities' (Choices, Forums, Quizzes, Resources, Wikis), 'People' (Participants), 'Administration' (Grades, Profile), and 'Sponsors' (Florida Institute of Technology logo). The main content area features a 'Start Here' section with icons for 'Start Here', 'Course News', 'Help!', 'Course Checklist', 'Forums', and 'Quizzes'. Below this is an 'Acknowledgements' section with text about NSF grants and the Association for Software Testing (AST). A 'Your Instructors' section on the right shows photos and names of Doug Hoffman, Cem Kaner, and Becky Fiedler. A list of instructions for students is provided at the bottom right.

**Figure 3: Welcome page in software testing course delivered using Moodle with the optional Flexpage module installed.**

Some online instructors work at institutions using other course management systems. Their online classrooms look strikingly different. Figures 4 and 5 are two more screen shots of online courses. In Figure 4, the college used *Desire2Learn*, a commercial course management system and in Figure 5, the university used *Blackboard*. Although the courses pictured here are not BBST courses, many of the same elements are visible to students as they first log in to their online classroom. In these cases, the instructor knew her students might log in before class was scheduled to start. She wanted her online classroom to give the students as much information as possible even though she was still finalizing the details. She decided to open the classroom to her students but include a warning things might still change. Like the *BBST Foundations* class above, these online classrooms include an expression of welcome and detailed instructions for students about how they should proceed. The course management systems allow professors to link to specific resources students will need to get started.

The screenshot shows the Desire2Learn interface for the course 'MED 501 Teacher as Leader'. The page features a top navigation bar with links like 'My Home', 'Email', 'Locker', 'Schedule', 'FAQ', and 'Links'. Below this is a search bar and a 'News' section. The main content area includes a 'Welcome to MED 501' message with a large 'UNDER CONSTRUCTION' banner. The course description states: 'Credit Hours: 3. Prerequisites: Admission to program. Course Description: This course will introduce the Five Core Propositions from the NBTTS and provide an overview of leadership theories and styles. Teachers will reflect upon and develop their personal leadership skills, including communication, collaboration, mentoring, planning, and ethical decision-making.' The left sidebar contains sections for 'Events', 'Updates', 'Course Information', 'Discussions', and 'Book Info'. The right sidebar includes 'Podcast', 'Webinar', 'Tutorials', and 'Remote Resources'. Callout boxes highlight: 'Course title and official description' pointing to the course title and description; 'Links to important course documents' pointing to the 'Course Information' sidebar; and 'An expression of welcome and detailed information regarding resources' pointing to the 'Welcome to MED 501' message.

Figure 4: Welcome page in course delivered using Desire2Learn.

The screenshot shows the Blackboard interface for the course 'Curriculum Fundamentals CMT 660'. The top navigation bar includes 'Indiana State University', 'Home', 'Help', and 'Logout'. Below this is a breadcrumb trail: 'My Institution > Courses > Tegrity Campus'. The main content area features a banner for 'Curriculum Fundamentals CMT 660' with a date range of 'June 26, 2009 - July 03, 2009'. A message from Rebecca Fiedler, dated 'Mon, Apr 27, 2009', reads: 'Welcome to CMT 660 for Fall 2009. If you'd like to find out what to expect in the Fall semester, please feel free to browse this course web site. Be warned, though! I am still making a few changes and you need to view everything on this site as tentative. Watch for an email from me sometime in July. I'll update you on the status of the course in that email. In the mean time, take a look at an FAQs page I've prepared for you. Here's the information on the course textbooks. Order them soon so you have them when the course starts.' A list of textbooks is provided, including 'The Struggle for the American Curriculum' by Kliebard, 'Analyzing the Curriculum' by Posner, 'Basic Principles of Curriculum and Instruction' by Tyler, 'The School and Society and The Child and the Curriculum' by Dewey, 'The Saber-Tooth Curriculum' by Peddlwell, and 'Publication Manual of the American Psychological Association' (6th ed.) by the American Psychological Association. Callout boxes highlight: 'Course title and course number' pointing to the banner; 'Links to important course documents' pointing to the 'FAQs page' link; and 'An expression of welcome and invitation to browse the course information regarding resources and specific actions for students to take.' pointing to the welcome message.

Figure 5: Welcome page in course delivered using Blackboard.

## Send a welcoming email

If you have access to student contact information, send an email welcoming students to the course before the class begins. If students must purchase books or if the students are distributed around the world, you will probably want to allow a longer lead time than you might for an in-house professional development course.

The welcome email is a great opportunity to soothe some of the pre-course jitters your students may be feeling by letting them know what to expect and providing login instructions so they can explore the online classroom before the course actually begins. It also gives you a chance to troubleshoot any course login difficulties before everyone feels the pressure of deadlines. The welcome email is a good place to share your contact information and to remind students to take care of routine housekeeping matters such as updating operating system software, antivirus software, and media players.

## Post an instructor biography

If you are teaching a fully online course, you can post a bio to help students know more about you. Instead of using the typical short biographical information you use professionally, consider posting something letting a little more of your personality shine through. Adding a picture or video is easy, too.

## Communicating in the friendly classroom

Just as skilled communication is an asset in the face-to-face classroom, skillful online communication helps the online classroom run more efficiently. One of the advantages of communicating online is instructors generally have the benefit of extra time to more carefully craft their messages. We encourage you to take advantage of this fact every chance you get!

## Mind your manners

The Internet is home to a lot of advice on communicating online. According to *Wikipedia*, the term “netiquette” is a portmanteau of network etiquette. If you need a refresher course on minding your manners online—or if you merely need to share a resource on netiquette with someone else—you might be interested in Virginia Shea’s *Netiquette*, available in print and online (<http://www.albion.com/netiquette/book/index.html>). The book covers business netiquette, social netiquette, as well as the legal and philosophical issues in netiquette.

## Establish protocols

Students appreciate knowing what to expect of their instructors and what their instructors expect of them. As important as setting student expectations is for face-to-face classrooms, it seems even more important in online classrooms. This is especially true when speaking of communication matters—perhaps because online interactions can sometimes take a bit longer. Wise online instructors let students know how quickly to expect responses to emails and discussion forums. If you tell students that you read and respond to email within 24 hours, they are not likely to become impatient and grumpy until at least 24 hours have passed. Conversely, if you tell students you only expect them to read their email three times a week you must refrain from sending messages requiring shorter turnaround times.

Regular posts, such as unit previews and feedback posts, can help set communication protocols and establish the flow of the class. Regular posts from you keep everyone engaged and on track. They let students know you are paying attention to the course.

### **Edit your response**

Draft your answer to an email or discussion post. Before you click Send, Submit, or Post, take a moment to review your message. Is what you've said as clear as you can make it? Have you used jargon not understood by your reader? Has your response stayed on topic or strayed from your original post? Do you have some additional resources you might share? How about the tone of the message? Does it reflect the feeling you're trying to convey? If you're feeling irritated with a student, did your irritation come through? If it did, are you sure you want it to show or would it be better to post your response later?

### **The tone of your messages**

As you teach and work online, you must give thought to the tone in your writing. It is easy to be misperceived as "terse." As you develop course materials or craft responses to students, make a conscious effort to warm up the tone of your writing with one or two friendly thoughts. Where appropriate, use active and lively language to convey warmth and personality.

### **Conveying emotion**

Some instructors will feel comfortable with the judicious use of the emoticon as a useful technique for communicating online. If something you plan to say might be misinterpreted, sometimes adding an emoticon to help convey your real meaning is helpful. However, two cautions about emoticons are in order:

1. One can never expect to say something rude and erase it with an emoticon. Rude is rude. Please don't be rude.
2. Excessive use of emoticons can diminish the professionalism in your communication. It is always best to take the time to express yourself clearly. Every now and again, an emoticon between friends is a useful shortcut.

Some instructors prefer not to use emoticons and rely on other techniques to convey their message appropriately. For example, Kaner makes parenthetical remarks such as [when you read this, please imagine a smile on my face and a warm encouraging tone of voice, not a criticizing one], when he wants to help his readers understand the message he's trying to send.

### **Humor**

Many BBST instructors will be working with students from other countries and for whom English is a second, third, or even fourth language. It's important to understand what is humorous to a native English speaker doesn't always work for the non-native English reader. Anything involving a play on words, ambiguity, or indirect meaning, may be incomprehensible to readers who have not mastered the subtlety of the language. Technical writers are encouraged to strip all humor out of their books and manuals because this is such a difficult problem.

Stripping all humor from the online classroom deprives an instructor of the opportunity to create an informal and warm atmosphere in the class. However, instructors who use humor should understand the challenge they may be creating for some students. Our advice is to use humor with caution—especially at the beginning of an online class. If you'd like to convey your sparkling sense of humor early in the class, try to do it in a way that cannot be misunderstood.

### Helping students ask for help

Sometimes students are embarrassed to ask for help. In online classes, you can help students feel more comfortable about asking questions by conveying a welcoming attitude toward questions and creating a forum specifically for such questions. In our online courses, this discussion forum is titled *Help!!! Discussion Forum*. Here's a sample message one might post early in a course.

In the online classroom, your instructor can't see the confused look on your face. If you are having trouble with something in class, please don't be afraid to say something. I've designated a special forum for you and your classmates to ask for help. Generally, it is best to use that forum instead of email. If a concept is difficult, or an assignment is unclear, chances are good another classmate is facing the same difficulty. By posting your question in the designated forum, everyone will benefit from the answer. From time to time, privacy demands indicate an email to the instructor is a better communication channel for your question. Unless indicated otherwise, the public forum should be where you ask for and receive help in the class.

If you need help, please don't wait until the last minute to ask. When you do ask, give plenty of detail about what is causing your confusion. To increase your chance of getting a timely and accurate response to your question, include all the information a potential helper will need to offer help. This might include the titles of specific documents containing confusing information or links to web pages without the information you expected. In the case of an unclear assignment, state your understanding of the assignment and ask if you understood it correctly.

Asking for help with technical problems is even more challenging. A technical troubleshooter needs information like what computer operating system and software you are using and the sequence of events preceding the problem. Even then, it's important to say, "this is exactly what happened" or convey the content of any error messages. It's a little like filing a bug report, isn't it?

Don't forget we are all in this together. If you see a request for help—and you know how to help—please do! I won't mind.

## Creating social spaces in the online classroom

Most face-to-face classes have plenty of opportunities for students to socialize with each other and their instructor. Whether the instructor does an icebreaker activity or not, students can strike up conversations during breaks or before and after class to get to know each other better. Many online students appreciate the same opportunities in their online classes. At a minimum, we recommend online instructors set up a discussion forum designed specifically for ongoing interactions of a more social nature. We've seen such forums called a variety of names including *At the Water Cooler*, *Hallway Hangout*, *Cybercafe*, and *KaffeeKlatsch*. No matter the name, be sure to invite students to participate in this forum for interesting, but non-class-related discussions.

In a fully online class—and in hybrid classes with little opportunity for face-to-face interaction—consider also setting up a discussion forum for students to introduce themselves to one another. Typically, instructors ask students to include information about their experience with the class topic and encourage them to share information about hobbies and outside interests. Invite them to include pictures of themselves. Some students will feel more connected to their classmates after they have seen a picture and come to know their classmates better. Although you should not respond to every post throughout the class, try to make each and every student who offers an introduction feel welcome by posting a response to their introduction.

## Managing the online classroom

A well-organized online classroom will generally save students from unnecessary frustration. Where possible, keep your course syllabus and general reference documents where students can easily retrieve them no matter where they are in the course. As your course proceeds, use the course structure and procedures to set up a predictable rhythm so students know what to expect, where to find things, and how and when they can participate. Your students will be happy and productive as they busily work on course tasks instead of sending frantic emails asking you for yet another clarification.

Following are some tips to help organize and present content:

- Create an assignment checklist for students to print and post near their computer. The checklist might include a one-line summary of the assignment, a place to record a grade, a due date, and an indication of which part of the course management system the student will find or complete the task. Figure 6 is a sample created as a spreadsheet from a Research class Fiedler taught. Figure 7 is a sample from the *BBST Foundations* class created using the optional *Progress Tracker* module available for *Moodle* 1.9 and higher.

✓	Topic	Assignment	Submit	Due
	<b>1</b>	<b>Getting Started With the Basics</b>		
	Jan 12-17	Req: Examine course policies and web site		
		Req: Read Chs 1 & 2		
		Rec: Textbook web activities as needed		
		DBP: Meet & Greet discussion forum	Bb Disc Bd	Sat
		DBP: 3-2-1 Assignment	Bb Disc Bd	Sat
		DBP: Course Agreements	Bb Disc Bd	Sat
	<b>2</b>	<b>Variables, Hypotheses &amp; Research Ethics</b>		
	Jan 18-24	Req: Text: Chs 3 & 4		
		Rec: Read <i>The IRB, the HSR -- and the Ethics of Insider Research</i>		
		Rec: Textbook web activities as needed		
		Opt: AERA Ethical Standards		
		Opt: Review notorious experiments		
		DBP: Ways of Knowing	Bb Disc Bd	Sat
		Open Book Quiz & Discussion Forum	Quizzes	Sat

Figure 6: Excerpt from a research class assignment checklist created using spreadsheet software.

**BBST Foundations (Master)**

Main Menu Start Here Lesson 1 Lesson 2 Lesson 3 Lesson 4 Lesson 5 Lesson 6 Lesson 7 Exam Prep Exam Sign out

BBST-OSI > Foundations\_Master > Checklists > Course Checklist

### Course Checklist

Use this checklist to keep track of your progress in completing course tasks. You must click Save at the bottom of the page to save your progress. You can add other items as necessary. Moodle provides little control over formatting this checklist. Please note that items furthest to the left indicate that you have completed all tasks listed directly above. For example, the checklist outlines all Lesson 2 tasks (indented one level) and then gives you a final item saying "All Lesson 2 tasks completed." We know this is a little confusing but it is the most organized view we can provide within Moodle's constraints.

Required items:  0%

All items:  0%

- Lesson 1: Deadline INSERT DATE
  - Agree to course policies (Start Here tab)
  - Forum: Introduce yourself to the class (Start Here tab)
  - Skim the BBST Orientation (Start Here tab)
  - View Lecture 1 video
  - Complete Lecture 1 quiz
  - Forum: Respond to the Meet & Greet forum
- Lesson 2: Deadline INSERT DATE
  - Forum: Describe your role
  - View Lecture 2 video
  - Required Reading: Kaner, Hendrickson & Brock's Managing the Proportion of Testers to (Other) Developers
  - Complete Lecture 2 quiz
  - Assignment: Skim the Exam Prep tab and start drafting answers to questions in the Exam Cram forum.
    - Optional: Participate in Quiz 1 Q&A discussion forum as needed
    - Optional Recommended Reading: Bach's Heuristic Test Strategy Model

Figure 7: Excerpt from BBST Foundations created using the optional Progress Tracker module available for Moodle 1.9 and higher

- Use the course management system's calendar feature to note deadlines and due dates.
- Provide clear and detailed descriptions of major assignments and post them conspicuously. Figure 8 is a screenshot from the *BBST Foundations* course in *Moodle* with the optional *Flexpage* module installed. Each lesson tab includes detailed assignment instructions and, as appropriate, course handouts.

Figure 8: Posting assignment instructions using Moodle

- Use *Instructor Announcements* to remind students of upcoming obligations and point them to the resources they need to meet those obligations.
- Maintain consistency in due dates as appropriate. For example, requiring students to post their first discussion by Wednesday and respond to their peers by Saturday is a reasonable structure. If you use that same structure each week, students can focus on the content of your course instead of trying to remember if their work is due Tuesday or Wednesday or Thursday of this week.
- Make as much material as possible available to adult learners as soon as you reasonably can. Although hiding future work from the students might simplify and focus what the student sees right now, it will deprive some time-pressed students notice of what's to come. Some students, especially working professionals, will need to manage their schedule to ensure tasks are completed on time. Knowing what lies ahead allows them to do that.

- Apply what you know about web usability to design course content. Things like white space, clear navigation, and reasonably short documents help students find their way within your course content and don't unnecessarily slow download times.
- Use file names meaningful to the students. If you only teach one course at a time, the name syllabus.txt might tell you exactly what you need to know. However, your students are probably taking more than one course at a time and might have an easier time staying organized if you named your file cs101syllabus.txt. If you do that for them, they might be more willing to do so for you when you ask them.
- Keep the most current content at the top of the screen to minimize scrolling. It's a small thing, but students appreciate it and it saves everyone from unnecessary scrolling. Depending on the course management system you use, you may be able to highlight current content in other ways without restricting access to past or upcoming content.

## **Time management**

For face-to-face classes, most interactions with students occur in the classroom once or twice a week and in providing feedback and grades on major assignments. In an online classroom, the interactions can go 24 hours a day for 7 days a week. They can start before the course begins and continue after the course ends. One of the challenges online instructors face as they teach their first online class is to resist the pull to be "always connected." Instead, think of an optimal workflow that lets you meet the obligations you have for interaction, feedback, and other things.

It might help you to note start dates for modules and due dates for major assignments on your personal calendar. While you have your calendar in hand, consider blocking out times to grade those assignments and craft feedback messages to your students. If you know you have to assign students to groups and release special group forums, mark those on your calendar, too. As you create your schedule, think about the reality of your students' schedules and the deadlines you've given them. If you can fit the flow of your schedule around theirs, chances are good your course will flow smoothly.

Here's an example of how you can minimize the aggravation of late assignments. If you assign a deadline of midnight Saturday night, do you really want to start grading at 12:01 on Sunday morning? Perhaps you'll decide to wait until Monday to grade. You can enforce a penalty for late assignments, but allowing a one-day cushion in your schedule will help you grade all the assignments together instead of most of them—and then the late ones when they finally come in. The final grades will be the same, but you'll be less aggravated by late submissions because they won't impact your work.

When you work with adult learners and working professionals, you can take advantage of their expertise to help provide feedback and minimize your grading burden. Done thoughtfully, this gives your students extra opportunities to sharpen their own skills as they critically examine and evaluate the work from others. Particularly in software testing courses, students can learn a lot from exploring how someone with a very different background approaches the same problem. The BBST courses use peer review extensively.

Professors teaching undergraduate classes cannot use this strategy as extensively as professional development trainers working with experienced testers. We expect each instructor and course designer to modify the BBST materials to make them appropriate for his or her own teaching context.

Establish a routine for reading and responding to discussion forums. Are you comfortable reading online or do you prefer to read offline? Do you have travel or a doctor's visit slated just after a major assignment is due? If so, download the assignments for offline reading to make your waiting time more productive. Once you're back online, you can post grades in the online gradebook and upload or email the graded assignments.

### **Organizing assignments and establishing file naming conventions**

In an online course, students can submit assignments via email, as discussion postings, as attachments to discussion postings or email, and via the course management system's dropbox or assignments features. Each of these submission avenues has implications for the instructor and in this section, you will consider those implications to make an informed choice about how you prefer your students to submit their work.

First, consider the file naming conventions you'd like to establish in your class. The students will probably name their first assignment something like *assignment1.rtf* and you'll need to rename each assignment as you download it or risk overwriting a previous assignment submission. Instead, require students to use a specific file naming convention making it as easy as possible to keep everyone's digital files organized. One convention we've used successfully is to suggest *lastname\_assignmenttitle.rtf*. Not only does it make it simple to locate an individual's assignment, but it also groups the same individual's assignments together in the course directory. Of course, some instructors like to keep all similar assignments together and can do so by placing assignments in subdirectories. Some course management systems take care of the file-naming problem for you. In that case, you don't need to worry about file naming conventions.

Second, consider the issue of acceptable file formats. If everyone has the same word processing software, this will probably be a straightforward decision. If your students use a variety of word processing files, then let them know what kinds of attachments you can read and accept. If documents use extensive formatting, then ask students to submit Rich Text Files (rtf) or Portable Document Format (pdf) files. Most word processors will save to one or both of those file formats. If not, there are several free pdf conversion utilities available on the Internet.

Finally, once you've figured out what file types you'll accept and how files should be named, turn your attention to how students should submit assignments.

- **EMAIL**—Asking students to email assignments to you is probably the least efficient method of collecting assignments from students. The flood of email can quickly become overwhelming as individuals send their assignment, realize they've forgotten an attachment and send another email, and then ask you to verify you received their message and attachment. The process repeats itself in the reverse direction when it's time to grade work and provide feedback to students. Additionally, heavy use of email means submissions and communications are not archived with the rest of the course. While archiving may not be necessary for you, we have found it to be more useful than we anticipated and in surprising ways.

- **DISCUSSION POSTINGS**—Asking students to submit short assignments as discussion postings is often an excellent way to accept student work in terms of both student learning and instructor efficiency. You can quickly and easily grade the postings (possibly providing private feedback via email) and students have the benefit of seeing how classmates approached the assigned task. For longer assignments, asking students to provide a summary of the assignment in the discussion forum and attach a longer document as a file is a useful way to share student work between classmates but within the privacy of the online classroom. As the instructor, you still must download and open each separate file which can become tiresome. In many cases, you'll need to provide private feedback to each student via email.
- **DROPBOX FOR ASSIGNMENTS** (or similar feature)—Most course management systems have a dropbox feature that allows students to upload computer files to the course management server without using an FTP client. Typically, students can leave a message for their instructors as part of the submission process. The course management system usually lets a students know whether their file upload was successful. After the deadline for an assignment submission passes, you can download all the submitted files in one archived file for grading and feedback. You have the option of returning the files and comments to students through the same dropbox feature or via private emails. With this system, students cannot see their peers' work.
- In practice, some instructors ask students to share their work in discussion forums and submit a copy via the dropbox. It's a little extra work for students and a big time saving for instructors.

No matter which method of assignment submission you choose, be sure to communicate it to your students so they can't miss it—in the description of the assignment, a checklist of all assignments, and through *Instructor Announcements*.

## Organizing email

As an online instructor, you will want to streamline your email management as much as possible. Making smart choices about how students submit assignments will help. Channeling as much course communication from your Inbox to the course discussion forum will help. Taking a proactive stance to course communications will help. Describing course content and assignments clearly and concisely will help. Once you've done all of that, you will still need to deal with the course-generated email that remains. One of the more efficient ways of doing that is to ask students to put the course number in the subject line and then create a rule in your email client that routes all course-related email to a specific folder which you must check on a regular basis. This helps keep course-related email separate from your other email messages.

## Going out of town

If you do a good job setting up the protocols and patterns in your class, your students will come to rely on them in managing their personal schedules. This is understandable and appropriate. When you know you will be away from normal Internet access for travel or other reasons, let the students know ahead of time. You do not need to explain reasons to them—unless you would like—but you should extend the courtesy of letting them know you will be a little less accessible than usual.

If you are taking a laptop and know you will have Internet access when you reach your destination, you might not need to say anything. If you will not have good Internet access but plan to spend some time in Internet cafes or hotel business centers, let them know that you will be less accessible than usual. If you are not going to have Internet access at all, let them know they will not be able to get in touch with you until a certain date. This will save them from feeling frustrated when you cannot respond. Fiedler is careful to keep her students informed when she travels—the only comments her students make are to wish her safe travel.

If you have a teaching assistant or co-instructor, they may be able to pick up the slack while you are away. No matter what you decide, let students know what to expect while you are away.

### **Setting boundaries for difficult students**

Every now and again, you may come across a student who is difficult to manage and crosses boundaries. This is true in face-to-face situations as well as online. Dealing with a difficult online student has advantages and disadvantages. The primary disadvantage is that the online student can try to contact you no matter the time of day. The primary advantage is that you have much more control of when the difficult student can get your attention and how quickly you will respond. In addition, you can easily save emails and instant message logs documenting the interactions with that student. Here are some tips for dealing with difficult students:

- Wait to respond. It's easier to respond with a cooler head. Waiting gives you time to get advice from a trusted colleague. It also conveys to the difficult student you are not at their mercy because Internet access and email access is so convenient for them.
- Use the technology at your disposal to ration the time and attention you give the student. For example, you can set up a rule in your email client routing the difficult student's messages to a specific folder. Check that folder every 24 or 48 hours (per your published policy) and process all of the emails at once—responding to issues as appropriate. Often you can direct the student to post their questions in the discussion forum. Once their question is posted there, you or the difficult student's classmates can respond by pointing to the relevant sections of the course content.
- If a difficult student calls or IMs you outside of office hours, explain you are not available now but you can give them some time during office hours. If they persist, use Caller ID to help you know when to let their call go to voicemail or block their IMs.
- If possible, respond to a difficult student putting the bulk of "work" surrounding the interaction on them. For example, Fiedler has had online students contact her to challenge grades. When that happens, she usually tells them she's happy to consider their request for a grade change and asks them to review all of the feedback she's already given (both public and private); the assignment description; the published rubric; their own work and get back to her letting her know on what basis they think they deserve a better grade. If they have a legitimate complaint, she can address it but this happens infrequently. Often, the student drops the matter when they realize they have to make their case. As it turns out, they usually write back saying, "Now I understand why I deserve the grade you gave me."

- When dealing with a difficult student, keep copies of all correspondence. Once you believe the problem with a specific student has the potential to result in a grade appeal or other academic, criminal, or civil penalty, craft all of your responses keeping the review process in mind.
- Be proactive about dealing with the difficult student. Communicate with your department head or supervisor to let him or her know a problem may be brewing. You may get some needed advice or guidance to make things easier to handle down the road. Think carefully about which aspects of this background communication should be in writing and which aspects should be face-to-face or over the phone. In online classes, it is easy to gather information from trusted colleagues out of sight of the student.
- If you become afraid of the difficult student and what he or she might do, immediately take advantage of the services of your institution to get help for this student and for yourself.

## Setting policies for your classes

Setting and communicating your policies is important to help students know what you expect of them. If you're working within an institution, there will be policies in place to guide you.

*Moodle* users can take advantage of *Moodle's* Choices capability to share policies. Publish the policy as a Yes/No Choice and require each student to accept (choose Yes) each policy. Other course management systems may have similar features. If not, posting your policy in a discussion forum works, too. In that case, set up one thread called "I understand and agree to the NameOfPolicy Policy" and another called "I have a question about the NameOfPolicy Policy." Students can respond to the appropriate thread. Their response provides you with documentation you might need later.

Consider sharing some or all of the following types of policies with students and posting them before the course starts.

### Communications policy

How frequently will you read and respond to student emails? How often should students read their email? How frequently should students monitor course discussions? How often will *you* check the course discussion forums—especially the one where students request help? How long should students expect you will need to grade their assignments?

Most students appreciate getting feedback on their work (even though they might not like the feedback once they hear it!). Online students are no different. They appreciate knowing approximately when they can expect to hear from you because they don't have any of the visual clues they had when they were in face-to-face classes. Earlier in this manual, we suggested sending *Weekly Feedback* to everyone in the class. The same holds for updating the course gradebook. A predictable pattern of communication from the instructor helps to reinforce the rhythm and flow of the class and puts the students at ease.

Once you've decided what you expect from your students and what they can expect from you, announce or publish your expectations to your students. Then, try to meet your obligations in a timely manner and hold your students accountable for the same.

### **Late work policy**

Late submissions inconvenience peers and instructors who must give feedback; reduce the quality of feedback as reviewers rush to complete the task; deprive class members of the opportunity to learn from the late submission; and, in the case of group projects, block other group members from moving forward on their tasks. In short courses, lateness too often leads to a failure to complete the course and disruption for other students. Communicating your expectations and how you will handle late submissions at the outset will make it easier to enforce your policy when the need arises.

### **Academic integrity policy**

The academic integrity post should define academic integrity for students, point them to broader institutional policies and resources, and outline potential consequences for academic integrity violations. For an example, refer to the Intellectual Property Policy for the Black Box Software Testing Courses at <http://www.testingeducation.org/BBST/policies/academicintegrity.pdf> or one from your institution.

### **Acceptable use policy**

The institution under which you are running your course will likely have an Acceptable Use Policy for their servers and network. If not, you are welcome to review and modify the *AST Moodle Site AUP* for your own course. It is available at <http://www.testingeducation.org/BBST/policies/aup.pdf>.

### **Privacy policy (most applicable to academic institutions)**

The Family Educational Rights and Privacy Act of 1974 (FERPA) established regulations governing who has access to information contained in student records. If you are teaching in an academic setting, you may want to provide FERPA information to your students.

In some cases, companies arrange for professional development classes for their staff. If the company expects information about final grades, the CMS tools may provide a convenient way for you to get the waiver you need from students granting you permission to submit grade information to their employer.

## **Managing online discussions**

### **Requiring student discussion**

Should you require students to participate in online class discussions? We think so.

Vibrant discussion among students is exciting to students and instructors alike. Sometimes these discussions spontaneously occur in a face-to-face classroom, but they are more likely to emerge when a skilled teacher facilitates a discussion among students by asking the right questions and prompting students to participate.

In an online class, a skillful instructor can achieve the same result, but only if students notice what is happening in the discussion forums. The best way to make sure they notice is to require participation in discussions. In this section, you will consider some ideas for promoting this kind of constructive interaction. You might not use all of them—but we hope it will be useful to have a few extra tricks up your sleeve.

### **Make it part of the grade**

If you are assigning grades in your course, you can assign a percentage of the grade to discussion participation. A lower percentage might be appropriate if you don't wish to require frequent or substantive posts. However, if you expect more frequent or more elaborate posts, you will probably allocate a higher portion of student grades to reflect discussion participation. Busy students—especially busy adult students—will quickly figure out what is required to pass a course and what is merely optional.

### **Set your expectations**

Help students succeed in your class by clearly laying out your expectations for participation. If you have a minimum number of posts (say, two per week), tell them that's your expected minimum. If you want to stimulate peer-to-peer interaction, you can require students to respond to others. If you have a certain standard for quality, let students know that as well. Discourage trivial posts such as "I agree" because they take time to read but don't add to the conversation. Provide rubrics to describe what you expect in terms of your students' quality of writing and contributions to the conversation. See a sample discussion rubric in the *Appendices*.

### **Design participation into the assigned activities**

Some topics and courses lend themselves particularly well to the discussion forum. For example, students can post responses to required or supplemental readings, videotaped lectures, or course-related news events. Many online instructors ask students to share assignments on the course discussion forum—particularly if student assignments cover a diverse set of topics. An additional benefit to this practice is that students often do a better job on a task they know will be posted for their peers to see. Another option is to assign student presentations easily shared in an online discussion forum.

### **Getting students to interact with each other**

The trick to leading discussions online is to know when you should let the conversation unfold and when you should jump in. Instructors are often wise to hang back in the discussion forum to let the discussion among the students unfold. Remember discussion forums are asynchronous. It can take several days for everyone to notice a discussion and participate in it. If you enter such discussions prematurely, your involvement may unintentionally suppress a useful and productive discussion.

In contrast, some discussions cry for immediate instructor involvement. Examples include tamping down disagreements losing their civil tone, clearing up unnecessary or unproductive confusion about a course assignment, and stepping in to resolve technical problems impeding progress of the class. If a discussion has veered off-topic or is entering an unproductive path, you can respond to gently steer the topic back on course. Finally, if a student has posed a great question and hasn't gotten a response, it's appropriate to post a note of encouragement such as,

“Great observation and question, Chris! I’m anxious to hear what your classmates have to say.” Pointing others to that insight is a good idea, too.

To help us strike the right balance, we always include a discussion area specifically for students to request help. Although anyone is welcome to help another, as instructors, we try to monitor and respond to requests posted in that area once or twice each day so problems interfering with progress in the course are resolved as quickly as possible.

In discussion forums focusing on the content of the course, our approach is to hang back. We often post the following message to let students know instructors are paying attention to the content-focused discussion, but waiting to get involved until the time for involvement is right.

You can find this note, and others like it, in the *Fieldstones* Appendix.

This is a good discussion.

You’re unlikely to see many comments from the instructors in this topic for another couple of days. Not because we’re not reading with interest—we are. It’s because the instructional value is better for you if we keep our mouths shut while you work through the issues, piping in occasionally to ask a question or make a minor clarification but then we step back, out of your way.

After the discussion subsides, one of us might make a longer comment or two, but in many cases, the discussion will resolve itself without a word from us—and that’s a good thing.

## Organizing course discussion forums

Organizing discussion forums is an important part of managing online discussions. It is easier for you and your students to participate in class discussions if the discussions are well-organized. In addition to special purpose discussion spaces (e.g., *Instructor’s Announcements*, *Help! Discussion Forum*, and social spaces) create dedicated discussion spaces for each assignment or lesson. See the chapters on preparing for the specific course(s) you will teach for the list of discussion forums to support the topics in BBST courses.

## Establishing protocols for discussion forums

In addition to clear communication and standard rules of online behavior, it’s useful to help students learn a few protocols which keep the discussion forums easy to navigate. For example, when students post a homework assignment, encourage them to start a new thread with a descriptive subject line. When they are responding to someone else or answering a question, they should reply to the existing thread.

Sometimes a discussion will veer in a new direction. In that case, students can signal they are taking a tangent from an existing thread by using the reply feature, but entering a new subject

line. This will make it easier for those who wish to return to the post later. In some instances, you may decide to set up a discussion forum prohibiting students from starting new threads.

### **Encouraging participation**

Your students will soon figure out if you are actively participating in the course discussions or not. Critique, feedback, and encouragement will help students to become more involved. There are several ways you can participate in course discussions without dominating them. You can ask students to elaborate on their ideas or provide examples. Asking follow-up questions and inviting participation in particularly interesting (or potentially interesting) threads is a good way to get students involved. Help students remember to stay focused on responsiveness to their peers by including responsiveness as part of grading and feedback.

### **Advanced discussion moderation skills**

In *Facilitating Online Learning: Effective Strategies for Moderators*, George Collison and colleagues (2000) at the Concord Consortium articulate a collection of advanced discussion moderation skills to help instructors and online moderators guide groups to their goals. With examples drawn from personal experience, the authors outline six voices, eight tones, and a number of critical thinking strategies. Combined in different ways, these elements equip discussion leaders with a wide variety of approaches to facilitating online discussion. See the table on the next page for a synopsis of the facilitator's palette. For serious online instructors, their book offers advice to improve the way you moderate discussions and develops the idea of full-spectrum questioning adapted from work in the critical thinking movement.

Collison, et al (2000) refer to full-spectrum questioning as content-neutral—focusing on questions to probe understanding and assumptions rather than the details of course content. Similarly, Paul & Elder (2006) use discipline-neutral terms to describe critical thinking. For discussion leaders, the questions associated with Paul & Elder's "universal intellectual standards" of clarity, accuracy, precision, depth, relevance, logic, significance, breadth, and fairness help instructors and discussion participants think and communicate more clearly for deeper and more meaningful learning. Finally, Gause & Weinberg (1989) offer context-free questions to help analysts and developers elicit information about projects and products.

### **Route the communication to the classroom**

Every now and then, a student will send you a private note with an important message or observation. When that happens, encourage the student to post it in the appropriate discussion forum so everyone can benefit from it. When you discover something everyone needs to know, be sure to post it in the announcements area or send a group email. This will lighten your email burden and minimize student frustration.

## References and resources

George Collison, Bonnie Elbaum, Sarah Haavind, & Robert Tinker (2000), *Facilitating Online Learning: Effective Strategies for Moderators*, Atwood Publishing: Madison, WI. ISBN 1 891859 33 1

Richard Paul & Linda Elder. (2006). *The Miniature Guide to Critical Thinking Concepts and Tool*. Foundation for Critical Thinking: Dillon Beach, CA ISBN 0-944583-10-5

Donald C. Gause & Gerald M. Weinberg (1989). *Exploring Requirements: Quality Before Design*, Dorset House Publishing: New York. ISBN 0-932633-13-7

The Facilitator's Palette			
Voices		Tones	Critical Thinking Strategies
<b>Generative Guide</b>	Helps students discover alternatives that are new or previously overlooked	<b>Neutral</b> —a good baseline for interactions	<b>Identifying direction</b> Analyzes discussion to suggest possible directions or alternatives and/or asks for thoughts
<b>Conceptual Facilitator</b>	More like an instructor, this voice can be used to focus attention on conceptual areas that need attention	<b>Curious</b> —particularly useful for pointed questions	<b>Sorting ideas for relevance</b> Helps students identify relative importance of the active lines of thought and discussion
<b>Reflective Guide</b>	Uses restatement to refocus conversation or exploration in a fruitful direction	<b>Humorous</b> —frequently useful but must be used with care	<b>Focusing on key points</b> Works with all 6 voices; might be the best strategy for mediation; lists contributions and highlights connections
<b>Personal Muse</b>	Models internal dialogue such as examining beliefs, thinking critically, digging deeper, breaking barriers	<b>Imaginative</b> —for when you are inspired to be creative	<b>Full-spectrum questioning</b> Helps lead a discussion onto more substantive ground
<b>Mediator</b>	Moves discussion away from stated positions toward new lines of inquiry; clarifies issues; restates goals, etc		<b>Making connections</b> Uses analogy, inference, and other techniques to help students break the barriers of their assumptions or beliefs
<b>Role Play</b>	Takes on a persona to introduce alternative perspectives or encourage dialogue in other directions		<b>Honoring multiple perspectives</b> Most useful in mature dialogues, the facilitator outlines the variety of views or perspectives

Abstracted from Facilitating Online Learning: Effective Strategies for Moderators by Collison, et al

## Chapter 3

# Assessment and Grading

Instructors and students familiar with the “typical” professional development course will immediately notice assessment of students is handled very differently in BBST courses—both in how students are assessed and the extent of those assessments. Those who teach software testing in colleges and universities are probably more accustomed to using assignments and grades than their practitioner peers, but their models for assessment will vary. In this section of the manual, we examine several ideas regarding assessment and how they are used in the BBST courses. But first, let’s look at a few differences between commercial and academic courses.

### Differences between commercial and academic courses

In a traditional commercial course, a consultant has students in a classroom for a few days. The days are filled with a barrage of ideas from the consultant to the students. Most consultants (and the people who hire them) know they are lucky to convey one idea per day sufficiently well that students will be able to successfully apply it in the work setting. The short commercial course covers a broad range of topics in a shallow way. There are no homework assignments, no exams, and few skill-building activities.

Academic courses take a different approach. The professor or instructor is with the students for a few hours per week over a period of several months. The pace for presenting new ideas is considerably slower. In fact, it is quite common for the professor and students to spend one or two weeks covering a key concept more deeply. Students expect homework on the concepts presented in class—although they sometimes complain about the amount of homework. They also expect some type of assessment on the material they are learning—and most work diligently to perform well on those assessments. The academic instructor expects students to learn many concepts and skills well enough to apply and master some of them.

For BBST courses, the materials have been segmented into collections of lectures and activities each focusing on one key area of software testing. Individually, these segments can be used as professional development mini-courses taught over a four-week period. Combined, the mini-courses contain enough material for one or two semester-long courses in software testing. However you decide to use the materials, we recommend giving students time to check their understanding with course quizzes, participate in testing exercises, review work from their peers to see other perspectives, and demonstrate what they’ve learned in a final exam. In these respects, the four-week mini-course professional development versions of the BBST courses more closely resemble traditional academic courses than commercial courses. The key difference between BBST and traditional academic courses is how assessment is used.

## Formative and summative assessment

When many people think of assessment, they think of tests, projects, and final grades. Generally, these types of assessments are summative—taken at a given point in time to evaluate what a student has learned up to that point. These kinds of assessments “count” when determining whether or not a student passes or fails a course. When students talk about negative experiences with assessment, they are often referring to summative assessments.

In contrast, formative assessment takes place as learning occurs. The purpose of formative assessment is to promote learning, not judge whether or not learning has taken place. Formative assessment is more diagnostic in nature and allows learners to know how well they are mastering a task or concept. When accompanied by feedback, students learn how they can improve their performance. Of course, another important advantage to using formative assessment is that it lets you know where your own instruction is not working in time to make modifications.

Some experts explain the differences between formative and summative assessments by drawing a distinction between assessment *for* learning (formative) and assessment *of* learning (summative). This distinction emphasizes the difference in purposes represented by formative and summative assessment.

It is important to note that even though there is a firm difference in *intent* between formative and summative assessments, participating in a summative assessment (such as writing a final exam) is often a significant learning experience for the student. In the BBST series, we see every assessment—formative or summative—as a learning opportunity.

### An example of formative and summative assessment

Let’s look at how formative and summative assessments can be applied in a software testing course. We’ll use a combination of BBST video lectures and multiple-choice quizzes to illustrate the discussion. Each course topic has one or more videos and a corresponding set of multiple-choice quiz questions for students and instructors to use. How might an instructor use these materials in her class? There are several obvious ways.

The first approach, and likely the most traditional one, is to have students take a multiple-choice quiz after watching one or more of the videos. Used this way, the quiz serves as a summative assessment to determine whether or not the student has learned the material in the video.

Alternatively, a teacher might ask students to take the quiz before watching the video (a pre-test), watch the video, and take the quiz after viewing the video (post-test). The pre-test/post-test structure described here is an example of summative assessment to determine what the student learned.

Another approach is to ask students to complete the multiple-choice quiz as they watch the video. This focuses student attention on key parts of the video. It also alerts them to areas where they may not understand important concepts or skills so they can look for more information on their own or ask for clarification from instructors or peers. Used this way, the multiple-choice quizzes are a valuable formative assessment tool.

To help you remember the timing and purposes of formative and summative assessments, we offer Robert Stake’s useful illustration: “When the cook tastes the soup, that’s formative. When the guests taste it, that’s summative!”

## Assessment and support materials in BBST courses

The BBST course materials have a variety of assessment support materials you can use or adapt including:

- assignments and exercises;
- quizzes;
- study guides;
- grading videos; and
- exams including short answer and essay questions.

We’ll examine each of these in turn.

### Assignments and exercises

Most assignments presented in the BBST course materials rely on authentic tasks—tasks similar to those found in the real world.

The usual pattern of activity in the BBST exercises is for students to also look at their peers’ approaches to the problem and offer comments. Before leaving the exercise, students return to their own work to reflect on how they would modify their initial response having heard the lecture and interacted with their peers. Their reflections on the exercises typically offer instructors rich insight into student understanding of the material presented in that section of the course. This cycle of preparation–instruction–reflection is central to the instructional model of the BBST courses and is represented in the four-week course model.

Do not underestimate the importance of the preparatory exercise as you modify BBST materials or develop your own exercises to use in your courses. A student’s prior knowledge of a topic is one of the most important influences on their ability to learn new information or skills. Talented teachers make the most of students’ prior knowledge by using strategies to remind students of what they already know. Like a painter priming a surface before painting or a gardener preparing the soil before planting, knowledge activation strategies prepare the student’s mind for the learning to come. The preparatory exercises motivate students to think about the challenges of the problem and ready them to hear a solution or an approach to developing their own solution.

Other assignments in BBST courses are completed as “group projects.” These tend to be more complex and take more time—much like tasks in the work place. Depending on the demographics of your students, group projects have the potential to give students experience working on a multinational team, including the challenges of navigating separation by time and place. In professional development mini-courses, these group projects are introduced early in the course with most work completed during Week Three. In university courses, a traditional semester-long course may have several group projects giving students a chance to apply their new skills and concepts to an authentic and realistic challenge.

It is impossible to write one set of guidelines adequately describing our grading expectations for all of the assignments. There are some common themes, and we have provided a generic rubric in the *Appendices* setting out baseline expectations applicable to most assignments.

### **Developing grading guidelines of your own**

In the BBST course materials, we will usually refer to a “rubric” although Walvoord and Anderson (1998) sometimes call these grading devices a “primary trait analysis.” Regardless of the name, developing one of these scoring tools to share with students eases your grading burden and helps students understand expectations for an assignment. The rubric makes those expectations explicit.

The basic steps for creating your own rubric or primary trait analysis are to identify the things that matter (attributes) for the assignment and create a scale to score student work with descriptors of student performance at each level for each attribute. Many rubrics are presented as matrices listing the attributes down one side of the matrix and levels of performance across the top. The remaining cells hold descriptions of work on particular attributes at the corresponding levels. See the discussion rubric in the *Appendices* section for an example.

For less complex projects—or for essay style questions—you may consider using a checklist format. Typical checklists include a list of things that should be present in an answer along with a suggested point value for each.

### **Quizzes**

Each BBST course video has a corresponding quiz. In our courses, students get credit for taking a quiz but we do not use quiz grades to make pass/fail decisions for the course. They are formative, not summative. We use quizzes to focus student attention on key definitions, concepts and distinctions.

Because the software testing field is filled with controversy, you may need to reinforce the following points in discussions with students about the quizzes:

- The quizzes test whether students understand the lecture’s definitions or assertions. However, students can answer the questions correctly without adopting our definitions or views. Encourage students to use the quiz discussion forums to offer alternatives.
- The quizzes train students to deal with the precise wording that is inherent in difficult multiple-choice exams. Many students have never had a difficult multiple-choice test before.
- The quizzes offer a low-stakes assessment designed to help people determine whether they understood the lecture.

Appendix F includes a sampling of *Fieldstones* to help convey the *Philosophy of BBST Quizzes*, how they are used, and how students can learn to perform better on them. Consider sharing one of these with your students or adapting one to share.

In university courses, professors may have to assign grades for quizzes to maintain student motivation. In Kaner’s courses, quizzes typically count for 10 to 20% of the final grade if the

student does well on them or if the student doesn't even attempt them. However, if a student takes the quizzes but does poorly, they don't count against the student's final grade. This rewards students for attempting the quizzes but doesn't punish them for wrong answers.

## Study guides

In university courses and professional development courses alike, we urge students to begin preparing for their final exams from the start of class. To do that, we hand out a pool of questions including all of the potential questions on midterm and final exams. We encourage students to prepare answers to the questions in advance and peer review each other's work. The exams are closed book, but students who have worked on the questions in advance tend to remember their work and can provide thoughtful, well-organized answers (if they developed thoughtful, well-organized answers as part of their study).

To facilitate this practice in the *Moodle* courses, we create an *Exam Cram* forum pre-populated with the appropriate questions and encourage students to work on those from the start of class. We encourage students to spend time in the *Exam Cram* forum thinking about strategies for the question, drafting answers, seeking clarification, and generally studying for the exam. If they do this well, problems and confusion surface before the exam. This method allows students enough time to consider and prepare their answers, which allows instructors to expect better answers. The *Exam Cram* forum or study guide also provides a structure around which students—or groups of students—can study together. Finally, providing potential questions in advance means non-native English speakers are not at a disadvantage when facing complex questions.

The optimal way for students to use the *Exam Cram* forum is to draft answers individually and post drafts for peer feedback. They can also review how other students have approached the same questions. The interactions around the answers give students new insights and ideas for improving their answers. The best time for them to do this is at the end of the segment of the course relating to this question. The student participates in the preparatory exercise, watches the video and works through the multiple-choice questions, then drafts answers for the essay.

Your role in terms of student study sessions is to hang back to let students do the heavy thinking—intervening only to show you are paying attention, or when necessary (for example, to clarify a genuine ambiguity in a study guide question).

The biggest risks in this approach are:

- Students are often not accustomed to writing essay exams and provide weak answers missing the important points or shotgun answers not responsive to the questions. We find in the semester-length courses it helps students to specifically practice decomposing the questions (reading the question, then breaking it down into an outline with one line for each subsection they should have in their answer.) Students share their decompositions, without writing the complete answer, then give each other feedback. It appears practice in outlining helps students create better focused and more complete exam answers.
- In the BBST mini-courses, student feedback inevitably tells us students regret not having spent enough time in the *Exam Cram* forum, making the final exam more difficult and/or more disappointing than necessary.

- In the short professional development courses and semester-length courses, students often split the questions so one student answers the first few, another student answers the next few, etc., and then all the students in this workgroup attempt to memorize all the answers. This is a failing strategy in the semester-length course—there are too many questions to memorize and students who do this often blend answers to different questions during the time-limited, closed book exam. Kaner gives no credit for correct but irrelevant material in an answer and deducts points for incorrect material even if it is irrelevant. Only correct material directly responsive to the question earns credit, so an answer filled with irrelevant material typically fails badly. In the semester-length course, students often try splitting-and-memorizing for the first midterm, learn a painful lesson, and do work of their own for each question thereafter. In the BBST short courses, there are fewer questions, but fewer weeks. We see less of the split-and-memorize strategy as a result of less thorough exam preparation. Students don't have multiple exams (midterms and a final) and so you don't have the luxury of grading a midterm harshly to teach students a lesson from which they can fully recover with a good final exam.

We draw study guide questions from a constantly expanding pool of over 1000 definitions, short essay, and long essay questions. Since adding multiple-choice quizzes to the courses, we have stopped asking definition questions on the exams. However, we keep the questions in the set because other instructors might find these useful for their exams or in-class study sessions.

For a four-week short course, we provide a set of 20-30 questions relevant to the course. For the semester-length course, we provide a set of 100 questions. One of the appendices in this manual is a list of study guide questions drawn from a larger pool maintained at [testingeducation.org](http://testingeducation.org). The number of questions chosen for a course balances three interests:

- More questions allow for greater coverage of the material.
- More questions make it harder for a student to memorize answers written by other students.
- Too many questions take too much study time and discourage the students from writing preparatory answers.

## **Grading videos**

Each BBST course contains a link to videos explaining how Kaner grades essay exams. We encourage students to review them for in-depth explanations of his grading approach and comparative grading of several exam answers. You are welcome to share them with your students who will likely find them helpful not only in studying for exams but also preparing written assignments and discussion posts.

Kaner follows the grading process described in the videos in every university course he teaches.

In the AST courses, the final grade is complete/incomplete (essentially pass/fail). The AST courses are led by time-constrained volunteers and exams are peer-reviewed, then reviewed by the instructor(s) to determine whether the student's final exam, plus the quality of peer review, jointly indicate the work is sufficient to pass the course. These instructors rarely have enough time to do the full evaluation for each student described on the video; they only need to for the

few borderline students. When instructors are paid for their time, feedback becomes a higher priority.

### More on the exams and study guide questions

Kaner circulated the following notes to a meeting of university instructors:

The questions in the study guide often address browser or word processor issues. This is arbitrary. It reflects the applications we've tested recently in class. If your class is testing some other type of application, I suggest you modify these questions so most of them reflect that type.

Many of the questions in this list go beyond the detail available in the slides. In the course I teach, students get several supplementary readings, and I provide additional information in lecture.

Be thoughtful about the size of the list of study questions you give students. If the list is too long, students will not try to answer the questions before the exam; they'll just read the answers. The quality of their performance on the final will suffer substantially. I currently use a set of about 50 definitions, 25 short answers, and 25 long answers in a 1-semester course with a large population of students who write English as a second language. Your students might find a different pool more appropriate.

You'll notice several of the questions are related. This is intentional. Here's an example:

Long-Answer 4. You are testing the group of functions that let you create and format a table in a word processor (your choice of *MS Word* or *OpenOffice*). List 5 ways these functions could fail. For each potential type of failure, describe a good test, and explain why it is a good test for that type of failure.

Long-Answer 5. You are testing the group of functions that let you create and format a table in a word processor (your choice of *MS Word* or *OpenOffice*). Think in terms of persistent data. What persistent data is (or could be) associated with tables? List three types. For each type, list 2 types of failures which could involve that data. For each type of failure, describe a good test and explain why it is a good test for that type of failure. (There are 6 failures, and 6 tests, in total).

Long-Answer 6. You are testing the group of functions that let you create and format a table in a word processor (your choice of *MS Word* or *OpenOffice*). Think in terms of data you enter into the table. What data is (or could be) associated with tables? List five types of failures which could involve that data. For each type of failure, describe a good test and explain why it is a good test for that type of failure.

Long-Answer 7. You are testing the group of functions that let you create and format a table in a word processor (your choice of *MS Word* or *OpenOffice*). Think in terms of user interface controls. What user interface controls are (or could be) associated with tables? List three types. For each type, list 2 types of failures which could involve that data. For each type of failure, describe a good test and explain why it is a good test for that type of failure. (There are 6 failures, and 6 tests, in total).

Long-Answer 8. You are testing the group of functions that let you create and format a table in a word processor (your choice of *MS Word* or *OpenOffice*). Think in terms of compatibility with other software. What compatibility features or issues are (or could be) associated with tables? List three types. For each type, list 2 types of failures that could involve compatibility. For each type of failure, describe a good test and explain why it is a good test for that type of failure. (There are 6 failures, and 6 tests, in total).

Long-Answer 9. You are testing the group of functions that let you create and format a table in a word processor (your choice of *MS Word* or *OpenOffice*). Suppose a critical requirement for this release is scalability of the product. What scalability issues might be present in the table? List three. For each issue, list 2 types of failures that could involve scalability. For each type of failure, describe a good test and explain why it is a good test for that type of failure. (There are 6 failures, and 6 tests, in total).

These are all about testing the word processor's table functions, but the sequence tells a lesson.

- The first one simply identifies the function and asks the student to imagine potential failures. When students work only on this question, their answers are often superficial and defocused.
- The next three are taken from the Product Elements list of Bach's Heuristic Test Strategy Model (<http://www.satisfice.com/tools/satisfice-tsm-4p.pdf>)
- The last two are from the Quality Criteria list of Bach's model.
- The six together give the student six different perspectives on the same problem. The student will come up with different tests, after thinking about different risks. Collectively, they make a point—the more angles from which you come at the product, the more types of failures you can imagine (and the more bugs you can find). These questions thus provide an experience basis for talking about the Strategy model. In Bach's and my experience, students only come to understand the value of this model after a lot of practice.

You might ask a full sequence of questions like this on an assignment, but you would not (well, I would not) ask more than one or two of these questions on an exam. The questions have more value than use on an exam—they guide study, and so you can lead students to insights with a sequence of questions, followed up by comments in lecture after the students have had occasion (e.g. the test) to study.

It helps to actively encourage students to work together. I host two study sessions before each test or exam. I host a typical session on a weekend day at the local cafe, and pay for breakfast for anyone who arrives before 10:30 a.m. I don't answer the questions for the students. I sit in the cafe, but several tables away, doing my own work. I do help them get back on track when a few of them disagree with each other and can make no progress. (The main benefit of my presence is it makes clear to the students I think this is important, and they should come.)

Grade the first midterm aggressively. You might fail a lot of students. (Things change gradually, as your course develops a reputation.) Don't worry about it. They can rise to reasonable standards. Give comments on the answers, and conduct a review class (or long after-hours review session) in which you walk through questions, point out common mistakes, and give examples of better answers. If you use a detailed outline or checklist for grading, share it with them. And hand out some sample answers—I use good answers written by the students, rather than my own. The samples are imperfect, but they show what can actually be done in the exam situation.

I sometimes host a makeup midterm, in a 1-semester course.

- This is a voluntary makeup. Students who did well on the first midterm won't take it. I schedule the exam outside of class hours, and hold reviews (before and after) out of class hours.
- The makeup replaces the original midterm. If the student's grade goes up, good. If the grade goes down, it goes down. This limits the number of exams to grade. You don't get frivolous exams submitted just in case they're OK (which you do get if you allow students to use the highest grade of the two.) This course involves a lot of grading. You need to protect your time.

I do not always give a makeup midterm. I don't promise it in the syllabus and refuse to talk with students about it before they have finished the midterm (except to warn students who ask there might not be one). This is important—if students know there is a makeup midterm, some will prepare inadequately for the first midterm with the idea they can do well on the makeup.

These exams are just part of the assessment strategy for the Testing course. They give students a focus for interacting with the lecture and reading materials, but students also need to develop experience with the testing techniques, troubleshooting, and bug reporting. For those, you have to give assignments and homework, not exams.

## Providing feedback for students

Feedback is generally regarded as a useful tool to improve student learning and performance. However, done poorly, feedback is detrimental to these goals.

### Hattie and Timperley's model of feedback

Hattie & Timperley (2007) proposed a model of feedback useful to organizing our discussion. They assert, and few instructors would argue, the purpose of feedback is to close the gap between a student's current understanding or ability to perform and the desired level of understanding or performance capability. They point out both students and teachers can work to decrease this gap.

To close the gap, students can increase their efforts and use more effective strategies. However, the student might also abandon or lower their performance goals. For students, either way, the effect is the same—the gap has decreased. Most instructors would argue the first approach is productive and the latter approach counterproductive.

What can you, in your role as instructor, do to close the gap between what students can do and their goals for performance? The first task is to provide or help students select specific goals that are appropriately challenging. Once the goals are selected, you can work to secure the student's commitment to attaining the goal. Finally, you can help students reach their goals by offering effective learning strategies and feedback.

According to Hattie & Timperley, effective feedback answers three questions for students.

1. Where am I going? The answer to this questions points students to goals. Hattie & Timperley refer to this as "feed up."
2. How am I going? This aspect of feedback focuses on a student's past performance and Hattie & Timperley refer to it as "feed back."
3. Where to next? Finally, feedback helps students understand the next steps which Hattie & Timperley refer to as "feed forward."

Hattie & Timperley argue that there are four levels of feedback and that feedback must be directed at the proper level. Those levels are:

1. Task
2. Process
3. Self-regulation
4. Self as a person

Task feedback focuses on how a student performs a task. Sometimes called corrective feedback, it focuses on whether an answer is right or wrong or whether a student performed a skill correctly or incorrectly. Task feedback can also help students acquire more information to improve their performance. This feedback is more effective when you offer brief comments

rather than simply grades. You should generally avoid complexity when offering task feedback, particularly to lower performing students.

Feedback addressing underlying processes helps students acquire a deeper level of learning than merely providing task feedback. Process feedback can suggest strategies, help students choose from among a variety of strategies, and learn to detect their own errors. The last is particularly valuable because it cues a student to reassess his or her performance and seek more information or select another strategy as appropriate.

Self-regulation refers to a student's ability to monitor his or her own progress. Hattie & Timperley suggest six aspects of feedback at this level influence the effectiveness of feedback: "the capability to create internal feedback and to self-assess, the willingness to invest effort into seeking and dealing with feedback information, the degree of confidence or certainty in the correctness of the response, the attributions about success or failure, and the level of proficiency in seeking help" (p. 94). Low performing or ineffective students rely on their teachers or other external sources for feedback and rarely develop effective self-regulatory strategies. Learners with effective self-regulatory strategies can learn to monitor their own abilities, understanding, and strategy selection. They can also become proficient at evaluating their own progress in acquiring knowledge or new skills and evaluate themselves against their goals. These self-regulated learners are often willing to seek help and information they need to progress toward their goals although this willingness evaporates if their self-esteem is threatened or they anticipate social embarrassment.

The final level of feedback is about the self as a person. A comment such as "good job" is an example of non-specific praise all too prevalent in classrooms. Such non-specific praise is not effective at increasing learning although some students like to hear it. The problem with this type of feedback is that it draws attention from the task to the person. Therefore, it contains little information about achievement or learning and students cannot use it to improve their understanding or performance. However, when such feedback is directed at the task, self-regulation, or strategies, it can be effective at helping a student develop confidence.

As students are learning new information or new skills, they will need task-focused feedback. Eventually, instructors need to provide feedback about process and self-regulation as well. This helps close the gap between a student's current understanding or performance and the goals set for them.

### **Things to do when giving feedback**

Many factors impact the effectiveness of feedback (specificity, timing, ability of the learner, complexity, etc.). Research findings on feedback sometimes report conflicting results. Valerie Shute (2008) has reviewed the research on feedback and offers the following guidelines based on that review.

1. Feedback should focus on the task and not the learner. "You're so smart" focuses on the individual whereas "Yes! You remembered to use the new technique" focuses on the task. When giving task-focused feedback, include suggestions on how the learner can improve.
2. Use elaborated feedback given in manageable chunks to enhance learning. More than just verifying a student's correct or incorrect answer or effort, elaborated feedback

gives specifics about the problem. Try to gauge the ability of students to determine how complex the feedback can be. Lower-performing students are especially vulnerable to becoming overwhelmed by excessive amounts of complex feedback.

3. Keep feedback as simple as possible, but no simpler. It's especially important to keep feedback focused. Unsurprisingly, higher-performing students can handle more complex feedback than lower-performing peers.
4. Feedback should be specific and clear. It should tie to the learner's goals and performance to keep student frustration at a minimum.
5. Let students know how they are performing relative to the learning and/or performance goals. Clarify goals as necessary.
6. Give unbiased, objective feedback. Feedback from a trusted source is more likely to be heeded. In the case of computer-based instruction, perceived biases are minimized when compared to human-delivered feedback. Shute's general advice is to provide feedback in writing where possible. However, we remind you to be particularly sensitive to the tone and wording of feedback.
7. Use feedback to orient students to "learning" goals rather than performance goals. Research demonstrates students focused on learning are more likely to persist through difficult tasks while those with a "performance" orientation more regularly quit in the face of difficulty.

### **Things to avoid when giving feedback**

Shute's (2008) examination of the research on feedback also offers the following cautions on giving feedback:

1. Do not give normative comparisons. Grading on the curve or other techniques that compare one student—either directly or indirectly—with another student draws attention from the task to the individual. This is generally detrimental to learning.
2. Be cautious about providing overall grades. Where possible, provide comments focusing on strengths, weaknesses, and suggestions to improve rather than overall grades. This helps learners focus on the content of comments rather than grades.
3. Do not give feedback drawing attention from the task to the student. This includes "praise" (which should only be used sparingly, if at all) and feedback discouraging a student or threatening his or her self-esteem.
4. Do not interrupt the learner with feedback if the learner is actively engaged. This is disruptive to learning.

### **Sample feedback post**

The following message is a Feedback message Scott Barber sent to students after they took (and had trouble with!) the first quiz in the course. Notice he starts off on a very positive note—congratulating the class on a strong start and commending students who are working ahead. Once he reminds students in his class to get started in the forum to discuss exam questions, he

turns his attention to providing feedback about the quiz. He starts off by offering the strategy he thinks will most likely help his students succeed at the next quiz (it's an open-lecture quiz, use it that way). Next, he acknowledges the testing field has multiple definitions for certain terms and reminds students in this course, they'll use the definitions in the lectures. After that, he explains how important it is to read precisely—not just for the quiz but also as a testing professional. After Scott gives this broad feedback, he goes into the details of a few quiz questions to help his students understand why they might have missed some of them. Finally, Scott mentions a good discussion taking place in another section of the course and suggests students who haven't noticed it already, go see what's happening over there.

### **WEEK 1-A (SUNDAY TO WEDNESDAY)**

I'm very pleased to see that we're off to a strong start and that no one has (that I know of) had any medical complications due to nerves or exhaustion. Can't ask for much more than that. :-)

Many of you are already working ahead. Good for you. Some of you have started drafting your answers in the *Exam Cram* forum. Good for you as well. For those of you who have not reviewed the exam study guide or started drafting your answers, I strongly encourage you to do so. You will be glad you did when week 4 rolls around!

### **THE QUIZ**

Most folks were challenged by the quiz. That's good. What would be the point of a learning tool that didn't make you think? That said, below are some things to keep in mind to make it so that you're being challenged by the content rather than the activity or the format.

- One challenge that some students had is that they took the quiz after they worked through the video and slides (if they worked through the video and slides).

Don't do that.

The quiz is a study aid. Work with it while you work through the lecture/slides/readings. This isn't just about getting the "right" answer in the most convenient way. More important, if the question confuses you, you are right at the part of the lecture/reading that can clarify this material. If you don't like the answer in the quiz or you are still confused, it's time to post on the forum. Not to improve your grade on the quiz but to improve your comprehension of the material.

- Another challenge is that students relied on other definitions than the ones in the course. Ultimately, the point of the quiz is not to ask whether our definition is your preferred definition. The point is to check that you know what our local definition is, because that's the one we'll rely on in this course and in subsequent AST-BBST courses.
- A third challenge typically involves inexperience with precise reading. We can demand more careful reading from you than from programmers or students because you are testers. It's a key part of your job skill to read carefully and precisely. That doesn't mean the questions/answers are perfectly clear. They've gone through a lot of rework, but there may still be bugs.

Below is some discussion on the most frequently missed questions.

**QUESTION 2: ACCEPTANCE TESTING DEFINITION (63% OF YOU GOT THIS CORRECT):**

Yes, people sometimes find bugs during acceptance testing. But the goal of acceptance testing, in our experience (across a lot of organizations with a lot of different approaches) is not to find bugs during acceptance testing. It is to close the project.

**QUESTION 3: ACCORDING TO THE LECTURE'S DEFINITION OF BLACK BOX TESTING (68% OF YOU GOT THIS CORRECT):**

You don't have to memorize the lecture's definition, but you have to show that you are aware of it.

**QUESTION 4: WHAT IS THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN BLACK BOX AND GLASS BOX TESTS? (37% OF YOU GOT THIS CORRECT):**

Almost everyone mishandled the question.

It is true that:

*(b) Black box tests are typically better suited to measure the software against the expectations of the user, whereas glass box tests measure the program against the expectations of the programmer who wrote it.*

And it is also true that:

*(c) Glass box tests focus on the internals of the program whereas black box tests focus on the externally visible behavior.*

However, the question does not ask, what is the difference between these two tests. It asks what is the significance of the difference. Answer (c) doesn't provide any information relevant to that question. Therefore it cannot be the right answer, even though every word is correct.

**QUESTION 9: PROGRAMMER TESTING USUALLY REFERS TO (58% OF YOU GOT THIS CORRECT):**

So what did the slide say?

*The programmer tests her own code, or code she's going to maintain. She uses her knowledge of the code to focus and prioritize tests. Programmers typically use an array of tools to test more easily or more automatically.*

*The test-driven programmer uses tests to guide her design and programming decisions or to improve her understanding of another programmer's code.*

*Programmer testing is typically (but not necessarily) glass box, verification-oriented, and often includes both structural and behavioral tests.*

The lecture didn't say "any testing by a programmer." And this doesn't say that either. Is this programmer testing just because a programmer did it?

**QUESTIONS 13, 14, & 15: STAKEHOLDERS:**

Even though most of you answered this question correctly, I wanted to point out that there is a good discussion related to these questions in the Quiz Discussion forum that I'd encourage each of you to check out if you haven't done so already.

Scott's feedback is very detailed. As the course progresses, he may not continue to give this much feedback; however, he knows many of the students in this class are new to online learning and the BBST materials. He takes extra care to lay the groundwork early for his students' success later in this course—and subsequent courses.

### **Tools for providing feedback**

You will provide a lot of feedback to students in discussion forum posts, *Instructor Announcements*, and email messages to students. A variety of other tools work particularly well for the online instructor. Your feedback can be as elaborate as you'd like it to be.

Most of us remember teachers handing back assignments with comments scribbled in red ink. Some of the comments you could read. Some you could guess. Others remained indecipherable. Online instructors can use the collaboration and editing tools in their software in a similar way. Microsoft *Word* is a popular option for this. Some instructors use the Track Changes feature and others use Comments. Adobe's *Acrobat* suite allows instructors to note comments while preserving the formatting of the student's work.

If you prefer the more familiar look of handwritten feedback, you can attach a graphics tablet to your computer (or use a tablet) and use your stylus as a pen. In part two of his video on Grading Exams (hosted at Google Video), you can see Kaner's use of handwritten feedback starting at about 6:33 into the video.

Another alternative is to create a feedback video using screen capture software and a microphone. You can see an example of someone grading an essay at [http://ia301504.us.archive.org/0/items/Reader\\_Response/journalism.swf](http://ia301504.us.archive.org/0/items/Reader_Response/journalism.swf). Individual feedback like this will be time-consuming, but with a little imagination—and editing—you can create useful feedback videos for your students.

## References and resources

For more information on assessment techniques, we recommend Angelo and Cross' (1993) *Classroom Assessment Techniques* published by Jossey Bass. The authors offer an array of flexible, high-quality assessments you can modify for your own use. Most techniques from the collection help professors and instructors collect formative assessment information.

*The Field-tested Learning Assessment Guide* (FLAG), based at the University of Wisconsin-Madison offers a dozen assessment techniques at <http://www.flaguide.org/>. For each technique, site visitors can read a description of the technique, a rationale for using it, instructions, variations, limitations, and a brief synopsis of the supporting theory. The FLAG website has a handy tool to help you match course goals and classroom assessment techniques.

Jonathan Mueller's *Authentic Assessment Toolbox* (at <http://jonathan.mueller.faculty.noctrl.edu/toolbox/index.htm>) provides an introduction to authentic assessment including examples of authentic tasks and advice on choosing assessment tasks. Mueller explains holistic and analytic rubrics and offers advice on how to create them and when each should be used.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, 77, 81–112. This article reviews both positive and negative impact of feedback and proposes a model that can make your feedback more effective.

Shute, V. (2008) Focus on formative feedback. *Review of Educational Research*. 78, 153-189. Reviews the existing research on formative feedback and offers guidelines on how to use—and how not use—feedback.

Walvoord, B.E. and Anderson, V.J (1998). *Effective grading: A Tool for Learning and Assessment*. Jossey-Bass, San Francisco, CA.

For a more comprehensive presentation of James Bach's *Heuristic Test Strategy Model* see <http://www.satisfice.com/tools/satisfice-tsm-4p.pdf>

## Chapter 4

# Learning Theory Tidbits

This brief chapter is intended to introduce Computer Science professors and those with computer backgrounds to some of the learning theories undergirding the BBST courses. Although providing a comprehensive explanation of the relevant theories is beyond the scope of this manual, we provide references and resources so you can seek additional information.

Some people in technical fields, and specifically the testing field, recommend a passive-learning viewpoint for training and supervising testers and programmers. Encouraging us to bow to the infinite wisdom of ancient martial arts masters, they tell us novices should follow prescribed rules for months or years until they are competent enough to vary the rules. Eventually, they will become black belts in development and be able to make their own rules. As Mr. Miyagi put it in *The Karate Kid* (Internet Movie Database):

*“We make sacred pact. I promise teach karate to you, you promise learn. I say, you do, no questions.”*

In contrast, active-learning theorists argue people learn by asking questions, by building and testing their own models, and by pushing the limits and breaking the rules to see what happens. In educational theory, we use terms such as constructivism, inquiry-based learning, problem-based learning, or case-based learning. To help people understand complex documents, we teach them active reading skills. This is especially applicable to software testing when we consider specification-based testing.

We have an odd split between theory and practice in modern education. In the name of standards and accountability, today’s educators are compelled to give multiple-choice tests. Because of the high stakes nature of many of these tests, teachers focus instruction in ways to help students pass the exam. The result often encourages uncritical parroting of what has been taught. In contrast, active-learning is the main theory taught in schools of education and supported by research foundations, such as the National Science Foundation. Further more, active-learning advocates dominate the discussion in the field of andragogy (the study of learning by adults as distinguished from pedagogy — learning by children).

### Adult learning theory

Malcolm Knowles is widely viewed as a pioneer in andragogy (the teaching of adult learners). He bases his work and his advice about reaching adult learners on a set of assumptions

1. Adult learners need to know why they are learning something.
2. Adult learners view themselves as autonomous and capable of directing themselves.
3. Previous experiences of adult learners are valuable resources used in learning.

4. Adult learners must be prepared to learn new things by understanding the relevance to their lives.
5. Adult learners need problems and tasks relevant to their jobs or social tasks.
6. The strongest motivation for adult learners comes from within.

Although Knowles' work is the subject of some controversy, we find his principles useful as we develop and teach BBST courses. In particular, you will see advice in this manual stating adults are self-directed; our students' experience is a valuable resource for our courses—and sometimes we must provide experiences on which they can build; and students want courses relevant and authentic to their real-world experience. To find out more about Knowles' work, read *The Adult Learner: The Definitive Classic in Adult Education and Human Resource Development* (6<sup>th</sup> edition) by Knowles, Holton, & Swanson (2005).

## **Constructivism**

Constructivism is another popular learning theory. Jerome Bruner is often credited as an early constructivist but many others have contributed their perspectives to constructivism. The basic premise in constructivism is that individuals must construct their own understanding of a topic. Passive lectures and explanations are less effective than hands-on experiences and activities engaging students to ask their own questions about a topic and develop their own solutions. The constructivist teacher focuses efforts on providing the experiences and environment preparing students to learn. Lessons often focus on “messy” or “ill-defined” problems to encourage students grasping what they are able to understand and elaborate on that to acquire more knowledge and understanding. Constructivist classrooms are characterized by autonomous learners, open-ended questions, a focus on higher-level thinking, challenging experiences, open-ended questions, social interactions, manipulatives, models, and interactive materials.

## **References and resources**

For more information on constructivism, consider the following texts:

*Beyond Constructivism: Models and Modeling Perspectives on Mathematics Problem Solving, Learning, and Teaching* by Richard A. Lesh and Helen M. Doerr.

*In Search of Understanding: The Case for Constructivist Classrooms* by Jacqueline Brooks and Martin Brooks.

And finally, for a general book on learning, consider:

*How People Learn: Brain, Mind, Experience, and School: Expanded Edition* by the Committee on Learning Research and Educational Practice and the National Research Council.

## Chapter 5

# Bloom's Taxonomy and Software Testing

*The following is modified from Cem Kaner's blog posts on assessment at <http://kaner.com/?p=31>, <http://kaner.com/?p=32>, and <http://kaner.com/?p=33>.*

In 1948, a group of “college examiners” gathered at an American Psychological Association meeting decided to try to develop a theoretical foundation for evaluating whether a person knows something and how well they know it. The key product of that group was Bloom's Taxonomy (1956). The Bloom Committee considered how to evaluate levels of cognitive knowledge (distinct from psychomotor and affective) and proposed six levels:

- Knowledge—the ability to state or identify facts or ideas.
- Comprehension—the ability to summarize ideas, restate them in other words, or compare them to other ideas.
- Application—the ability to use the knowledge to solve problems.
- Analysis—the ability to identify patterns, identify components, and explain how they connect to each other.
- Synthesis—the ability to relate different things to each other, combine ideas to produce an explanation.
- Evaluation—the ability to weigh costs and benefits of two different proposals.

It turns out to be surprisingly difficult to assess a student's level of cognitive knowledge. All too often, we think we are measuring one thing while we actually measure something else.

For example, suppose I create an exam asking students:

*What are the key similarities and differences between domain testing and scenario testing? Describe two cases, one better suited for domain analysis and the other better suited for scenario, and explain why.*

This is obviously an evaluation-level question, right? Well, maybe. But maybe not. To consider the alternative possibilities, suppose a student handed in a perfect answer to this question. That answer might demonstrate evaluation-level understanding of the material or it might demonstrate less:

- **Knowledge.** Maybe students saw this question in a study guide (or a previous exam), developed an answer while they studied together, then memorized it. In this instance, a student has memorized an answer written by someone else.
- **Comprehension.** Maybe students prepared a sample answer for this question, or saw this comparison online or in the textbook, or the teacher made this comparison in class and this student learned the comparison just well enough to be able to restate it in her own words.
- **Application.** Maybe the comparison was given in class (or a study guide, etc.) along with the two “classic” cases (one for domain, one for scenario), but the student had to figure out why one works well for domain and the other for scenario. He had to consider how to apply the test techniques to the situations.

These cases reflect a very common problem. How we teach, how our students study, and what resources our students study from will impact student performance on exams: what they *appear* to know—even if they don’t make much of a difference to the underlying competence—and how well they actually know it.

The distinction between competence and performance (<http://www.google.com/search?q=competence+versus+performance>) is fundamental in educational and psychological measurement. It also cuts both ways. In the example above, performance indicates a deeper knowledge of the material than the student actually has.

Instructors often see the reverse: underperformance. In these cases, students know the material well but lack test-taking skills so score less well on exams than they should.

The extensive discussions of racial bias and cultural bias in standardized exams are about the distinction between competence and performance. Some groups perform less well on some exams because of the details and method of examination rather than a difference in underlying knowledge or cognitive skills.

When we design an assessment we have to consider the performance overlay on top of the student’s underlying competence with the material:

- What level of knowledge does the assessment appear to evaluate?
- Could someone who knows less of the material or knows it less deeply perform as well as someone who knows it at the level we are trying to evaluate?
- Might someone who knows this material deeply perform less well than we expect (for example, because they see ambiguities that a less senior person would miss)?

In our opinion, an assessment is not well designed and should not be used for serious work if questions like these are not carefully considered in its design.

## Anderson & Krathwohl's update to Bloom's taxonomy

Bloom's taxonomy has been a cornerstone of instructional planning for 50 years, however challenged by difficult questions about how to apply it.

For example, consider the difference between "knowledge" of facts and of procedures. The word is the same ("knowledge"). In Bloom's terminology, the basic meaning is the same: a student can demonstrate "knowledge" of something by echoing back what they memorized, whether they understand it or not. But if you examine students' knowledge of a fact, you ask them to STATE it ("The world is flat."). In contrast, if you examine students' knowledge of a procedure, you probably ask them to DO it. If you would assess them differently, should you treat them as the same type of knowledge?

What about knowing a model? If knowing a fact lets you say something and knowing a procedure helps you do something, maybe knowing a model helps you predict something. Does say = do = predict = know?

Similarly, think about synthesizing or evaluating these different things. Is the type and level of knowledge really the same—would we test people's knowledge in the same way—for these different kinds of things?

Extensive discussion (e.g. Anderson & Sosniak, 1994) of the Bloom committee's taxonomy led to upgrades, such as Anderson & Krathwohl's (2000) and Marzano's (2000).

Rather than ordering knowledge on one dimension, from easiest-to-learn to hardest, the new approaches look at different types of information (facts, procedures, etc.), as well as different levels of knowledge (remember, apply, etc.).

I find the Anderson / Krathwohl (2000) approach more intuitive and easier to apply. Their model looks like this:

The Knowledge Dimension	The Cognitive Process Dimension					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual knowledge						
Conceptual knowledge						
Procedural knowledge						
Metacognitive knowledge						

*Figure 8: Anderson & Krathwohl's (2000) update to Bloom's Taxonomy*

Metacognitive knowledge is knowing how to learn something. For example, much of what test professionals know about troubleshooting, debugging and active reading is metacognitive knowledge.

## Extending Bloom’s taxonomy to software testing

One of the key improvements in Anderson and Krathwohl’s update to Bloom’s taxonomy was the inclusion of different types of knowledge (The Knowledge Dimension), as well as different levels of knowledge (The Cognitive Process Dimension). See Figure 8.

This is a useful model, but there are things we learn as software testers that don’t quite fit in the knowledge categories. After several discussions with James Bach, I adopted the following revision as the working model I use:

The Knowledge Dimension	The Cognitive Process Dimension					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Facts						
Concepts						
Procedures						
Cognitive Strategies						
Models						
Skills						
Attitudes						
Metacognition						

Figure 9: Anderson & Krathwohl’s model modified for software testing

Here are my working definitions/descriptions for the components of the knowledge dimension:

### Facts

A “statement of fact” is a statement that can be unambiguously proved true or false. For example, “James Bach was born in 1623 is a statement of fact (but not true for the James Bach we know in the software testing community). A *fact* is the subject of a true statement of fact.

Facts include such things as:

- tidbits about famous people;
- famous examples (the example might also be relevant to a concept, procedure, skill or attitude); and
- items of knowledge about devices (for example, a description of an interoperability problem between two devices).

## Concepts

A *concept* is a general idea. “Concepts are abstract in that they omit the differences of things in their extension, treating them as if they were identical.” (*Wikipedia: Concept*).

In practical terms, we treat the following kinds of things as “concepts” in this taxonomy:

- definitions
- descriptions of relationships between things
- descriptions of contrasts between things
- description of the idea underlying a practice, process, task, heuristic (whatever).

We can teach the same thing at different levels. For example, we can teach the consistency-with-competing-products oracle heuristic as a concept, a cognitive strategy or a model.

The basic level for this heuristic is its definition or description: According to the consistency-with-competing-product heuristic, the tester would compare the behavior of a program under test with a respected competitor and report a bug if this program’s behavior seems inconsistent with, and possibly worse than, the competitor’s.

A heuristic is a fallible guide for making a decision. We know it sometimes leads to the wrong choice, but on average, it is more often right. We use heuristics when we don’t have stronger decision-support tools (rules) available.

Sometimes, a heuristic or a rule states an imperative. For example, “report bugs like this” and “stop at a red light” are imperatives. Sometimes a heuristic or a rule states a causal relationship (“Stop smoking before it kills you”). Sometimes a heuristic or a rule states a norm (“Don’t wear undershorts outside of your pants at work”).

In each of these cases, the basic description expresses a concept. An examination checking whether the student knew the basic description would be testing at the conceptual level. This exam could check conceptual knowledge at different levels:

- A question checking only whether students knew the definition well enough to say it or recognize it would be at the “Remember” level (what Bloom’s taxonomy called the “Knowledge” level).
- A question requiring students to explain the concept is at the “Understand” level.
- A question requiring students to use the heuristic or the rule, for example, to make a decision based on it, is at the “Apply” level.
- A question requiring students to compare several heuristics and rules, explain when one is more useful than the others, and why is an example of higher-order work (“Analyze” and “Evaluate”).

However, the consistency-oracle heuristics are not merely concepts.

If a tester's approach to evaluating a program is guided by the consistency oracles, he or she is using the oracles as a cognitive strategy.

Additionally, if someone describes this oracle in a formalized way, he or she is probably working with it as a model.

## Procedures

*Procedures* are algorithms. They include a reproducible set of steps for achieving a goal. Consider the task of reporting a bug. Imagine someone has broken this task down into subtasks (simplify the steps, look for more general conditions, write a short descriptive summary, etc.) and presented the tasks in a sequential order. This might be a procedure or a cognitive strategy.

This description is intended as a procedure if the author expects you to do all of the steps in exactly this order every time.

The description is intended as a cognitive strategy if it is meant to provide a set of ideas to help you think through what you have to do for a given bug, with the understanding you may do different things in different orders each time. In such cases, the description is a useful reference point as you go.

## Cognitive strategies

*Cognitive strategies* are guiding procedures students can use to help them complete less-structured tasks, such as those in reading comprehension and writing.

"There are some academic tasks that are "well-structured." These tasks can be broken down into a fixed sequence of subtasks and steps that consistently lead to the same goal. The steps are concrete and visible. There is a specific, predictable algorithm that can be followed, one that enables students to obtain the same result each time they perform the algorithmic operations. These well-structured tasks are taught by teaching each step of the algorithm to students.

In contrast, reading comprehension, writing, and study skills are examples of less-structured tasks—tasks that cannot be broken down into a fixed sequence of subtasks and steps that consistently and unfailingly lead to the goal. Because these tasks are less-structured and difficult, they have also been called higher-level tasks. These types of tasks do not have the fixed sequence that is part of well-structured tasks. One cannot develop algorithms that students can use to complete these tasks." (Rosenshine, 1997, section 3, para 2 and 3)

In cognitive strategies, we include heuristics (fallible but useful decision rules), guidelines (fallible but common descriptions of how to do things), and good (rather than "best") practices.

Cognitive strategies and models are related in that *deciding to apply* a model and *figuring out how to apply* a model involve cognitive strategies. Also, *deciding to create* a model to represent or simplify a problem and *figuring out how to create* a model involve cognitive strategies. However, the model itself is a simplified representation of something, done to give you insight into the thing you are modeling.

## Models

A model is a simplified representation created to make something easier to understand, manipulate or predict some aspects of the modeled object or system. It is an expression of something we may not completely understand in terms of something we think we do understand.

A state-machine representation of a program is a model.

Deciding to use a state-machine representation of a program as a vehicle for generating tests is a cognitive strategy.

Slavishly following someone's step-by-step catalog of best practices for generating a state-machine model of a program to derive scripted test cases for unskilled personnel to follow is a procedure.

This definition of a model is a concept.

The assertion "Harry Robinson publishes papers on software testing and models" is a statement of fact.

## Skills

Skills are behaviors improvee with practice. Effective bug report writing is a skill, and includes several other skills. One of those sub-skills is the ability to take a visible failure and vary your test conditions until you find a simpler set of conditions yielding the same failure. This is skilled work. Getting better at skilled work takes time and practice.

Instruction about skills will often feature examples demonstrating skilled work, like "Here's how I use this technique" or "Here's how I found that bug." The specific demonstrations might be of a procedure, cognitive strategy, or skilled performance. In many cases, it would be accurate and useful to class something as both a skill and a cognitive strategy.

## Attitudes

"An attitude is a persisting state that modifies an individual's choices of action" (Gagne, Briggs, & Wager, 1992, p. 48). Attitudes are often based on beliefs (a belief is a proposition held as true whether it has been verified true or not).

Instructional materials often attempt to influence the student's attitudes. For example, when we teach students complete testing is impossible, we might spin the information in different ways to influence student attitudes toward their work:

- Given the impossibility, testers must be creative and must actively consider what they can do at each moment to yield the highest informational return for their project.
- Given the impossibility, testers must conform to the carefully agreed procedures because these reflect agreements reached among the key stakeholders rather than diverting their time to the infinity of interesting alternatives.

Attitudes are controversial in the software testing field. Refusal to acknowledge the legitimacy of differences in attitudes has been the source of unnecessary pompous bombast and ill will.

In general, if we identify an attitude or an attitude-related belief as something to include as an assessable item, we should expect to create questions that:

- define the item without requiring the examinee to agree it is true or valid;
- contrast it with a widely accepted alternative, without requiring the examinee to agree it is better or preferable to the alternative;
- adopt it as the One True View, but with discussion notes referencing the controversy about this belief or attitude. This is something to handle with care. Summary rejection of alternative views will alienate the people who hold those beliefs or attitudes, as well as some (perhaps many) of the undecided. The impact of this alienation won't be limited to this attitude, or belief, or topic. It damages the credibility and goodwill of the instructor (or the course) with the student, interfering more broadly with the student's learning.

## **Metacognition**

Metacognition refers to the executive process involved in such tasks as:

- planning (such as choosing which procedure or cognitive strategy to adopt for a specific task);
- estimating how long it will take (or at least, deciding to estimate and figuring out what skill/ procedure/staffing to apply to obtain that information);
- monitoring how well you are applying the procedure or strategy; and
- remembering a definition or realizing you don't remember it and digging through web searches for an adequate substitute.

Much of context-driven testing involves metacognitive questions. For example:

- Which test technique would be most useful for exposing what information of what interest to whom?
- What areas are most critical to test next, in the face of this information about risks: stakeholder priorities, available skills, or available resources?

Questions / issues that should get you thinking about metacognition are:

- How to think about ...
- How to learn about ...
- How to talk about ...

In the BBST courses, the section on specification analysis includes a long metacognitive digression into active reading and strategies for getting good information value from the specification fragments testers encounter, search for, or create.

## References and resources

### Bloom's Taxonomy

Benjamin Bloom's (1956) *Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain*, University of Chicago Press.

Don Clark's page on *Bloom's Taxonomy*,  
<http://www.nwlink.com/~donclark/hrd/bloom.html>

Mary Forehand's short chapter on Bloom's Taxonomy ([http://projects.coe.uga.edu/epltt/index.php?title=Bloom%27s\\_Taxonomy](http://projects.coe.uga.edu/epltt/index.php?title=Bloom%27s_Taxonomy)) published in the ebook, *Emerging Perspectives on Learning, Teaching, and Technology*, edited by Michael Orey and published in conjunction with the Association for Educational Communications and Technology (AECT) under a Creative Commons license. Pay particular attention to the matrix for the Revised Bloom's Taxonomy developed by Anderson & Krathwohl (2001).

Tammy Goodwater's entry in the *Encyclopedia of Educational Technology* at  
<http://coe.sdsu.edu/eet/Articles/BloomsT/>

National Teaching & Learning Forum, *The Six Major Levels of Bloom's Taxonomy of the Cognitive Domain*, <http://www.ntlf.com/html/lib/suppmat/84taxonomy.htm>

Teacher Tap, *Critical & Creative Thinking—Bloom's Taxonomy*,  
<http://eduscapes.com/tap/topic69.htm>

Wikipedia entry, *Taxonomy of Educational Objectives*,  
[http://en.wikipedia.org/wiki/Bloom%27s\\_taxonomy](http://en.wikipedia.org/wiki/Bloom%27s_taxonomy)

### Anderson & Krathwohl revision

For more discussion of the basics of the Anderson & Krathwohl revision, review the "Bloom's Revised Taxonomy" entry (<http://coe.sdsu.edu/eet/Articles/bloomrev/index.htm>) in the *Encyclopedia of Educational Technology* published by the San Diego State University Department of Educational Technology.

Anderson, L.W., Krathwohl, D.R., Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2000), *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Allyn & Bacon.

Anderson, L.W. & Sosniak, L.A. (Eds.) (1994) *Bloom's Taxonomy Educational Objectives: A Forty-Year Retrospective*, National Society for the Study of Education.

Fisher, D., *Models—Course Development. Instructional Design—The Taxonomy Table*,  
<http://oregonstate.edu/instruct/coursedev/models/id/taxonomy/>

Marzano, R.J. (2000) *Designing a New Taxonomy of Educational Objectives*, Corwin Press.

### **Additional materials**

Barak Rosenshine, "Advances in Research on Instruction", Chapter 10 in J.W. Lloyd, E.J. Kameanui, and D. Chard (Eds.) (1997) *Issues in educating students with disabilities*. Mahwah, N.J.: Lawrence Erlbaum: Pp. 197-221. Available at <http://epaa.asu.edu/barak/barak.html>

Robert M. Gagne, Leslie J. Briggs & Walter W. Wager (1992) *Principles of Instructional Design* (4th Ed), p. 48. This is a classic instructional design textbook covering a wide range of issues.

## Chapter 6

# Writing Multiple-Choice Questions

*Lightly updated from Cem Kaner's Blog at <http://kaner.com/?p=34>.*

This chapter provides a tutorial on creating multiple choice questions, framed by Haladyna's (2004) heuristics for test design and Anderson & Krathwohl's (2000) update to Bloom's taxonomy. For readers who use the multiple-choice questions in the BBST materials, these guidelines shaped the development of those questions. For readers interested in writing their own exams, these guidelines offer advice to help you with your task.

My interest in computer-gradable test questions is to support teaching and learning rather than high-stakes examination. Some of the design heuristics are probably different for the former case, rather than the latter. For example, which is the more desirable attribute for a test question:

- a. defensibility (you can defend its fairness and appropriateness to a critic) or
- b. potential to help a student gain insight?

In high-stakes exams, (a) [defensibility] is clearly more important, but as a support for learning, I'd rather have (b) [support for insight].

This tutorial's examples are from software engineering, but from my perspective as someone who also has taught psychology and law, I think the ideas are applicable across many disciplines. For this tutorial, the advice and examples specifically target the BBST Courses.

These notes summarize lessons from the last Workshop on Open Certification (WOC 2007) and private discussions related to BBST.

## Chapter outline

- Standards specific to the BBST Questions
- Definitions and examples
- Item writing guidelines
  - Content guidelines
  - Style and format guidelines
  - Writing the stem
  - Writing the options
- References

## Standards specific to BBST course questions

As you develop questions, you might consider posing questions with two, three, and four different options as answers. The following table outlines how these questions in the BBST courses are presented and scored.

Structure	Typical Presentation	Scoring
<b>2 options</b>	<p><b>Choose the answer:</b></p> <ul style="list-style-type: none"> <li>a) First option</li> <li>b) Second option</li> <li>c) Both (a) and (b)</li> <li>d) Neither (a) nor (b)</li> </ul>	<p>If the correct answer is (c) then the examinee will receive 25% credit for selecting only (a) or only (b).</p>
<b>3 options</b>	<p><b>Choose the answer:</b></p> <ul style="list-style-type: none"> <li>a) First option</li> <li>b) Second option</li> <li>c) Third option</li> <li>d) (a) and (b)</li> <li>e) (a) and (c)</li> <li>f) (b) and (c)</li> <li>g) (a) and (b) and (c)</li> </ul>	<p>If the correct answer is (d), the examinee will receive 25% credit for selecting only (a) or only (b). Similarly for (e) and (f).</p> <p>If the correct answer is (g) (all of the above), the examinee will receive 25% credit for selecting (d) or (e) or (f) and 10% for the other choices.</p>
<b>4 options</b>	<p><b>Choose the answer:</b></p> <ul style="list-style-type: none"> <li>a) First option</li> <li>b) Second option</li> <li>c) Third option</li> <li>d) Fourth option</li> </ul>	<p>Full credit for a correct answer and no credit for an incorrect answer.</p>
<b>4 options</b>	<p><b>Choose the answer:</b></p> <ul style="list-style-type: none"> <li>a) First option</li> <li>b) Second option</li> <li>c) Third option</li> <li>d) Fourth option</li> <li>e) (a) and (c)</li> <li>f) (a) and (b) and (d)</li> <li>g) (a) and (b) and (c) and (d)</li> </ul> <p>There will be a maximum of 7 choices. The three combination choices can be any combination of two, three or four of the first four answers.</p>	<p>If the correct answer is like (e) (a pair), the examinee will receive 25% credit for selecting only (a) or only (b) and nothing for selecting a combination that includes (a) and (b) but also includes an incorrect choice.</p> <p>If the correct answer is (f) (three of the four), the examinee will receive 25% credit for selecting a correct pair (if (a) and (b) and (d) are all correct, then any two of them get 25%) but nothing for selecting only one of the three or selecting a choice that includes two or three correct but also includes an incorrect choice.</p> <p>If the correct answer is (g) (all correct), the examinee will receive a 25% credit for selecting a correct triple.</p>

## Definitions and examples

Following are a few terms commonly used when discussing the design of multiple-choice questions. See the reference examples in Table X for illustration.

**TEST** In this chapter, the word “test” is ambiguous. Sometimes we mean a software test (an experiment that can expose problems in a computer program) and sometimes an academic test (a question that can expose problems in someone’s knowledge). In these definitions, “test” means “academic test.”

**TEST ITEM** A test item is a single test question. It might be a multiple choice test question or an essay test question or some other format.

**CONTENT ITEM** A content item is a single piece of content, such as a fact or a rule, something you can test on.

**STEM** The opening part of the question is called the stem. In example B, the stem is “Which is the best definition of the testing strategy in a testing project?”

**DISTRACTOR** An incorrect choice. In example B, (b) and (c) are distractors.

**CORRECT CHOICE** The correct choice for example B is (a) “The plan for applying resources and selecting techniques to achieve the testing mission.”

**THE QUESTION FORMAT** The stem is a complete sentence and asks a question answered by the correct choice and the distractors. Example A uses Question format.

**THE BEST ANSWER FORMAT** The stem asks a complete question. Most or all of the distractors and the correct choice are correct to some degree, but one of them is stronger than the others. In example B, all three answers are plausible but in the BBST course, given the BBST lectures, (a) is the best.

**THE INCOMPLETE STEM FORMAT** The stem is an incomplete sentence the correct choice and distractors complete. Example C is in the incomplete stem format.

**COMPLEX FORMATS** In a complex-format question, the alternatives include simple answers and combinations of these answers. In example A, the examinee can choose (a) “We can never be certain the program is bug free” or (d) which says both (a) and (b) are true or (f) which says all of the simple answers (a, b and c) are true.

**LEARNING UNIT** A learning unit typically includes a limited set of content sharing a common theme or purpose, plus learning support materials, such as a study guide, test items, an explicit set of learning objectives, a lesson plan, readings, lecture notes or video, etc.

**HIGH-STAKES TEST** A test is high-stakes if there are significant benefits for passing the test or significant costs of failing it.

<b>A</b>	<p>What are some important consequences of the impossibility of complete testing?</p> <ul style="list-style-type: none"> <li>a) We can never be certain the program is bug free.</li> <li>b) We have no definite stopping point for testing, which makes it easier for some managers to argue for very little testing.</li> <li>c) We have no easy answer for what testing tasks should always be required, because every task takes time that could be spent on other high importance tasks.</li> <li>d) (a) and (b)</li> <li>e) (a) and (c)</li> <li>f) (b) and (c)</li> <li>g) All of the above</li> </ul>
<b>B</b>	<p>Which is the best definition of the testing strategy in a testing project?</p> <ul style="list-style-type: none"> <li>a) The plan for applying resources and selecting techniques to achieve the testing mission.</li> <li>b) The plan for applying resources and selecting techniques to assure quality.</li> <li>c) The guiding plan for finding bugs.</li> </ul>
<b>C</b>	<p>Complete statement coverage means ...</p> <ul style="list-style-type: none"> <li>a) You have tested every statement in the program.</li> <li>b) You have tested every statement and every branch in the program.</li> <li>c) You have tested every IF statement in the program.</li> <li>d) You have tested every combination of values of IF statements in the program.</li> </ul>

D

The key difference between black box testing and behavioral testing is:

- a) The test designer can use knowledge of the program's internals to develop a black box test, but cannot use that knowledge in the design of a behavioral test because the behavioral test is concerned with behavior, not internals.
- b) The test designer can use knowledge of the program's internals to develop a behavioral test, but cannot use that knowledge in the design of a black box test because the designer cannot rely on knowledge of the internals of the black box (the program).
- c) The behavioral test is focused on program behavior whereas the black box test is concerned with system capability.
- d) (a) and (b)
- e) (a) and (c)
- f) (b) and (c)
- g) (a) and (b) and (c)

E

What is the significance of the difference between black box and glass box tests?

- a) Black box tests cannot be as powerful as glass box tests because the tester doesn't know what issues in the code to look for.
- b) Black box tests are typically better suited to measure the software against the expectations of the user, whereas glass box tests measure the program against the expectations of the programmer who wrote it.
- c) Glass box tests focus on the internals of the program whereas black box tests focus on the externally visible behavior.

## Item-writing guidelines

Several papers on the web organize their discussion of multiple-choice tests around a researched set of advice from Haladyna, Downing & Rodriguez or the updated list from Haladyna (2004). I'll do that too, tying their advice back to our needs for software testing. I begin with a set of guidelines, then apply them to writing multiple-choice questions for BBST courses.

### Content guidelines

1. Every item should reflect specific content and a single specific cognitive process, as called for in the test specifications (table of specifications, two-way grid, test blueprint).
2. Base each item on important content to learn; avoid trivial content.
3. Use novel material to measure understanding and the application of knowledge and skills.
4. Keep the content of an item independent from content of other items on the test.
5. Avoid overly specific and overly general content.
6. Avoid opinion-based items.
7. Avoid trick items.
8. Format lists of choices vertically instead of horizontally.

### Style and format concerns

9. Edit items for clarity.
10. Edit items for correct grammar, punctuation, capitalization and spelling.
11. Simplify vocabulary so reading comprehension does not interfere with testing the content intended.
12. Minimize reading time. Avoid excessive verbiage.
13. Proofread each item.

### Writing the stem

14. Make the directions as clear as possible.
15. Make the stem as brief as possible.
16. Place the main idea of the item in the stem, not in the choices.
17. Avoid irrelevant information (window dressing).
18. Avoid negative words in the stem.

## Writing options

19. Develop as many effective options as you can, but two or three may be sufficient.
20. Vary the location of the correct answer according to the number of options. Assign the position of the correct answer randomly.
21. Place options in logical or numerical order.
22. Keep options independent; choices should not be overlapping.
23. Keep the options homogeneous in content and grammatical structure.
24. Keep the length of options about the same.
25. “None of the above” should be used sparingly.
26. Avoid using “all of the above.”
27. Avoid negative words such as not or except.
28. Avoid options giving clues to the right answer.
29. Make all distractors plausible.
30. Use typical errors of students when you write distractors.
31. Use humor if it is compatible with the teacher; avoid humor in a high-stakes test.

Now to apply those to questions for BBST courses.

## Content guidelines

1. Every item should reflect specific content and a single specific cognitive process, as called for in the test specifications (table of specifications, two-way grid, test blueprint).

The learning objectives for the *BBST Foundations* course are presented in the table below. Note also the table lists the level of knowledge and skills in the course content and defines the level of knowledge we hope the learner will achieve. For discussions of level of knowledge, see chapter five in this manual:

Learning Objectives of the BBST Foundations Course		Anderson/ Krathwohl level
1	Familiar with basic terminology and how it will be used in the BBST courses.	Understand
2	Aware of honest and rational controversy over definitions of common concepts and terms in the field.	Understand
3	Understand there are legitimately different missions for a testing effort. Understand the argument that selection of mission depends on contextual factors. Able to evaluate relatively simple situations that exhibit strongly different contexts in terms of their implication for testing strategies.	Understand, Simple evaluation
4	Understand the concept of oracles well enough to apply multiple oracle heuristics to their own work and explain what they are doing and why.	Understand and apply
5	Understand complete testing is impossible. Improve ability to estimate and explain the size of a testing problem.	Understand, rudimentary application
6	Familiarize students with the concept of measurement dysfunction.	Understand
7	Improve students' ability to adjust their focus from narrow technical problems (such as analysis of a single function or parameter) through broader, context-rich problems.	Analyze
8	Improve online study skills, such as learning more from video lectures and associated readings.	Apply
9	Improve online course participation skills, including online discussion and working together online in groups.	Apply
10	Increase student comfort with formative assessment (assessment done to help students take their own inventory, think and learn rather than to pass or fail the students).	Apply
11	Improve critical reading skills.	Analyze and/or Evaluate
12	Improve writing/written communication	May illustrate knowledge at each of the dimensions

For each of these objectives, we could list the items we want students to learn. For example:

- List the terms students should be able to define.
- List the divergent definitions students should be aware of.
- List the online course participation skills students should develop or improve.

We could create multiple-choice tests for some of these:

- We could check whether students could recognize a term's definition.
- We could check whether students could recognize some aspect of an online study skill.

But there are elements in the list not easy to assess with a multiple-choice test. For example, how can you tell whether someone works well with other students by asking them multiple-choice questions? To assess, watch how they work in groups, do not read multiple-choice answers.

Now, back to Haladyna's (2004) first guideline:

- Use an appropriate type of test for each content item. Multiple-choice is good for some, but not all.
- If you use a multiple-choice test, each test item (each question) should focus on a single content item. That might be a complex item, such as a rule or a relationship or a model, but it should be something you and the student would consider to be one thing. A question spread across multiple issues is confusing in ways having little to do with the content being tested.
- Design the test item to assess the material at the right level (see the table, above). For example, if you are trying to learn whether someone can use a model to evaluate a situation, you should ask a question requiring the examinee to apply the model, not one just asking whether he or she can remember the model.

When working with a self-contained learning unit, such as the individual BBST courses, it should be possible to:

1. List most of the items students should learn and the associated cognitive level.
2. **Base each item on important content to learn; avoid trivial content.**

In a recent workshop on developing questions, attendees adopted this heuristic: Don't ask the question unless you think a hiring manager would actually care whether this person knew the answer to it.

3. **Use novel material to measure understanding and the application of knowledge and skills.** That is, reword the idea you are asking about rather than using the same words as the lecture or assigned readings. This is important advice for a traditional surprise test because people are good matchers:

- If I show you exactly the same thing you saw before, you might recognize it as familiar even if you don't know what it means.
- If I want to write a more difficult question, I can put exact-match (but irrelevant) text in a distractor. You'll be more likely to guess this answer if you're not sure of the correct answer because this one is familiar.

This is important advice for BBST because the student can match the words to the readings in this open book test without understanding them. In open book exams, this doesn't even require recall.

On the other hand, especially in the open book exams, I like to put exact matches in the stem. The stem is asking a question like, What does this mean? or What can you do with this? If you use textbook phrases you are helping the student figure out where to look for possible answers. In the open book exam, the multiple-choice quiz is a study aid. It is helpful to orient the student to something you want him or her to think about and read further about.

#### 4. **Keep the content of an item independent from content of other items on the test.**

Suppose you define a term in one question, then ask how to apply the concept in the next. The student who doesn't remember the definition will probably be able to figure it out after reading the next question (the application).

It's a common mistake to write an exam building forward without realizing the student can read and answer the questions in any order.

#### 5. **Avoid overly specific and overly general content.**

The concern with overly specific questions is they are usually trivial. Does it really matter what year Boris Beizer wrote his famous *Software Testing Techniques*? Isn't it more important to know what techniques he was writing about and why?

There are some simple facts we might expect all testers to know.

*For example, what's the largest ASCII code in the lower ASCII character set, and what character does it signify?*

The boundary cases for ASCII might be core testing knowledge, and thus fair game.

However, in most cases, facts are easy to look up in books or with an electronic search. Before asking for a memorized fact, ask why you would care whether the tester had memorized that fact.

The concern with overly general questions is they also are usually trivial—or wrong—or both.

- #### 6. **Avoid opinion-based items.** This is obvious, right? A question is unfair if it asks for an answer some experts would consider correct and rejects an answer other experts would consider correct.

But we have this problem in testing.

There are several mutually exclusive definitions of “test case.” There are strong professional differences about the value of a test script; the utility of the V-model; even whether the V-model was implicit in the waterfall model (read early papers); or a more recent innovation.

Most of the interesting definitions in our field convey opinions. Industry standards documents (like the IEEE’s) publish “standard” definitions, but these don’t make the controversies go away. Instead, these standards are widely ignored and people use the definitions they like anyway. Therefore if we ask a definitional question and expect the IEEE definition as the correct answer, we have the problem many experts won’t accept that as the correct definition.

What tactics can we use to deal with this?

*a. The qualified opinion.*

For example, consider this question:

“The definition of exploratory testing is...”

and this answer:

“a style of software testing emphasizing the personal freedom and responsibility of the individual tester to continually optimize the value of her work by treating test-related learning, test design, test execution, and test result interpretation as mutually supportive activities running in parallel throughout the project.”

Is the answer correct or not?

Some people think exploratory testing is bound tightly to test execution; they would reject the definition.

On the other hand, if we changed the question to,

“According to Cem Kaner, the definition of exploratory testing is...”

that long definition would be the right answer.

Qualification is easy in the BBST course because you can use the qualifier, “According to the lecture.” This is what the student is studying right now and the exam is open book, so the student can check the fact easily.

Qualification is more problematic for closed-book exams like certification exams. In this general case, can we fairly expect students to know who prefers which definition?

The problem is qualified opinions contain an often-trivial fact. Should we really expect students or certification-examinees to remember definitions in terms of who said what? Most of the time, I don’t think so.

### *b. Drawing implications*

For example, consider asking a question in one of these ways:

- If A means X, then if you do A, you should expect the following results.
- Imagine two definitions of A: X and Y. Which bugs would you be more likely to expose if you followed X in your testing and which if you followed Y?
- Which definition of X is most consistent with theory Y?

### **7. Avoid trick items.**

Haladyna (2004, p. 104) reports work by Roberts identifying several types of (intentional or unintentional) tricks in questions:

1. The item writer's intention appeared to deceive, confuse, or mislead test takers.
2. Trivial content was represented (which violates one of our item-writing guidelines).
3. The discrimination among options was too fine.
4. Items had window dressing irrelevant to the problem.
5. Multiple correct answers were possible.
6. Principles were presented in ways not learned, thus deceiving students.
7. Items were so highly ambiguous even the best students had no idea about the right answer.

Some other tricks undermining accurate assessment:

8. Put text in a distractor irrelevant to the question but exactly matching something from the assigned readings or the lecture.
9. Use complex logic (such as not (A and B) or a double negative)—unless the learning being tested involves complex logic.
10. Accurately qualify a widely discredited view: According to famous-person, the definition of X is Y, where Y is a definition no one accepts any more, but famous-person did in fact publish it.
11. In the set of items for a question, leave grammatical errors in all but the second-best choice. (Many people will guess that the grammatically-correct answer is the one intended to be graded as correct.)

Items requiring careful or critical reading are not necessarily trick items. This varies from field to field. For example, my experience with exams for lawyers and law students is they often require very precise reading. Testers are supposed to be able to do very fine-grained specification analysis.

Consider Example D:

D. *The key difference between black box testing and behavioral testing is:*

The options include several differences that students find plausible. Every time I give this question, some students choose a combination answer (such as (a) and (b)). This is a mistake because the question calls for “*The key difference,*” which cannot be a collection of two or more differences. Careful reading is an important skill for software testers and questions requiring precise reading are fair.

Consider Example E:

E. *What is the significance of the difference between black box and glass box tests?*

A very common mistake is to choose this answer:

*Glass box tests focus on the internals of the program whereas black box tests focus on the externally visible behavior.*

The answer is an accurate description of the difference, but it says nothing about the significance of the difference. Why would someone care about the difference? What is the consequence of the difference?

Over time, students learn to read questions like this more carefully. My underlying assumption is they also learn or apply, in the course of this, skills they need to read technical documents more carefully. Those are important skills for both software testing and legal analysis, so they are relevant to the courses motivating this tutorial. However, for other courses, questions like these might be less suitable.

On a high-stakes exam with students who had not had a lot of exam-preparation training, I would not ask these questions because I would not expect students to be prepared for them. On the high-stakes exam, the ambiguity of a wrong answer (might not know the content vs. might not have parsed the question carefully) could lead to the wrong conclusion about the student’s understanding of the material.

In contrast, in an instructional context in which we are trying to teach students to parse what they read with care, there is value in subjecting students to low-risk reminders to read with care.

## **Style And format concerns**

### **8. Format items vertically instead of horizontally.**

If the options are brief, you could format them as a list of items, one beside the next. However, these lists are often harder to read and much harder to keep formatting consistent across a series of questions.

### **9. Edit items for clarity.**

I improve the clarity of my test items in several ways:

- I ask colleagues to review the items.
- I co-teach with other instructors or with teaching assistants. They take the test and discuss the items with me.
- I encourage students to comment on test items. I use course management systems, so it is easy to set up a question-discussion forum for students to query, challenge or complain about test items.

In my experience, it is remarkable how many times an item can go through review (and improvement) and still be confusing.

#### **10. Edit items for correct grammar, punctuation, capitalization and spelling.**

It is common for instructors to write the stem and the correct choice together when they first write the question. The instructor words the distractors later, often less carefully and in some way inconsistent with the correct choice. These differences become undesirable clues about the right and wrong choices. Guard against this by re-reading all options as a final step.

#### **11. Simplify vocabulary so reading comprehension does not interfere with testing the content intended.**

There's not much point asking a question the examinee doesn't understand. If the examinee doesn't understand the technical terms (the words or concepts being tested), that's one thing. But if the examinee doesn't understand the other terms, the question simply won't reach the examinee's knowledge.

#### **12. Minimize reading time. Avoid excessive verbiage.**

Students whose first language is not English often have trouble with long questions.

#### **13. Proofread each item.**

Despite editorial care, remarkably many simple mistakes survive review or are introduced by mechanical error (e.g. cutting and pasting from a master list to the test itself).

### **Writing The Stem**

#### **14. Make the directions as clear as possible.**

Consider the following poorly-written question:

A program will accept a string of letters and digits into a password field. After it accepts the string, it asks for a comparison string, and on accepting a new input from the customer, it compares the first string against the second and rejects the password entry if the strings do not match.

1. There are 218340105584896 possible tests of 8-character passwords.
2. This method of password verification is subject to the risk of input-buffer overflow from an excessively long password entry

3. This specification is seriously ambiguous because it doesn't tell us whether the program accepts or rejects / filters non-alphanumeric characters into the second password entry

Let us pretend each of these answers could be correct. Which is correct for this question? Is the stem calling for an analysis of the number of possible tests, the risks of the method, the quality of the specification, or something else?

The stem should make clear whether the question is looking for the best single answer or potentially more than one, and whether the question is asking for facts, opinion, examples, reasoning, a calculation, or something else.

The reader should never have to read the set of possible answers to understand what the question is asking.

### 15. Make the stem as brief as possible.

This is part of the same recommendation as guideline #12 above. If the entire question should be as short as possible (#12), the stem should be as short as possible. However, "as short as possible" does not necessarily mean "short."

Here are some ideas for stems. Notice they may not be short, but they can be as brief as possible:

- The stem describes some aspect of the program in enough detail it is possible to compute the number of possible software test cases. The choices include the correct answer and three miscalculations.
- The stem describes a software development project in enough detail so the reader can see the possibility of doing a variety of tasks and the benefits they might offer to the project, and then asks the reader to prioritize some of the tasks. The choices are of the form, "X is more urgent than Y."
- The stem describes a potential error in the code, the types of visible symptoms this error could cause, and then calls for selection of the best test technique for exposing this type of bug.
- The stem quotes part of a product specification and then asks the reader to identify an ambiguity or to identify the most serious impact on test design an ambiguity like this might cause.
- The stem describes a test, a failure exposed by the test, a stakeholder (who has certain concerns) who receives failure reports and is involved in decisions about the budget for the testing effort, and asks which description of the failure would be most likely to be perceived as significant by that stakeholder. An even more interesting question (faced frequently by testers in the real world) is which description would be perceived as significant (credible, worth reading and worth fixing) by Stakeholder 1 and which other description would be more persuasive for Stakeholder 2. (Someone concerned with next months' sales might assess risk very differently from someone concerned with engineering / maintenance cost of a product line over a 5-year period. Both concerns are valid, but a good tester might raise different consequences of the same bug for the marketer than for the maintenance manager).

Another trend for writing test questions addressing higher-level learning is to write a very long and detailed stem followed by several multiple choice questions based on the same scenario.

Long questions like these are fair game (normal cases) in exams for lawyers, such as the Multistate Bar Exam. They are looked on with less favor in disciplines that don't demand the same level of skill in quickly reading and understanding complex blocks of text. Therefore, for our purposes, questions like these are probably less popular.

- They discriminate against people whose first language is not English and who are therefore slower readers of complex English text, or more generally against anyone who is a slow reader, because the examinee is pressed for time.
- They discriminate against people who understand the underlying material and who can reach an application of that material to real-life-complexity circumstances if they can work with a genuine situation or a realistic model (something they can appreciate in a hands-on way) but who are not so good at working from hypotheticals that abstract out all information the examiner considers inessential.
- They can cause a cascading failure. If the exam includes 10 questions based on one hypothetical and the examinee misunderstands that one hypothetical, he or she might underperform on all 10 questions.
- They can demoralize an examinee who lacks confidence/skill with this type of question, resulting in a bad score because the examinee stops trying to do well on the test.

However, in a low-stakes exam without time limits, those concerns are less important. The exam becomes practice for this type of analysis, rather than punishment for not being good at it.

In software testing, we are constantly trying to simplify a complex product into testable lines of attack. We ignore most aspects of the product and design tests for a few aspects, considered on their own or in combination with each other. We build explicit or implicit mental models of the product under test, and work from those to the tests, and from the tests back to the models to help us decide what the results should be. Therefore, drawing out the implications of a complex system is a survival skill for testers and questions of this style are entirely fair game in a low stakes exam designed to help the student learn rather than a high-stakes exam designed to create consequences based on an estimate of what the student knows.

#### **16. Place the main idea of the item in the stem, not in the choices.**

Some instructors adopt an intentional style in which the stem is extremely short and the question is largely defined in the choices.

The confusingly-written question in guideline #14 was an example of a case in which the reader can't tell what the question is asking until he reads the choices. In #14, there were two problems:

- the stem didn't state what question it was asking
- the choices themselves were fundamentally different, asking about different dimensions of the situation described in the stem rather than exploring one dimension with a correct

answer and distracting mistakes. The reader had to guess which dimension was of interest as well as deciding which answer might be correct.

Suppose we fix the second problem but still have a stem so short you don't know what the question is asking for until you read the options. That's the issue addressed here in guideline #16. For example, here is a better-written question not passing muster under Heuristic #16:

A software oracle:

- a) is defined this way.
- b) is defined this other way.
- c) is defined this other way.

The better question under this heuristic would be:

What is the definition of a software oracle?

- a) this definition
- b) this other definition
- c) this *other* other definition

As long as the options are strictly parallel (they are alternative answers to the same implied question), I don't think this is a serious a problem.

### 17. Avoid irrelevant information (window dressing).

Imagine a question includes several types of information in its description of some aspect of a computer program:

- details about how the program was written
- details about how the program will be used
- details about the stakeholders who are funding or authorizing the project
- details about ways in which products like this have failed before

All of these details might be relevant to the question, but probably most of them are not relevant to any particular question. For example, to calculate the theoretically-possible number of tests of part of the program doesn't require any knowledge of the stakeholders.

Information is irrelevant if you don't need it to determine which option is the correct answer *unless* the reader's ability to wade through irrelevant information of this type in order to get to the right underlying formula (or generally, the right approach to the problem) is part of what you are testing.

## 18. Avoid negative words in the stem.

Here are some examples of stems with negative structure:

- Which of the following is NOT a common definition of software testing?
- Do NOT assign a priority to a bug report EXCEPT under what condition(s)?
- You should generally compute code coverage statistics UNLESS:

For many people, these are harder than questions asking for the same information in a positively-phrased way.

Some evidence indicates there are cross-cultural variations. That is, these questions are harder for some people than others because of their original language training in childhood. Therefore, a bad result on this question might have more to do with the person's heritage than with their knowledge or skill in software testing.

However, the ability to parse complex logical expressions is an important skill for a tester. Programmers make lots of bugs when they write code to implement things like:

NOT (A OR B) AND C

So testers have to be able to design tests anticipating the bug and check whether the programmer made it.

It is not unfair to ask a tester to handle some complex negation if your intent is to test whether the tester can work with complex logical expressions. But if you think you are testing something else, and your question demands careful logic processing, a bad answer will not tell you whether the problem was the content you thought you were testing or the logic that you didn't consider.

Another problem is many people read negative sentences as positive. Their eyes glaze over when they see the NOT and they answer the question as if it were positive (Which of the following IS a common definition of software testing?) Unless you are testing for glazy eyes, you should make the negation as visible as possible. I use *ITALICIZED ALL-CAPS BOLDFACE* in the examples above.

## Writing the choices

### 19. Develop as many effective options as you can, but two or three may be sufficient.

Imagine an exam with 100 questions. All of them have two options. Someone who is randomly guessing should get 50% correct.

Now imagine an exam with 100 questions, all having four options. Under random guessing, the examinee should get 25%.

The issue of effectiveness is important because an answer that is not credible (not effective) won't gain any guesses. For example, imagine you saw this question on a quiz in a software testing course:

Green-box testing is:

- a) common at box manufacturers when they start preparing for the Energy Star rating.
- b) a rarely-taught style of software testing.
- c) a nickname used by automobile manufacturers for tests of hybrid cars.
- d) the name of Glen Myers' favorite book.

I suspect most students would pick choice (b) because (a) and (c) are irrelevant to the course and (d) is ridiculous. So even though there appear to be 4 choices, there is really only one effective one.

The number of choices is important, as is the correction-for-guessing penalty, if you are using multiple choice test results to assign a grade or assess the student's knowledge in a way with consequences for the student.

The number of choices is much less important if the quiz is for learning support rather than for assessment.

**20. Vary the location of the right answer according to the number of options. Assign the position of the right answer randomly.**

There's an old rule of thumb—if you don't know the answer, choose the second one in the list. Some inexperienced exam-writers tend to put the correct answer in the same location more often than if they varied location randomly. Experienced exam-writers use a randomization method to eliminate this bias.

**21. Place options in logical or numerical order.**

The example that Haladyna gives is numeric. If you're going to ask the examinee to choose the right number from a list of choices, then present them in order (like \$5, \$10, \$20, \$175) rather than randomly (like \$20, \$5, \$175, \$120).

In general, the idea underlying this heuristic is the reader is less likely to make an accidental error (one unrelated to their knowledge of the subject under test) if the choices are ordered and formatted in the way making them as easy as possible to read quickly and understand correctly.

**22. Keep options independent; choices should not be overlapping.**

Assuming standard productivity metrics, how long should it take to create and document 100 boundary tests of simple input fields?

- a) 1 hour or less
- b) 5 hours or less
- c) between 3 and 7 hours
- d) more than 6 hours

These choices overlap. If you think the correct answer is 4 hours, which one do you pick as the correct answer?

Here is a style of question that might look overlapping at first glance, but is not:

What is the best course of action in context C?

- a) Do X because of RY (the reason you should do Y).
- b) Do X because of RX (the reason you should do X, but a reason the examinee is expected to know is impossible in context C)
- c) Do Y because of RY (the correct answer)
- d) Do Y because of RX

Two options tell you to do Y (the right thing to do), but for different reasons. One reason is appropriate, the other is not. The test is checking not just whether the examinee can decide what to do but whether he or she can correctly identify why to do it. This can be a hard question, but if you expect a student to know why to do something, requiring them to pick the right reason as well as the right result is entirely fair.

### **23. Keep the options homogeneous in content and grammatical structure.**

Inexperienced exam writers often accidentally introduce variation between the correct answer and the others. For example, the correct answer:

- a) might be properly punctuated
- b) might start with a capital letter (or not start with one) unlike the others
- c) might end with a period or semi-colon (unlike the others)
- d) might be present tense (the others in past tense)
- e) might be active voice (the others in passive voice), etc.

The most common reason for this is some exam authors write a long list of stems and correct answers, then fill the rest of the questions in later.

The nasty, sneaky tricky exam writer knows test-wise students look for this type of variation and so introduces it deliberately:

Which is the right answer?

- a) this is the right answer
- b) This is the better-formatted second-best answer.
- c) this is a wrong answer
- d) this is another wrong answer

The test-savvy guesser will be drawn to answer 2 even though it is not the best answer.

Tricks are one way to keep down the scores of skilled guessers, but when students realize you're hitting them with trick questions, you can lose your credibility.

**24. Keep the length of options about the same.**

Which is the right answer?

- a) this is the wrong answer
- b) This is a really well-qualified and precisely-stated answer obviously more carefully considered than the others, so which one do you think is likely to be the right answer?
- c) this is a wrong answer
- d) this is another wrong answer

**25. "None of the above" should be used carefully.**

As Haladyna points out, there is a fair bit of controversy over this heuristic:

- If you use it, make sure you make it the correct answer sometimes and the incorrect answer sometimes
- Use it when you are trying to make the student actually solve a problem and assess the reasonableness of the possible solutions

**26. Avoid using "all of the above."**

The main argument against "all of the above" is if there is an obviously incorrect option, then "all of the above" is obviously incorrect too. Thus, test-wise examinees can reduce the number of plausible options easily. If you are trying to statistically model the difficulty of the exam, or create correction factors (a "correction" is a penalty for guessing the wrong answer), then including an option that is obviously easier than the others makes the modeling messier.

In BBST courses, we aren't "correcting" for guessing or estimating the difficulty of the exam. The goal is to get the student to read the material carefully and think about it. Difficulty of the question is more a function of difficulty of the source material than of the question.

Another argument is more general. Several authors, including Haladyna, Downing, & Rodriguez (2002), recommend against the complex question allowing more than one correct answer. This makes the question more difficult and more confusing for some students.

Even though some authors recommend against it, our question construction adopts a complex structure allowing selection of combinations (such as (a) and (b) as well as all of the above)—because other educational researchers consider this structure a useful vehicle for presenting difficult questions in a fair way. See for example Wongwiwatthanakit, Popovich & Bennett (2000) and their references.

Note in the BBST structure, the fact there is a combination choice or an all of the above choice is not informative because most questions have these.

There is a particular difficulty with this structure, however. Consider this question:

Choose the answer:

- a) This is the best choice
- b) This is a bad choice
- c) This is a reasonable answer, but (a) is far better—or this is really a subset of (a), weak on its own but it would be the only correct one if (a) was not present.
- d) (a) and (b)
- e) (a) and (c)
- f) (b) and (c)
- g) (a) and (b) and (c)

In this case, the student will have an unfairly hard time choosing between (a) and (e). We have created questions like this accidentally, but when we recognize this problem, we fix it in one of these ways:

Alternative 1. Choose the answer:

- a) This is the best choice
- b) This is a bad choice
- c) This is a reasonable answer, but (a) is far better—or this is really a subset of (a), weak on its own but it would be the only correct one if (a) was not present.
- d) This is a bad choice
- e) (a) and (b)
- f) (b) and (c)
- g) (a) and (b) and (c)

In this case, we make sure (a) and (c) is not available for selection or we give full points for both (a) and for (a) and (c).

Alternative 2. Choose the answer:

- a) This is the best choice
- b) This is a bad choice

- c) This is a reasonable answer, but (a) is far better—or this is really a subset of (a), weak on its own but it would be the only correct one if (a) was not present.
- d) This is a bad choice

In this case, no combinations are available for selection.

### **27. Avoid negative words such as not or except.**

This is the same advice, for the options, as we provided in guideline #18 for the stem, for the same reasons.

### **28. Avoid options giving clues to the right answer.**

Some of the mistakes mentioned by Haladyna, Downing, & Rodriguez (2002) are:

- Broad assertions that are probably incorrect, such as always, never, must, and absolutely;
- Choices sounding like words in the stem, or words sounding like the correct answer;
- Grammatical inconsistencies, length inconsistencies, formatting inconsistencies, extra qualifiers or other obvious inconsistencies pointing to the correct choice;
- Pairs or triplet options pointing to the correct choice. For example, if every combination option includes (a) (such as (a) and (b) and (a) and (c) and all of the above) then it is pretty obvious that (a) is probably correct and any answer excluding (a) (such as (b)) is probably wrong.

### **29. Make all distractors plausible.**

This is important for two reasons:

- If you are trying to do statistical modeling of the difficulty of the exam (“There are 4 choices in this question, therefore there is only a 25% chance of a correct answer from guessing”) then implausible distractors invalidate the model because few people will make this guess. However, in our tests, we aren’t doing this modeling so this doesn’t matter.
- An implausible choice is a waste of space and time. If no one will make this choice, it is not really a choice. It is just extra text to read.

One reason an implausible distractor is sometimes valuable is sometimes students do pick obviously unreasonable distractors. In my experience, this happens when the student is:

- ill, and not able to concentrate;
- falling asleep, and not able to concentrate;
- on drugs or drunk, and not able to concentrate or temporarily afflicted with a very strange sense of humor;

- having serious difficulty understanding the questions (English is a second or third language);
- out of time and guessing randomly in order to “complete” the quiz; or
- copying answers (in a typical classroom test, looking at someone else’s exam a few feet away) and making a copying mistake.

I rarely design test questions with the goal of including blatantly implausible options, but a few slip by anyway.

I didn’t expect these to be very interesting in the BBST courses because I expected no one to choose them. However, some students consistently score terribly on the multiple-choice quizzes. When I have reviewed their answering patterns, I’ve sometimes seen many implausible-answer selections. This suggests a serious problem: some students have serious language-comprehension problems. Some lack the most fundamental understanding of course materials. Some are emotionally blocked when they deal with formal exams. These problems call for different types of interventions than simply telling the student the right answer.

### **30. Use typical errors of students when you write distractors.**

Suppose you gave a fill-in-the-blank question to students. In this case, for example, you might ask the student to tell you the definition rather than giving students a list of definitions to choose from. If you gathered a large enough sample of fill-in-the-blank answers, you would know what the most common mistakes are. Then, when you create the multiple-choice question, you can include these as distractors. The students who don’t know the right answer are likely to fall into one of the frequently-used wrong answers.

I rarely have the opportunity to build questions this way, but the principle carries over. When I write a question, I ask myself, “If someone was going to make a mistake, what mistake would they make?”

### **31. Use humor if it is compatible with the teacher; avoid humor in a high-stakes test.**

Robert F. McMorris, Roger A. Boothroyd, & Debra J. Pietrangelo (1997) and Powers (2005) advocate for carefully controlled use of humor in tests and quizzes. I think this is reasonable in face-to-face instruction, once the students have come to know the instructor (or in a low-stakes test while students are getting to know the instructor). However, in a test involving students from several cultures, who have varying degrees of experience with the English language, I think humor in a quiz can create more confusion and irritation than it is worth.

## References and resources

There's a lot of excellent advice on writing multiple-choice test questions. Here are a few sources I've found particularly helpful:

1. National Conference of Bar Examiners, *Multistate Bar Examination Study Aids and Information Guides*.
2. Steven J. Burton, Richard R. Sudweeks, Paul F. Merrill, Bud Wood, *How to Prepare Better Multiple-Choice Test Items: Guidelines for University Faculty*, Brigham Young University Testing Services, 1991.
3. Thomas M. Haladyna, *Writing Test Items to Evaluate Higher Order Thinking*, Allyn & Bacon, 1997.
4. Thomas M. Haladyna, *Developing and Validating Multiple-Choice Test Items*, 3rd Edition, Lawrence Erlbaum, 2004.
5. Thomas M. Haladyna, Steven M. Downing, Michael C. Rodriguez, A Review of Multiple-Choice Item-Writing Guidelines for Classroom Assessment, *Applied Measurement in Education*, 15(3), 309-334, 2002.
6. Robert F. McMorris, Roger A. Boothroyd, & Debra J. Pietrangelo, Humor in Educational Testing: A Review and Discussion, *Applied Measurement in Education*, 10(3), 269-297, 1997.
7. Ted Powers, Engaging Students with Humor, *Association for Psychological Science Observer*, 18(12), December 2005.
8. The Royal College of Physicians and Surgeons of Canada, *Developing Multiple Choice Questions for the RCPSC Certification Examinations*.
9. Supakit Wongwiwatthanakit, Nicholas G. Popovich, & Deborah E. Bennett, Assessing pharmacy student knowledge on multiple-choice examinations using partial-credit scoring of combined-response multiple-choice items, *American Journal of Pharmaceutical Education*, Spring, 2000.
10. Bibliography and links on *Multiple Choice Questions* at <http://ahe.cqu.edu.au/MCQ.htm>

# SECTION 2

## TEACHING THE FOUNDATIONS OF SOFTWARE TESTING COURSE

## Preface to section 2

This section of the *Instructor's Manual* is about teaching *BBST Foundations of Software Testing*, the first four-week course in the three-course BBST series. Throughout this section, we write to a general audience about things they may decide to do to customize the course. If you are teaching for an organization, you may not have the privileges or the freedom to make these changes. If that is the case for you, please speak to the appropriate personnel about any changes you wish to make.

### Organization of this section

#### **Chapter 7: Preparing to teach the BBST Foundations course**

Even if you have the lectures on tape and have developed homework, quizzes and exams, online courses require a lot of preparation before the official start date. In our experience (and the experience of countless colleagues), thorough preparation before the start of class is important for online courses and online courses are more likely to fail badly in the hands of a poorly organized instructor.

Chapter 7 lays out the tasks we urge you to complete before the first day of class. For discussion focused on how and why to do tasks like these, please see Section One of this manual.

#### **Chapter 8: Teaching the BBST Foundations course**

We divide the course into eight lessons, each spanning half-week segments. Each segment includes a weekend day and some weekdays: (a) Sunday to Wednesday and (b) Thursday to Saturday. Many students do most coursework on the weekend; this schedule gives them a weekend day for every lesson.

Tasks are due on the last day of the segment. Most tasks start the first day of the lesson and some tasks run two or more lessons. As lessons complete, give students feedback on their performance, alert them to what's coming in the next lesson, and assist those having trouble making the progress needed to move into the next lesson.

Chapter 8 lays out the instructor tasks on lesson-by-lesson timelines. The chapter has sections for each lesson, ongoing tasks, and end-of-course tasks. Be certain to read each section of the chapter. Please see Section One of this guide for more information about how or why these tasks are important.



## Chapter 7

# Preparing to Teach the BBST Foundations of Software Testing Course

## Set up your online classroom

Good teachers prepare their classrooms before students arrive. Commercial instructors make sure technical equipment is working, arrange for lunch, and familiarize themselves with the locations of restrooms and water fountains so they can keep attendees comfortable. Kindergarten teachers make many of the same arrangements and also decorate bulletin boards, set up play areas, and make nametags for the little ones. In their own ways, all of these instructors are making their classrooms a welcoming and comfortable space for the students.

Similarly, online instructors have a set of tasks to prepare their online classrooms for their students. This chapter describes these tasks.

## Review course structure, policies and content

Familiarize yourself with the course objectives and instructional strategies. The resources available to the students include videos, readings, grading guides, and quizzes with feedback. You can find additional instructor-support materials at [testingeducation.org/BBST](http://testingeducation.org/BBST). Be sure to review these resources as you prepare to teach your own class. If you have not watched them recently, view the videos. Take the quizzes. If you know other instructors, consult with them as you have questions—to do this effectively, you will have to prepare for the course in advance. Give yourself enough time to discover you are confused, to ask questions, to get answers and to work with those answers until you can deal appropriately with that part of the course.

The quizzes, in particular, bring grief to underprepared instructors. The questions have been carefully written and polished over time. They are intentionally difficult. Many students are accustomed to easy quizzes and expect to get high grades with minimal study. Our quizzes are open-book, but it is common for students to score 40% to 70% in their first few BBST quizzes because they have to develop better test-taking skills (such as, more careful reading). Students who are used to getting A's (90% in the United States) may be shocked by these low grades. Some will consider dropping the course. Others will protest, sometimes quite vigorously. If you are not prepared to respond knowledgeably and confidently, you will lose credibility with your students.

To prepare for this, you must work through the quizzes yourself, in advance. Question them. If you cannot defend the answer and the analysis in one of the quiz questions, drop it from your course before students see it. Putting yourself into a position of having to apologize for the questions or join the students in disagreeing with them will reduce the credibility of the course, reduce your credibility, and diminish the value of the course to your students. Similarly, it is important to understand the course assignments; what distinguishes strong from weak performance; and the exam study guide questions. What you can't work with, replace.

## Review and modify the course

If you are teaching for an organization, you may receive a “copy” of the course to use for your class. Once you have access to your course, familiarize yourself with everything in the course. It is particularly important to check all links in the course to be sure none have broken as the Internet continues to grow and evolve. Fix any broken links. Delete any content you don’t want to use for the class you will be teaching and add content as appropriate.

The course you receive was likely created as a copy of an earlier course or from a course backup. You may find remnants of the earlier course that need to be removed. In particular, pay attention to the following areas:

- List of students—remove any that are not in your section of the course.
- Discussion forums—Your set of discussions will have some generic posts describing tasks or policies. You may need to edit some of these to fit your circumstances. The forums may also have posts submitted by previous students and non-generic instructor responses. Delete these.

If you are teaching an AST-approved version of this course, you must not delete content, significantly modify the assignments, or substitute examination questions without prior AST approval. Contact the chair of the AST’s Education SIG to discuss any changes you wish to make.

If you are developing a course for the first time, you can acquire most resources you will need from <http://www.testingeducation.org/BBST> or the National Science Digital Library at <http://www.nsd.org>.

## Determine your policies

Setting and communicating your policies is important to help students know what you expect of them. *Moodle* users can take advantage of *Moodle’s* Choices capability to share policies. Publish the policy as a Yes/No Choice and ask students to respond. If your Course Management System doesn’t have a similar capability, consider posting your policy in a discussion forum and ask students to reply to your post indicating their agreement. The students’ responses document you have provided them with the policy information. Once all students have agreed to the policies, you can hide the forums or choices section to keep your online classroom uncluttered. Do not delete the responses in the event you may need the documentation later.

Consider sharing some or all of the following types of policies with your students and posting them before the course starts. See Chapter 2 for a brief discussion of these policies:

- Late work policy
- Academic integrity policy
- Acceptable use policy
- Privacy policy

## Set up discussion forums

Class discussions are more easily organized if you have a variety of discussion forums to handle them in an organized way. Some discussion forums will focus on specific course content or assignments. Some will support students' study efforts by providing a place to ask for help or talk about course content in an ungraded format. Others will provide workspace for groups. Still other discussion forums provide opportunities to socialize. In *BBST Foundations of Black Box Software Testing*, start with the following discussion forums:

1. Course Announcements
2. Help! Forum
3. Hallway Hangout (A social forum)
4. Exam Cram Forum (Ungraded)
5. Lesson 1: Meet & Greet (A social forum)
6. Lesson 2: Describe the Role of the Test Group
7. Lesson 3: Oracles Orientation
8. Lesson 4: Integer Square Root Function
9. Lesson 5: Exam Coaching Lab
10. Mission of Testing Group 1: Early Development
11. Mission of Testing Group 2: Late Development
12. Mission of Testing Group 3: Custom Software
13. Mission of Testing Group 4: Medical Software
14. Mission of Testing Group 5: Computer Game
15. Oracle Heuristics (one forum for each of 5 groups)
16. Oracle Heuristics Phase 3: Product or Feature's Purpose
17. Oracle Heuristics Phase 3: User Expectations
18. Oracle Heuristics Phase 3: History
19. Oracle Heuristics Phase 3: Within Product
20. Oracle Heuristics Phase 3: Comparable Products
21. Quiz Q&A Discussion forums (one for each of 6 quizzes. Hidden at start of class)

## Working with co-instructors

If you plan to work with one or more co-instructors, spend some time working out details about how the instructor role will be divided among the instructors. Designate a lead instructor and use a task-tracking list to coordinate the tasks. At the time of this writing, instructors for the Association for Software Testing used *Google's* document sharing service for this. Remember that timely feedback is critical—particularly in short courses.

## Publish the course task list

Providing students with a single document listing course tasks and deadlines helps them manage their time and work load. We have provided a sample task list for each class in the Appendices of this book. Create a similar document for your course and post it online.

Depending on the course management system (CMS) you are using, you may be able to build the course schedule using a CMS tool. For example, if you use *Moodle 1.9* (and newer) you can install an extra module called *Progress Tracker* that allows students to check off tasks they've completed. Visit [Moodle.org](http://Moodle.org) for more information on *Progress Tracker*.

## Quizzes

Most course management systems allow you to designate start and end dates for quizzes. Once your course task list is updated with the appropriate dates, set quiz dates in the CMS to correspond with the published dates.

We recommend having all quizzes open at the start of class so students can work ahead if their personal and professional schedules require it. Set the quiz close dates to enforce deadlines posted in the course materials.

We provide an opportunity for students to discuss quiz questions after the quiz has closed. Prepare the quiz discussion forum for each quiz by populating it with quiz questions and answers—one thread per question. In the *BBST Foundations* course, we set each forum to open once the quiz ends or open the quiz discussion forums manually. Some instructors follow the same policy for *BBST Test Design*. Others (including Kaner) open all forums at the start of the *BBST Test Design* course, so students can post comments on a quiz as soon as they finish the quiz. If you manage the quiz forums this way, be sure to remind students to stay out of a quiz forum until they have taken the quiz.

## Prepare for grading

Tracking student progress is an important instructor responsibility. Most course management systems have a gradebook function to streamline this task. Alternatively, you can set up a spreadsheet. Be sure to set up grading space for each graded assignment and anything else you'd like to track. If you don't want to use the traditional A, B, C, D, and F letter grades, think about what you can do as an alternative. You can set up customized grading scales. Possible alternatives include:

- Fail / Pass
- Incomplete / Complete

- No Credit / Credit
- Not Done / Weak / Acceptable / Good / Excellent
- Nothing submitted / Substantially incomplete / Unresponsive / Insufficient / Weak / Adequate / Good / Excellent / Instructor quality (*This is the scale Kaner uses.*)

For professional development classes, we prefer to avoid using *Fail* because we recognize students are often pulled away from the class for more important or urgent projects at work. Instead, we prefer to report the student performance as *Incomplete*.

*Tracking progress* does not necessarily require a detailed evaluation of each submitted piece of work. For example, in a professional development course, it is usually enough to note whether the student submitted a lab and if so, whether it was adequate. This will tell you whether the student is keeping up with the course. You might look at individual pieces of work in much greater detail, but you might have time only to look in detail at a few students' work each week.

This inconsistency will not work in an academic course. University students reasonably expect every piece of their work will be formally graded. Academic grades are high-stakes. Access to scholarships and future jobs can depend on a transcript (the record of grades). But in a professional development course, the student is under no such pressure. The student needs feedback, not a grade. You have to manage your time in a way to give students sufficient feedback. On the professional development schedule and rate of pay, you cannot afford to waste hours arguing with professional development students about whether a piece of work deserved a "C" or a "B". Changing the letter-grade will not change the quality of the work submitted. Give them the feedback about their quality you believe they will find most useful.

If you use a Course Management System's gradebook, you can set it to show the students their grades. We do this as a matter of routine in academic courses. However, in professional development courses, we treat the gradebook or the grading spreadsheet as a place for private notes for the instructor.

## **Post your introduction**

Just as commercial instructors and Kindergarten teachers arrive early to welcome their students, online instructors can post a friendly introduction in the *Meet & Greet* forum. In it, include your name, location, employment, hobbies or interests, and a digital photo. Try to craft a message conveying your professional credentials but does so in a way that lets some of your personality shine through. Scott Barber did this using a bit of self-deprecating humor in his:

## **SUBJECT** Scott Barber's Introduction

My typical "short" bio says...

*Scott Barber is the CTO of PerfTestPlus, Vice President & Executive Director of the Association for Software Testing (AST), co-founder of the Workshop on Performance and Reliability (WOPR) and co-author of Performance Testing Guidance for Web Applications. A recognized expert in performance testing and analysis, he combines experience and a passion for solving performance problems with a scientific approach to produce accurate results.*

*Mr. Barber is an international keynote speaker, trainer, consultant, writer of articles for a variety of publications.*

All I have to say to that is "Wow! What a geek!!!" What I'd like it to say is something like "Scott is pretty good at testing and teaching testing—And he sure has a lot of fun doing both of those things." So far, no one who has asked for a short bio has been interested in that one.

I live in FL, but I travel a lot, so I'm not even sure what time zone I'm in right now, let alone what time zone I'll be in by the time anyone reads this. I do know that I've very recently brought my day performance testing family of training workshops (Performance Testing Software Systems: A Heuristic Approach) to market, and spending every spare moment I can find with my sons Nicholas and Taylor (8 & 5).

I'm looking forward to working with everyone here... some of you for the first time, others for the first time in this format.

Be sure to return to the *Meet & Greet* forum to greet students as they join the class and post their introductions.

## **Make a first impression**

Depending on your individual circumstances and your access to student contact information, we recommend sending at least one—and possibly two—messages before the course starts. In your message, try to convey a warm welcome to students as well as the logistical information (web address, user name, enrollment keys or passwords, etc.) students need to begin the course.

We also find it useful to set students' expectations on workload and remind them about routine housekeeping matters, such as updating antivirus software, downloading appropriate media players, updating system software, and paying attention to a backup strategy for course work. Be sure to coordinate messages with any course registration correspondence to avoid duplication.

## **Set the rhythm of the course**

Our professional development courses are designed keeping the typical work day / weekend day structure in mind. Each week has two lessons. The first lesson runs from Sunday to Wednesday and the second from Thursday to Saturday. Each lesson includes a weekend day,

so students who can only work on the weekend can complete the lesson. You can reinforce this segmentation with well-timed messages.

Generally speaking, the student week looks like this:

**Sunday through Wednesday**—Students work on a lesson with their initial posting due no later than Wednesday.

**Thursday to Saturday**—Students work on another lesson that frequently requires them to review and respond to other students. If assigned, students complete one or more peer reviews of work submitted in the first part of the week.

You might make some posts during this period, but the goal is to acknowledge and encourage progress, rather than to make a substantial contribution. Most instructor feedback during the exercises is in the form of directing questions rather than critiquing or answering the exercise question. The course is designed so much of the student's learning comes from discussing course content with other students, giving and receiving peer review, and attempting quizzes and assignments. Reading and receiving instructor feedback also contributes to student learning. Often instructor feedback is given to the group as a whole and not always to specific individuals. The online course is not individual tutoring.

The instructor's week proceeds as described here:

Log in to the course every day. Be sure to check the *Help!* forum and handle any problems blocking students from making progress. Alternatively, you might prefer to subscribe to all postings in the *Help!* forum so messages come directly to an email account you read frequently. Most course management systems have this capability.

Other than *Help!*, there is no need to respond to students each day—or to spend a lot of time reading the daily posts. However, a daily login allows you to monitor student progress and intervene if a discussion thread goes off track.

We recommend you make at least two posts each week (*Highlights of the Coming Week* and *Weekly Feedback*) to maintain a sense of instructor presence in the minds of the students and reinforce the rhythm of the class. These posts should go in the course announcements forum with all students subscribed via email.

## Highlights of the coming week

Posted on Saturday or Sunday, this instructor posting gives students an overview of the coming week and highlights particularly interesting or difficult areas about the content they will encounter in the coming week. If the workload for the coming week is a bit heavier than usual, this post is a good opportunity to warn students of that fact. Making this post also gives you a chance to remind students how to correct persistent problems you have noticed in previous weeks or tell students what aspects of their performance you will be watching closely. You may also share additional resources especially relevant to student efforts for the coming week.

## Weekly feedback

The weekly feedback post is exactly what it sounds like and should generally be posted on Sunday or Monday. This is sometimes combined with the *Highlights of the Coming Week* in a single posting. In this post, you can point out broad themes you identified over the course of the past week; draw attention to individual contributions that are particularly insightful or noteworthy; or invite further participation in an especially engaging thread. Use this post to identify and correct any broadly held misunderstandings you've noticed (but never in a way that would embarrass individual students). To correct misunderstandings, you can ask students to review a particular chunk of course content; point them to additional resources; or create another resource for them. If at all possible, start and end this post on a positive note.

In some cases, you may choose to address an individual's substandard work in a private email.

## Pre-course checklist

- Set up a private discussion group / mailing list with your co-instructors.  
There are several free alternatives to accomplish this.
- Decide how instructors will share course tasks.
- Check to make sure all links in the course are working.
- Check course content for updates and modifications.
- Finalize and post course policies.
- Accept the course policies yourself.
- Set up discussion forums for the course.
- Confirm existing posts (such as those in the *Exam Cram* forum) display in the student view.
- Set up gradebook items.
- Update course task list with deadlines.
- Post updated course task list.
- Update quiz start/end dates.
- Post introductions from all instructors.
- (Optional) Send welcome message to all students introducing yourself and providing log-in instructions.
- (Optional) Send pre-course reminder.
- (Optional) Schedule final exam if necessary.

## Chapter 8

# Teaching the *BBST Foundations of Software Testing* Course

This chapter details the learning objectives for the *BBST Foundations of Software Testing* course and offers guidance on facilitating the learning activities.

For each lesson, we provide a summarizing table of tasks and a more detailed description of the activities you will facilitate. The table serves as an overview for the lesson and as a checklist to help you ensure all tasks are completed on time. You may need to modify the pace. We anticipate the task lists will be useful but will require modification for your particular situation.

## Learning objectives for *BBST Foundations*

The fundamental objective of *BBST Foundations* is to prepare students for the next courses in the BBST series. That preparation includes learning the content and developing skills for succeeding in courses of this type.

In terms of content, many students:

- see testing as a simple code-focused activity (programmers running simple tests of their own code) or fairly simple, repetitive, paperwork-intensive work;
- believe the field is well-understood, with broad agreement on terminology, techniques and best practices;
- lack basic training in programming and discrete mathematics and, because of this, cannot understand core testing concepts like “rounding error” and “coverage.” At university, we encounter many Computer Science students who have studied these concepts but do not know how to apply classroom learning to testing.

In terms of learning skills, *BBST Foundations* is an online course. We expect a typical class to include students from all over the world, including many cultures and across many time zones.

For many professional-development students, this is:

- their first online course.
- their first experience with multinational group projects.
- the first course in several years with homework and assessment.

Thus, along with introducing students to key testing ideas, this course has to help many students develop basic skills and work through counterproductive preconceptions. This course is not for everyone. Students don’t have to change their fundamental views to succeed in this course but they must suspend contrary views effectively enough to let themselves understand

what the course teaches. Students who cannot do this are unlikely to grasp key points in later BBST courses.

Course Objectives		Anderson/Krathwohl (2001) level
1	Familiar with basic terminology and how it will be used in the BBST courses.	Understand
2	Aware of honest and rational controversy over definitions of common concepts and terms in the field.	Understand
3	Understand there are legitimately different missions for a testing effort. Understand selection of mission depends on contextual factors. Able to evaluate relatively simple situations that exhibiting strongly different contexts in terms of their implication for testing strategies.	Understand, simple evaluation
4	Understand basic facts of discrete mathematics, data storage and manipulation in computing, to the extent needed to understand testing concepts.	Understand, rudimentary application
5	Understand the concept of oracles well enough to apply multiple oracle heuristics to their own work and explain what they are doing and why.	Understand and apply
6	Understand complete testing is impossible. Improve ability to estimate and explain the size of a testing problem.	Understand, rudimentary application
7	Familiar with the concept of measurement dysfunction.	Understand
8	Improve ability to adjust focus from narrow technical problems (such as analysis of a single function or parameter) through broader, context-rich problems.	Analyze
9	Improve online study skills, such as learning more from video lectures and associated readings.	Apply
10	Improve online course participation skills, including online discussion and working together online in groups.	Apply
11	Increased comfort with formative assessment.	Apply
12	Improve critical reading skills.	Analyze and/or evaluate
13	Improve writing/written communication	May illustrate knowledge at each of the dimensions
Anderson, L. W., & Krathwohl, D. R. (Eds.). (2000). <i>A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of educational objectives: Complete edition</i> , New York: Longman.		



# Lesson 1 Tasks

	<b>Course Policies</b>	<b>Welcome and What time is it? Posts</b>	<b>Meet &amp; Greet</b>	<b>Course Orientation Review</b>	
<b>Preparation</b>	Posted before course.  Removed from main menu page after 2 or 3 days.	None	Discussion forums and instructor introductions posted before course start	None	
<b>Description</b>	Students ask questions about and agree to policies.	Sample announcements available in Appendix F	Students introduce themselves and respond to others.  Instructor(s) greet(s) all.	Course orientation web pages and video	
<b>Outcomes</b>	Students understand expectations.  Unenroll or otherwise follow up with students who fail to agree early in the week.	Information only	Students get acquainted with instructor and students. Creates a welcoming online space.	Students become familiar with course objectives and background	
<b>Tools</b>	Moodle Choices or course discussion forums	Course announcements	Course discussion forums	Web pages in course management system	
<b>Core readings</b>	Policies	None	None	Orientation pages	
<b>Communication</b>	Email non-responders urging them to respond. Notify those who have been removed from the course.	None beyond publishing these announcements. .	None beyond instructor responses to individual introductions	None	

	<b>Quiz for Lecture 1</b>	<b>Exam Cram Forum</b>	<b>Instructor Feedback</b>	
	Ensure quiz and video are available to students and set to close at the deadline. Take the quiz if you have not already.	Post questions for study guide if necessary and enable forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students complete quizzes while watching videos.	Students collaborate to prepare for final exam.	Lesson feedback from instructor	<b>Description</b>
	Increased understanding	Students draft answers for study guide questions.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Quiz, videos, slide sets	Course discussion forum	Course announcements and email	<b>Tools</b>
	See course	None	None	<b>Core readings</b>
	Encourage participation. Field questions.	Encourage participation in <i>Exam Cram</i> forum.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 1

# Overview

Lesson 1 introduces students to the course. The students are getting to meet each other and discover the mechanics of an online course. In terms of content, Lesson 1 is intentionally light—focusing on definitions of key terms we will use in the course.

Even though Lesson 1's content is limited, some students will spend a remarkable amount of time and invest a remarkable level of emotional energy in this part of the course. How you manage the discussions arising out of the Lesson 1 material will have a significant impact on your credibility and authority for the rest of the course.

Testing terminology is not uniform. One reason is the underlying philosophy of testing, is reflected in the language is not uniform. For example, some people think a test is not a test unless there is an oracle (an expected result telling you whether the test passed or failed). Testing without an expected result is, to them, incompetent. For them, it is natural to include an expected result as part of the definition of "test." However, other testers consider exploration of the product (which includes testing without knowledge of what will happen) to be quite useful. And others think there are many possible oracles for the same test and the skilled tester will focus on different potential errors (consider different oracles) at different times. To these people, the choice of oracle is a separate thing from the basic idea of a test. No definition of "test" will satisfy all three groups.

We do not attempt to satisfy everyone. Instead, we explicitly define the terms we will use in the course and expect students to understand what we mean when we use those words. Our terminology is eclectic. Most students will agree with at least some of our definitions and disagree with a few others.

Some students argue a definition is *wrong* and demand we correct it. They argue the multiple-choice questions are unfair because the questions take the lecture's definitions as correct even though (in the opinion of this student) the lecture's definitions are wrong. These arguments often dominate student discussions in Lessons 1 and 2. We recommend you deal with these objections patiently but firmly.

The course does not demand any student adopt our definitions, or viewpoints, as their own. However, the course *does* demand students make the effort needed to understand what the course is teaching.

The skill and tolerance needed to listen to someone in a way to understand what they *mean* by the words they use, is part of a broader communication skill we see as essential to good testing. Some testers get lost in their own opinion of what a product should do, or how it should behave, or how it should be described, and they never come to an understanding of the developers' intention or design. We think this leads to weak testing.

You may need to have private discussions with one or two students to help them get past an expectation technical words have One True Meaning.

## 1.0: Administrative tasks

### 1.0.1 Course policy agreements

At the beginning of each course, students should read and agree to the policies identified prior to the start of the course. Immediately after the course begins, monitor students' responses to the policies and send a reminder of this important obligation. Set a close deadline for students to complete this task.

Adhere to your institution's guidelines for dealing with students who do not agree to the policies. The Association for Software Testing requires instructors to remove any enrollees who have not agreed to the policies from the *Moodle* course shortly after the deadline passes. Be certain to notify students of any actions and, if appropriate, invite them to return for a course at a later time.

The timing of policy enforcement is important as it lays the groundwork and expectations throughout the rest of the course. Once the time for policy agreements has expired, edit the front page to remove the course-agreements blocks. Those policies and documentation of students' agreements to them will still be available in the lefthand navigation bar if you are using *Moodle*.

Here is a sample notification:

**SUBJECT** <insert course name here> Course Policies

**MESSAGE**

I see you're registered in our course. Welcome!

This note is a reminder we have course policies you **MUST** agree to, to participate in any BBST course. Please log into the course, review these policies, and indicate your agreement right away. If you have questions or concerns, please contact <<THE INSTRUCTOR>>, <<EMAIL ADDRESS>>.

The students who join this course participate with the expectation everyone else in the course has agreed to these policies. If you do not accept them by Tuesday of the first week of class, we must suspend your access to the course.

Cordially,

### 1.0.2 Welcome

Students taking their first BBST class are often surprised by how much they interact with their peers instead of direct interaction with their instructors. In this message, we try to set their expectations for the *BBST Foundations* course.

**SUBJECT** What you can expect in *BBST Foundations*

**MESSAGE**

Some of you are experienced online students and others are taking their first ever online course. As we begin this course, I want to take a few moments to set your expectations about how the course will unfold—especially as it relates to the feedback and interactions you will receive from your instructors and peers.

Keep the following things in mind to get the most out of the class:

- Be an active manager of your own learning experience. Spend time with the course resources we provide to understand them. Ask questions when you need help. Use the appropriate forum for most questions. Contact the instructor privately if your question is of a personal nature and inappropriate for public discussion. Don't wait for the instructor to notice whether or not you are confused or unclear about something.
- Read the classwide feedback the instructor provides. Compare your answers and insights to the classwide feedback. Where did you excel and where did you fall short? Did you miss anything entirely? Instructors put most of their feedback in the classwide announcements so their comments don't get buried in an individual discussion thread where you and your classmates are more likely to miss them. Don't be surprised or offended if you don't get individual feedback from the instructor.
- Your classmates bring experiences and perspectives from a range of different development contexts. Expect to read their contributions and interact with them throughout the course. Ask them about things you don't understand and probe carefully to learn more about perspectives differing from yours.
- Peer review and feedback gives you a way to switch roles from creator to evaluator, which will help you more objectively evaluate your own work. Giving constructive critiques—ones the people we work with can appreciate and benefit from—is a key skill for software testers. This is an excellent opportunity to practice and improve that skill.
- Peer review and feedback can help you see opportunities to improve your own work, by seeing patterns of problems in the work of other students.
- Peer review provides feedback to students from several sources, rather than from one instructor. Peer feedback is more credible to some students than instructor feedback.
- Most important, careful evaluation of the questions and comments of other students gives you another type of opportunity to step back from your work and reflect on what the course is teaching.

### 1.0.3 What time is it?

One of the many challenges in online courses (and off-shore development) is time zone diversity. We use a post for this, titled *What time is it?* The full text of that post is located in the *Fieldstones* appendix. You should post one like it early in your course if your students are likely to have time zone challenges

## 1.1 Meet and greet

### Preparation

Prepare for the *Meet and Greet* activity by completing the following list of tasks:

- Set up a new discussion forum titled *Meet and Greet*.
- Post your introduction. (Co-instructors, if any, do the same.) If you can, attach a digital photo, audio, or video file to your post. (Co-instructors, if any, should do the same.) Adding multimedia elements to your introduction gives students a richer picture of who you are and introduces them to the possibilities of multimedia communication.
- Optionally, use the course announcement tool to remind students of this activity, tell them how to participate, remind them of the deadline, and encourage participation.

### Activity description

Students introduce themselves and respond to each other's posts. Typically, instructors ask students to include information about their experience with the class topic and encourage them to share information about hobbies and outside interests. Invite students to include pictures of themselves if they would like.

### Purpose

Some students will feel more connected to their classmates after they have seen a picture and come to know their classmates better.

### Tools

Course discussion forum. Your course management system (CMS) may call these discussion boards or threaded discussion groups. Throughout this book, we will refer to these as course discussion forums.

### Core readings

None

### Facilitation roles and strategies

Although an instructor should not respond to every post throughout the class, try to make each and every student who offers an introduction feel welcome by posting a response to their introduction.

If you notice students spending too much time in *Meet and greet* (at the expense of course content), you may need to remind them to practice good time management skills. This may become an issue at the end of the first week and beginning of the second.

### **Variations of the activity**

There are many icebreaker activities published in books and on the web. Many of them can be modified to work in an online environment.

## **1.2 Course Orientation**

### **Preparation**

Ensure links to the Orientation web pages and video are working.

Review orientation materials so you can answer student questions.

### **Activity description**

Students read orientation materials presented in the course and watch the Orientation video.

### **Purpose**

To acquaint students with the testing philosophy espoused by BBST and set their expectations for the course.

### **Tools**

Course management system

### **Core readings**

Orientation materials included in course

### **Facilitation roles and strategies**

Be prepared to answer student's questions about the information presented in the Orientation materials.

### **Variations of the activity**

Some instructors post a Scavenger Hunt with a series of questions and challenges for students to complete. Such activities can be ungraded, graded, or for extra credit.

## **1.3 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this chapter.

## **1.4 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate

## References and resources

The key references and resources for each Lesson are built into the course. To supplement these, we are writing a more comprehensive bibliography, similar to the one we published for *BBST Test Design* (Cem Kaner (2011), *A new course on test design: The bibliography*. <http://kaner.com/p=100>). We hope to publish by the end of 2012.

We will add resources on a lesson-by-lesson basis for specific materials to help you understand or teach the material more effectively.

# Lesson 2 Tasks

## Lecture 2 Orientation Exercise: Describe Your Role

### Mission Assignment

### Quiz for Lecture 2

	Lecture 2 Orientation Exercise: Describe Your Role	Mission Assignment	Quiz for Lecture 2	
<b>Preparation</b>	Review assignment instructions and ensure discussion forum is available to students.	Post groups for Mission Assignments.	Ensure quiz and video are available to students and the quiz is set to close at the end of the deadline. Take the quiz if you have not already.	
<b>Description</b>	Preparatory exercise for material presented in course videos and reflection afterward.	Begin Mission Assignment: consider test mission across a variety of contexts	Students complete quizzes while watching videos.	
<b>Outcomes</b>	Understand services and responsibilities differ across test groups. Groundwork for understanding mission and context.	Familiarity with Mission Assignment task	Increased understanding	
<b>Tools</b>	Course discussion forum	Course web pages, discussion forums, and wikis	Quiz, videos, slide sets	
<b>Core readings</b>	None	None	See course	
<b>Communication</b>	Monitor discussions and provide feedback.  Encourage insight, written communication, and presentation skills.	Post groups for Mission Assignments, encouraging students to start working immediately.	Encourage participation. Field questions.	

	<b>Exam Cram Forum</b>	<b>Quiz 1 Discussion Forum</b>	<b>Instructor Feedback</b>	
	Post questions for study guide, if necessary and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
	None	None	None	<b>Core readings</b>
	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 2

# Overview

Lesson 2 introduces students to *context-driven testing*:

- The goal underlying the preparatory exercise and required reading is to open the student's mind to the great variety of testers' roles. Students who come to you with no preconception about this learn something new, helping them when they interview for their first testing job. But other students come to the course with a narrow view of the roles of testers and test groups, thinking any role other than the one they know is wrong. In this lesson, we challenge them to unlearn that view.
- The lecture defines testing as a service to stakeholders. In particular, it is an empirical search for quality-related information about the product on behalf of those stakeholders. The key stakeholders often have different informational needs. To meet those needs, testers have to adjust how they test (what they do, what tools they use, how they prioritize their time).
- Testers must also adjust to the practical realities of the project, such as the budget, the schedule, the skills of the staff, and the availability of suitable tools.

At its core, context-driven testing reflects this dual adjustment: to the needs of the key stakeholders and to the practical realities of the project.

## 2.0 Administrative tasks

### 2.0.1 Post quiz-related fieldstones

Post the *BBST Philosophy of Quizzes* fieldstone at the end of first quiz. It is available in the *Fieldstones* appendix.

### 2.0.2 Assign Mission of Testing groups

Assign students to review peer work on the *Mission Assignment* and post those assignments. Also, announce your expectations for the peer reviews and encourage students to begin work on the project immediately.

Ensure each group has a wiki and discussion forum set up for the group's use. If your class is small, you do not need to use all of the groups. The following groups are available:

- Group 1: Early Development
- Group 2: Late Development
- Group 3: Custom Software
- Group 4: Medical Software
- Group 5: Computer Game

### **Kaner's method for assigning groups**

Start by laying out names in time zones and first languages. The goal is to maximize diversity within the groups. Next, check participation in the class and group people into three very rough categories:

- very active, leader
- not so active, or very new
- not likely to participate

You can determine the number of groups by ensuring each group has one leader and at least two people who are actively engaged in the course.

To assign tasks to each group, try to select a task based on what would be specifically interesting or challenging for one of the people in the group. While you probably won't know all of the students well enough to do this for everyone, information from *Meet & Greet* participation is likely to give you good ideas for some. For low-participation students, try to assign a task tempting them to participate. In other cases, assign tasks to stretch them.

### **Barber's method for assigning groups**

Scott Barber suggests assigning students by distributing the strongest students across the groups. After that, distribute the weakest students across the group. After the strongest and weakest students have been assigned, Scott suggests using the remaining students to make groups diverse with respect to time zones, culture, and gender. If you have several students from the same company, you can also split them across groups to maximize diversity.

Once the initial group task is completed, you often will have individuals review work by other groups. Try to make sure each group's work receives roughly the same amount of review. Within that, try to assign reviewers with relevant experience to the task. For example, if Susan was a game tester, she can review work by a group focused on a game testing task (assuming Susan wasn't already in the gaming group). It won't always be obvious where to place a reviewer. In those cases, review assignments must be made arbitrarily with the goal of even coverage. By the time you are assigning reviews, you may have good reason to believe one of your students is unlikely to complete the course. If that is the case, disregard those students as you try to balance the group reviews.

Finally, consider sorting your group assignment list by last name before posting to the course. This will make it more difficult for students to see patterns (real or imagined) in how you've assigned them to groups, thus minimizing student dissatisfaction with the resulting assignments.

## 2.1 Lecture 2 orientation exercise: Describe your role

### Preparation

Review instructions for the exercise.

Remind students to complete this exercise *before* they watch the video. Students should also limit the amount of time they spend on the preliminary part of this exercise to 60 minutes. There is no incremental benefit to spending a longer time on the preliminary exercise.

### Activity description

In the lesson 2 discussion forum, students describe the role of the test group (services and responsibilities) in their organizations. The writing prompt asks them to consider how their mix differs from what they think of as the “typical” test group and how they would change this.

### Purpose

The purpose of this exercise is to illustrate the wide variety of services and responsibilities test groups can have. Unless all students come from the same company—or the same industry—there is likely to be considerable diversity in role assignments represented in the class.

### Tools

Course discussion forum.

### Core readings

None

### Facilitation roles and strategies

Monitor the discussion, in the forum and in the wiki, asking for additional information or explanation, as appropriate. Also notice who is participating and send a note to those who are not. Monitor the unfolding discussion to prepare for the instructor’s feedback note at the end of the exercise.

Begin to emphasize the importance of written communication for the course. Provide tips on format and structure of answers as appropriate.

### Variations of the activity

None

## 2.2 Mission of testing group assignment

### Purpose

The assignment has two goals:

- First, it introduces students to group work in an online course. If the student body is diverse, the assignment can teach students about the real-world challenges of working on multi-national teams distributed across time zones. We kept the content of the assignment intentionally simple to allow students to focus on the technology of collaboration.

- Second, it illustrates how differences in a project's context will change how people should test a product. The success of this second goal will depend on your feedback to the class.

The assignment gives what looks like the same task to each group: plan the testing of a product's spreadsheet features. What differs are the project contexts. The first challenge for the students is to understand their context and its implications:

- Group 1's task (early development) is to *test along with the programmers as they write the code* to help the project manager and programmers understand the *implementation-related risks* as the programmers start. These testers are testing along with the programmers, probably doing glass box tests or creating test artifacts (such as data files), to help the programmers run their own tests. These testers are on the lookout for recurring *implementation* problems that could be dealt with now by the project manager, making the rest of the project go more smoothly. Some testers find it difficult to imagine this context. Instead, they try to refocus their group on specification reviews and test planning or other forms of preparation for a later black box testing effort. Sometimes it helps to suggest to these students to look into Extreme Programming (XP) and respond as if their group was working inside an XP project.
- Group 2 (late development) is the traditional black box testing project.
- Group 3 (custom software) is enabled and constrained by the contract. For example, if the contract requires detailed test documentation, the testers should create it. On the other hand, if there is no budget under the contract for creating and maintaining detailed test documentation, the testers shouldn't create it.
- Group 4 (medical software) must extensively document their testing. Some students check government standards (e.g. the US Food & Drug Administration or standards from comparable organizations in other countries) and describe their tasks specifically in terms of the standards. Others don't go this far but explicitly acknowledge that their work will be inspected by regulators and be used as legal evidence if defects in the software cause errors of treatment.
- Group 5 (computer game) presents a different view of quality. High quality games are entertaining. Entertainment is their purpose. Bugs reducing the entertainment value of the game are serious. For example, bugs that seem minor are serious if they slow the player down or increase the likelihood the player will make a disadvantageous mistake. Bugs causing the program to lose data or crash might be less serious than a spelling mistake. (For example, imagine how you would react if the program didn't accept your spelling of a critical word while you were trying to cast an important magical spell.)

Some students/groups will interpret their contexts differently. We gladly accept quite a variety of interpretations—as long as they are reasonably related to the assignment description. As with our notes on Group 1, some students want to ignore the context and do whatever they think are testing “best practices.” Sometimes the other students in the group put a stop to this. But if not, we recommend you intervene, gently, and suggest the students refocus on the description of their context.

Given a group understands the description of their context, they still have several questions to answer. We expect fairly brief answers to the assignment's specific questions. This is not the place for a long test plan.

## **Preparation**

If you have not already mastered this assignment yourself, work through it. Your students' answers won't be the same as yours—some will be both *different and better*.

If you aren't familiar with your course management system's wiki, do some writing with it. Your students will run into bugs in the wiki at the most inconvenient times. Check the CMS system's tech support site in advance for discussions of the wiki's bugs.

## **Tools**

If your CMS does not support a wiki, find another site where you and your students can create wikis, or use some other tool allowing multi-user collaborative editing and tracking of each author's changes. (You'll find the history mechanism very handy when you try to understand how a group's thinking evolved to create their final answer.)

## **Core readings**

None

## **Facilitation roles and strategies**

Monitor the discussion, noting novel approaches to solving the problem and common traps to be avoided. Also notice who is participating and send a note to those who are not. Monitor the unfolding discussion to prepare your feedback note at the end of the exercise.

In some classes, a few students overdo the test strategy analysis. Typically, they import a test-planning best practice they learned in some other course and try to apply it even though the assignment doesn't provide enough details to support that effort. We think it's important to manage this with care. On the one hand, it's a good thing when a student tries to integrate what they're learning in this course with their other knowledge. On the other hand, this effort sometimes comes to dominate a group's discussion. In the worst case (which we've seen several times), the other students in the group are intimidated or alienated from the assignment by a student who is showing off. Left unmanaged, this behavior may cause some students to drop the course—in our experience, this can drive away good students, not just weak ones. Therefore, the instructor must deal with this challenge in a proactive way.

We usually manage this gently in the public forums (asking a few focusing questions) and, if necessary, more bluntly by private email. We send a few notes to the vocal student, gradually leading them through the recognition the exercise doesn't provide enough information for their analysis to work, that briefer answers ignore their favored analytical structure are appropriate for this simple exercise, and asking them to be more considerate of the others. We prefer to do this as an email discussion rather than one note, because the single note can be read as a harsh rebuke. We also send private notes of encouragement to one or more of the other students in the group, especially students who were treated badly by the best-practicer.

Occasionally, a best-practicer will leave the course in protest over being reined in. If that happens in your class, reflect on whether the student's conduct would have driven other students out of the class. If so, then you should see this result as a success, not a failure.

### Variations of the activity

Use subsets of the suggested group tasks if your class is small or if students in your class have particular interests better served by a smaller subset of the suggested development environments.

## 2.3 Ongoing activities: lectures; exam cram; and quizzes & discussions

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## 2.4 Send *Highlights of the Coming Week* announcement

Instructors are welcome to craft their own announcements for the coming week or customize any we provide.

### Rationale:

We send students a note at the start of each week to prepare them for the next week's work. This is a model for that note.

**TITLE** Starting Week 2

#### POST

We're just coming to the end of the first week. Congratulations on what looks like an excellent start!

Here's what's coming up next week:

- The last two lectures (on the measurement problem and the impossibility of complete testing)
- The last two quizzes
- An orientation exercise and some associated readings

There are two tasks coming up spanning several segments of the course, the assignment and the preparation for the exam.

- Please start looking over the assignment now, and
- Please take a crack at one of the study guide questions, posting your analysis.

The most common pattern among students who don't complete the course seems to be:

- spends lots of time in Meet & Greet and other socializing activities
- spends no time on the Study Guide questions.

The result is the student spends many hours in the course, makes some good relationships, but misses a lot of the benefit of the class.

- The orientation exercise helps prepare you for the lecture—it raises a problem you probably won't fully solve, but gets you thinking about it. The lecture explores the problem in more depth.
- The quiz helps you check your understanding of the lecture and readings.
- The quiz discussions and orientation exercise discussions help you work through your questions and objections to the lecture material. "Work through" doesn't mean "overcome your resistance to"—We don't expect everyone to adopt the vocabulary or attitudes expressed in the course. "Working through" means developing a better understanding of the relationship between your views and those expressed in the lectures and readings.
- The assignment helps you extend the material you are learning into a much more student-controlled learning experience. The biggest challenge in this first course is simply transcontinental communication (a skill we all have to develop in a global economy). Later courses will pose tougher group tasks.
- The study guide questions pose conceptual problems you can work through. They assume you understand the lecture but they don't require you to adopt the lecture's view. Many of the best answers I have seen have pointed out the perspective from the lecture would lead to analysis X (with enough description to show you know what that analysis is) but you think analysis Y would be better because...
- Posting these in advance as study guide questions, instead of asking them as "surprise" exam questions you have never seen before, creates two opportunities:
  1. Writing the exam often triggers insights even in people who prepared answers in advance. (You have to write the answers fresh, no copying from prepared work allowed.)
  2. Reviewing/grading the exams of your peers triggers insights as well. Many people find this the instructionally most valuable part of the course.

You will not get most of the learning benefit of the exam if you don't work through the study guide questions in advance.

## **2.5 Send *Weekly Feedback* announcement**

Throughout the week, you should plan to review discussions, making notes of problem areas, interesting approaches, and general trends. Your notes will inform the *Weekly Feedback* note you send as soon as ready.

In your note to students, provide feedback on answer structure, organization, and clarity of presentation. Emphasize the value of both peer and self-reviews, noting they are required. Where possible, note an exemplary sample of each.

## **2.6 Record grades as appropriate**

Record grades in your grade book as appropriate.

# Lesson 3 Tasks

	Lecture 3 Orientation Exercise: Testing a Word Processor	Oracle Heuristics: Phase 1	Mission Assignment	
Preparation	Review instructions for assignment.	Review instructions for assignment. Assign students to groups and post assignments.	Post assigned reviewers for Mission Assignments	
Description	Preparatory exercise for material presented in course videos and reflection afterward	Groups work to determine 3 attributes describing the image of 3 companies and imagine image-related problems for each.	Groups complete their Mission assignment and comment on work from other groups as assigned.	
Outcomes	Students understand the complexity of the topic and gain new insights.	Groups demonstrate and apply consistency heuristics and create work product for next phase.	Appreciation of influence of context on a test group's efforts	
Tools	Course discussion forum	Discussion forums and wiki	Course web pages, discussion forums and wikis	
Core readings	None	Oracle Heuristics handout; <i>Testing without a map</i>	None	
Communication	Provide feedback to students about classic traps and shortcomings in this task. Note any exemplary submissions. Encourage insight and written communication skills.	Remind students to start task early.	Remind students of tasks and deadlines. Prepare feedback on Mission Assignment.	

	<b>Quiz for Lecture 3</b>	<b>Exam Cram Forum</b>	<b>Quiz 2 Discussion Forum</b>	<b>Instructor Feedback</b>	
	Ensure quiz and video are available to students and set to close at the end of the deadline. Take the quiz if you have not already.	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students complete quizzes while watching videos.	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Increased understanding	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Quiz, videos, slide sets	Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
	See course	None	None	None	<b>Core readings</b>
	Encourage participation. Field questions.	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 3

# Overview

Lesson 3 introduces students to *oracles*.

The classical view of oracles is they are mechanisms for determining whether a program has passed or failed a test. For example, see Miller & Howden, 1978 and Wikipedia: Oracle\_ (software\_testing). Along with this idea of the oracle, there is a classical idea testers will (or even *must*) have an oracle for every test. Thus, for example, Glen Myers (1979) tells us we must have an expected result for every test.

This lesson presents a different view. Ideally, the student will take three things away:

- 1. *No test has one true oracle. The best we can achieve are useful approximations.*** We think Elaine Weyuker (1980) was the first author to point this out. Douglas Hoffman (1998) published a pair of diagrams illustrating the core problem. We expect students to understand and remember these diagrams and their implications. When you specify a test, you decide some things you will intentionally do and some behaviors of the software under test you will intentionally look at as results of the test. But your specification is necessarily incomplete. It does not describe all aspects of the hardware and software state, before or after the test. For example, how often do you specify how fragmented the computer's memory will be before and after a test? Because of this, oracles are usually useful but they *can* be wrong: The program can appear to pass a test while failing in ways you do not notice or it can appear to fail even though it actually is responding appropriately. A decision rule that is fallible but useful is called a *heuristic*. All oracles are heuristics.
- 2. *We can describe the process of deciding a program probably passed or failed a test as the outcome of a comparison and identify several widely-used comparators.*** For example, you might decide the program under test is probably broken because its behavior is inconsistent with what it did before, or inconsistent with the behavior of an important behavior, or inconsistent with the behavior described in a specification. We expect students to learn the *consistency heuristics* presented in Bolton's (2005) *Testing without a map*.
- 3. *It is useful to have a collection of many very specific oracle heuristics, to support test automation.*** If a program is supposed to calculate the square root of 4 and it gives 3 instead of 2, that's a bug. When testing a function taking square roots, you might check the program's outputs match the outputs of another square-root calculator you trust. You might square a square root to see if you get back the original number. You might check whether repeatedly taking square roots uses up memory. None of these tests is comprehensive—the program can fail in ways these tests will not notice—but each of these tests describes a specific useful comparison and can be automated. You could test a billion square roots in any or all of these ways. The lecture slides provide a long table of examples of these types of oracles.

The most serious weakness of this lesson is it overemphasizes (1) and (2) relative to (3). The consistency heuristics are intellectually satisfying because they capture and classify most

(maybe all) types of oracles. But they are a generalization. They don't present the design details we find useful to automate our testing. We draw student attention back to the specific oracles in the quizzes and study guide questions (and later, in the *BBST Test Design* course).

The three key student activities in this Lesson are:

1. The orienting exercise (word processors) which students should do before watching the lecture
2. The oracle heuristics assignment
3. Completion of the mission of testing assignment

### 3.0 Administrative tasks

#### 3.0.1 Assign groups for phase 1 of the oracle heuristics assignment

Assign students to groups for phase 1 of the oracle heuristics assignment and post the information to the course site. You can use similar strategies to those described in Lesson 2.

### 3.1 Orientation exercise: Testing a word processor

#### Preparation

Review instructions for the exercise.

Remind students to complete this exercise *before* they watch the video. Students should also limit the amount of time they spend on the preliminary part of this exercise to 60 minutes. There is no incremental benefit to spending a longer time on the preliminary exercise.

#### Activity description

Students consider how they would test the correctness of font display for a text editing program before watching the video or reviewing ideas from other students in the course. Then they comment on answers from two other students. Then they watch the lecture, which gives its own answers to these questions.

#### Purpose

The font comparison problem involves both contextual and technical issues, but the question really emphasizes the technical issues:

- How could one determine whether the editor is displaying text in the correct typeface?
- How could one determine whether the editor is displaying text in the right size?
- How would one test whether the editor displays text correctly (in any font the user specifies)?

Certainly, the project context is important to help one decide how “correct” is correct enough. That is, we need to think through our investment in measurement precision. Beyond that, this is not designed to be a context-driven question.

## Tools

Discussion forum

## Core readings

None

## Facilitation roles and strategies

Monitor the discussion forum, noting novel approaches to solving the problem and common traps to be avoided. Also notice who is participating and send a note to those who are not. Monitor the unfolding discussion to prepare for your feedback note at the end of the exercise.

Many students will respond with trivial or wrong. When you notice these, consider responding with questions. For example:

- The student says there is a general specification laying out the sizes, or rules for sizes, for all typefaces. Rather than telling the student there is no such thing, ask them to find it.
- The student says you can evaluate them exhaustively by inspection. With over 10,000 typefaces available for Windows and many characters (different ones, too) in each typeface, how will the student find time to do all this inspection? Some students recognize there is a sampling problem; we're talking about the students who don't.
- The student says you can evaluate them by printing and checking the printouts. First, this is very time consuming. Second, good luck checking printouts. Third, what if the editor prints correctly but displays badly? This is about the display.
- The student says you can evaluate them against saved results, such as saved screenshots. OK. There are problems comparing bitmaps, but that's almost always too much to discuss in this course. But where do the saved screenshots come from? How long does it take to create these?
- The student says you can automate all of this testing, but without explaining how. Ask how that can be done?
- The student says you can check whether the program is making the right system calls to display the right typefaces. That addresses part of the problem (it would be a bug if the program decides to display Helvetica when you ask it to display Gill Sans) but what if the editor displays the letters incorrectly, for example shows them at the wrong size?

Be careful not to give away the answers before the peer and self-assessments are completed.

This exercise is drawn from Bach and Bolton's (2011) lecture notes. At the time Bach created the exercise (1990's), this was an unsolved problem. We know state of the work at that time at Adobe and in the LaserJet testing at Hewlett-Packard—both companies automated as much of their testing as they could but had to rely on human judgment calls for deciding the right characters from the right typeface were being shown (Adobe) or printed (HP) at the right size. Since then, technology has improved. It is reasonable, to imagine setting up a two-display system with the program under test on one display, a well-tested and widely used reference

program on the other display, sizing the windows so letters that should be the same size on each will actually be displayed as the same size, then running a long automated sequence selecting one typeface after another, displaying text on both screens at various sizes, and comparing bitmaps of the screens. We have not seen this being done now but we have the impression some knowledgeable colleagues have seen it done.

Therefore, it is entirely possible some students will give answers technologically reasonable. Don't fall into the trap of arguing one of these is impossible. You might end up looking foolish and losing credibility. However, this is an expensive setup. Companies specializing in writing word processors and desktop publishers might do something like this, but most testers at most companies will probably check font displays by eye. And when they do, they will face all of the challenges and tradeoffs described in the lecture.

After the students watch the lecture, they come back to the discussion forum and review their answers

### Variations of the activity

There are no content variations. We will consider replacing this in the next generation of *BBST Foundations*. The orienting activity poses a problem later solved in the lecture. If you change the activity, realize your activity will not be explained in the lecture. You might consider creating your own lecture to correspond with your activity.

Some instructors ask students to post reflections after watching the video. The central question to students for a reflection is, "Now you've seen the video, how would you change your answers?" On the 4-week timeline, consider whether your students will have enough time to do this added task in Lesson 3.

## 3.2 Oracle heuristics lab assignment: Phase 1

The lab is a three-phase assignment. The learning objectives for the lab assignment are:

- to understand and apply oracle consistency heuristics to software;
- to critically evaluate work and provide feedback to others; and
- to participate in a distributed work group.

### Preparation

Review instructions for the lab activity. Assign students to a group—maximizing diversity of experience and including some time zone diversity within the group.

### Activity description

Students work in groups via a wiki and discussion forum to identify three key image attributes of three distinct game manufacturers. They imagine and describe problems inconsistent with one company's image but not another's.

## Purpose

This activity gives students practice applying consistency heuristics to software created by strikingly different companies. In addition, the nature of the group experience provides students the opportunities to grapple with the challenges of distributed work groups in a low-stakes environment.

## Tools

Course discussion forum and wiki

## Core readings

Bolton's (2005) *Testing without a map*

## Facilitation roles and strategies

Monitor the group discussions as they unfold—intervening and guiding as necessary. Many students will underestimate the amount of time it takes to complete the group task. Remind them to start this task early. Remind them it is important to get Phase 1 done during Lesson 3 or they will delay the more complex Phases 2 and 3, creating scheduling problems for themselves in Lessons 4 and 5.

Students can get lost in this task, wasting a lot of time. In live classes, Kaner time-boxes Phase 1 to 30 minutes. This doesn't include the time it takes them to read the instructions for the assignment as a whole or to introduce themselves to their fellow group members. But once the pleasantries and the preparation are done, the core task can be done quickly. It takes only a few minutes—not more than 5—to get a sense of a company's image. Your feedback might note some of the diversity in ways students did this. Examples you will probably see (or maybe mention in feedback as other ideas) include:

- checking the company's website
- checking reviews of the company's products online
- checking reviews of the company (what do people say about it?)
- checking product advertisements

Students will also suggest a variety of different dimensions distinguishing between the companies. For example, how visually striking are their products? Family friendly? Reliable? Likely to work well across platforms? Fast? Graphically realistic? Playable? Interesting? Elegantly designed? Likely to realistically emulate physical laws (how things move, how far things are away, etc.)? Well documented? Well supported?

Students will disagree on the underlying facts. For example, they might argue about whether Microsoft products are reliable or not. The question is not about the reality of Microsoft. It is what image Microsoft has made for itself in the marketplace. Students will disagree about this too. Encourage students to get past this by focusing on the three attributes they can readily agree, or by splitting attributes so one student does the work for the attribute they are enthusiastic about while another student works on another.

The important thing is to get to Question 2, where students consider the implications of the attributes. Given their view of Microsoft's image, Apple's image, and Blizzard's image, what would be a bug (inconsistent with the image) to one company but not other companies? If they can answer this, they understand a lot about consistency and inconsistency with image.

### **Variations of the activity**

The BBST courses use the gaming industry because so many students are familiar with it. Instructors can vary this activity by changing the product or industry to which the consistency heuristics are applied. However, for the learning objectives to be achievable, there must be striking diversity within the industry, and most students must know enough about the industry and how to find out about its leading companies to form fast impressions of them.

We chose the consistency-with-image heuristic as a starting point because it is easy to understand. You can replace this with another consistency heuristic but make sure to pick one students are intuitively comfortable with, that requires them to do research to apply it, and is easy enough to work with they can do adequate initial research in a few minutes.

## **3.3 Mission of testing assignment (Continued)**

### **Preparation**

Students started this activity in Lesson 2. It is due at the end of Lesson 3. You will post comments during Lesson 4.

Your work during Lesson 3 is to monitor the discussion, intervene if necessary (see the notes in Lesson 2), and keep notes to prepare feedback at the end of the task.

## **3.4 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **3.5 Record grades as appropriate**

Record grades in your gradebook as appropriate

## References and resources

James Bach & Michael Bolton (2011). *Rapid Software Testing*. Course notes. <http://www.satisfice.com/rst.pdf>

Douglas Hoffman (1998). *A taxonomy for test oracles*. Quality Week. [http://www.softwarequalitymethods.com/Slides/Orcl\\_Tax\\_Slides.PDF](http://www.softwarequalitymethods.com/Slides/Orcl_Tax_Slides.PDF)

Edward Miller & William E. Howden (1978). *Software Testing and Validation Techniques*, IEEE Computer Society Press.

Glenford J. Myers (1979). *The Art of Software Testing*. Wiley.

Elaine Weyuker (1980). *On testing nontestable programs*. [http://www.testingeducation.org/BBST/foundations/Weyuker\\_ontestingnontestable.pdf](http://www.testingeducation.org/BBST/foundations/Weyuker_ontestingnontestable.pdf)



# Lesson 4 Tasks

	Lecture 4 Orientation Exercise: Impossibility of Complete Testing	Oracle Heuristics: Phase 2	Quiz for Lecture 4	
<b>Preparation</b>	Review instructions for assignment.	Review instructions for assignment.	Ensure quiz and video are available to students and set to close at the end of the deadline. Take the quiz if you have not already.	
<b>Description</b>	Preparatory exercise for material presented in course videos	Groups work to apply “Consistency with image” heuristic to a specific product & company	Students complete quizzes while watching videos.	
<b>Outcomes</b>	Helps students understand the complexity of the topic	Students gain practice applying a consistency heuristic.	Increased understanding	
<b>Tools</b>	Course discussion forum	Discussion forums and wiki	Quiz, videos, slide sets	
<b>Core readings</b>	Papers from Kaner and Marick	None	See course	
<b>Communication</b>	Monitor course discussions, providing assistance as needed.	Encourage participation. Monitor and field questions as appropriate.	Encourage participation. Field questions.	

	<b>Exam Cram Forum</b>	<b>Quiz 3 Discussion Forum</b>	<b>Instructor Feedback</b>	
	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
	None	None	None	<b>Core readings</b>
	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 4

# Overview

Lesson 4 introduces students to some very basic concepts in computing:

- how programs store data (different types of numbers, non-numeric characters, and basic control structures: strings, records, arrays, and lists);
- how programs do basic calculations (like addition);
- rounding errors and why they are inevitable if you do floating point calculations in the standard way
- how programs go from step to step (control structures, including sequences, branches, loops, method calls, exceptions and interrupts)

The storage-and-calculation material provides a basis for thinking about calculation errors, boundary values, overflows, and determining how many possible values a variable can have and thus, how many tests would be needed for “complete” testing. (This will be considered in the next lecture.)

The control-structure material provides a basis for thinking about structural coverage. The lesson ends with an introduction to the most common structural coverage measures which is how most common discussions of how much testing was done are organized.

Some students call this material academic, theoretical and impractical. We think the material has practical significance. We’ve seen working testers discredit themselves in meetings discussing bugs, coverage, or the size of testing tasks, by exposing the depth of their ignorance about basic computing facts.

The key student activities in this Lesson (apart from lectures, quizzes and study guide) are:

1. The orienting exercise on testing a square root function
2. The oracle heuristics assignment, phase 2

## 4.0 Administrative tasks

There are no administrative tasks specific to Lesson 4.

## 4.1 Impossibility of complete testing exercise

### Preparation

Review instructions for the exercise.

## Activity description

Students consider the time, cost, and effort required to test a simple calculation function (square root).

## Purpose

The exercise gets students thinking about how many tests are needed to test a simple calculation function.

The instructions make it clear the data already is stored in memory (there is no user interface) and the program will interpret the contents of memory as a 32-bit square root (there are no letters or other non-numbers). The entire focus is on testing the calculation itself. Does the program get the square root right or not?

The real-life example this exercise is based on is Hoffman's testing of a square root function (32-bit integers inputs) at MASPAC computer. Enough students will have trouble with this exercise, we work through the computing basics before coming back to Hoffman's example in the impossibility-of-complete-testing lecture (Lesson 5).

For students with a modest knowledge of computer arithmetic, most of these questions are very easy

## Tools

Course discussion forum

## Core readings

Kaner's *Software negligence and testing coverage* paper

Marick's *How to misuse code coverage* paper

## Facilitation roles and strategies

As you monitor the discussion forums, you will gain some insight into how much the students know about testing:

- Some students will ignore the instructions and describe how they would test a square root function by black box testing at the user interface.
- Some students will find it impossible to imagine testing a function if they can't test it through the user interface. This isn't a simple sloppy-reading error; it is a conceptual problem. In our experience, learning how data are stored in memory can expand the imagination of these students. In the course of it, they might need extra (often private) encouraging or coaching.
- Some students seem to refuse to imagine testing a function without also imagining how to test it through the user interface. This is not a simple sloppy-reading error. Instead, it reflects a bias the course might or might not help the student get beyond. If you give feedback, it should try to get the student to understand the user interface as a window to underlying computational and business rules. We can ask whether the UI is a good

window. But we also can ask whether the underlying rules are correct and correctly implemented. Separating these questions will make it possible to focus tests more effectively on each question in turn.

- Some students insist they can make tests of 33-bit integers (numbers that are too big) or letters or other non-numbers. Again this reflects a failure of understanding of data storage.
- Several students write this exercise with the belief a relatively small sample of tests can fully test a simple function like this. Actually, they need 4,294,967,296 tests. You will be giving your post-exercise feedback on this assignment during Lesson 5, while students are watching the lecture's presentation of Hoffman's example. Hoffman demonstrates the need for all those tests by exposing two bugs non-exhaustive testing would not have found. If you give feedback on the number of tests during Lesson 4, don't spend a lot of work on it. Point students forward to Lesson 5 and invite them to ask questions if the lecture doesn't clear it up.
- Many students think the program must print 2, and not 1.9999999999999999 as the square root of 4. You might probe this. Some students consider it a bug to show 1.9999999999999999 instead of 2 even if both numbers are stored exactly the same way in memory (the program can't tell them apart). How much code would it take to display the simplest (fewest digits after the decimal?) number equivalent to the one stored in memory? How would you test all that code?
- Some students say they can cover ALL the inputs to this function with X tests but would test life-critical functions with even more than X tests. What are they adding if they have already tested all the values? Ask them.

Finally, note the variation in experience across students. This can guide you in deciding how much feedback to give in the study guide forum and in deciding what is or is not a fair question on the exam.

### **Variations of the activity**

None

## **4.2 Oracle heuristics lab assignment: Phase 2**

### **Preparation**

Review instructions for this phase.

### **Activity description**

Students work with their group to apply the general questions listed in the course handout to testing a computer game made by Blizzard. Those who are unfamiliar with gaming may need to do some research on Blizzard and their products to complete this task.

### **Purpose**

In Phase 1, the students tried their first application of a consistency heuristic. Now it is time to analyze that heuristic. What is it? How does it work?

This task is a bridge. The students work together through an analysis of a heuristic with which they probably are comfortable. In Phase 3, they will work on their own through the same type of analysis, of a different heuristic. From there, they should be able to apply the same analysis to any of the consistency heuristics.

## Tools

Course discussion forum

## Core readings

Bolton's (2005) *Testing without a map* is a useful reference throughout all phases of this assignment

## Facilitation roles and strategies

Monitor the unfolding discussions and field questions as appropriate. Guide students to use the questions in the assignment handout to assist them in completing the task.

For some students, this is their first attempt to complete a systematic analysis. Feedback pointing out that they have missed one of the questions, or missed the focus of one, can be very helpful to these students.

## Variations of the activity

This is a continuation of Phase 1. The decisions about structure and content of the assignment made in Phase 1 govern Phase 2.

## 4.3 Ongoing activities: lectures; exam cram; and quizzes & discussions

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## 4.4 Send *Highlights of the Coming Week* post

Send students a note at the start of each week to prepare them for the next week's work.

## 4.5 Send *Weekly Feedback* post

Throughout the week, you should plan to review the orientation exercises and student submissions, making notes of problem areas, interesting approaches, and general trends. Your notes will inform the *Weekly Feedback* you send as soon as ready.

In your note to students, provide feedback on content and clarity of presentation. Emphasize the value of both peer and self-reviews, noting they are required. Where possible, note an exemplary sample of each.

## 4.6 Record grades as appropriate

Record grades in your gradebook or spreadsheet as appropriate.

# Lesson 5 Tasks

	Oracle Heuristics: Phase 3	Quiz for Lecture 5	Exam Coaching Lab	
Preparation	Review instructions. Assign students to a specific heuristic for individual analysis.	Ensure quiz and video are available to students and set to close at the end of the deadline. Take the quiz if you have not already.	Post one study guide question in coaching forum.	
Description	Students work individually to complete a heuristic analysis.	Students complete quizzes while watching videos.	Students draft exam answer for peer and instructor feedback.	
Outcomes	Individually demonstrate understanding and application of consistency heuristic.	Increased understanding	Improved understanding of written communications and exam preparation	
Tools	Course discussion forum	Quiz, videos, slide sets	Course discussion forum	
Core readings	None	See course	Essay Answers Handout	
Communication	Monitor forums—guiding, complimenting, and correcting as appropriate.	Encourage participation. Field questions.	Emphasize participation.	

	<b>Exam Cram Forum</b>	<b>Quiz 4 Discussion Forum</b>	<b>Instructor Feedback</b>	
	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Course discussion forum	Course discussion forum	Course announcements/email	<b>Tools</b>
	None	None	None	<b>Core readings</b>
	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 5

# Overview

Lesson 5 considers what it means to achieve complete testing.

Lesson 4 introduced the concept of coverage. Some people come to our course believing they can achieve complete testing by achieving complete structural coverage. This lesson demonstrates how severely mistaken this view is.

We expect students to remember six things from this lesson:

- Two key definitions:
  - Two tests are *distinct* if one test would expose a bug the other test would miss.
  - To achieve *complete testing*, you have to run every distinct test.
- Two key examples:
  - In the *MASPAR square root example*, testers had to run all 4,294,967,296 tests to find the function's two bugs.
  - In the *Telenova stack overflow example*, covering all branches, statements and independent sub-paths was not enough. To replicate a system-killing bug in the field, testers had to create sequences so long and complex it would be impossible to find all bugs like this in the lab. The lecture (the video, not the slides) pointed out Telenova's staff ultimately built a simulator feeding the program long sequences of inputs and checked the system's state with diagnostics. They found many other bugs using this long-random-sequence testing that would show up only intermittently in the field but be serious when they did show up. The lecture drew a sequence diagram for the stack overflow bug. It looked just like the sequence diagram of a famous example in Glen Myers' *Art of Software Testing*. Myers showed to test all sequences through his simple little program would take over 100 trillion tests. To find Telenova's other long-sequence bugs would have taken even more tests.
- One key formula:
  - If  $V_1$  through  $V_k$  are  $k$  independent variables, and if  $N_i$  is the number of possible values of variable  $V_i$ , then the number of combination tests of all the variables together is  $N_1 * N_2 * \dots * N_k$ .

- One conclusion:
  - *Complete testing is impossible and therefore all of testing involves tradeoffs.* Testing involves many tasks, such as designing and running tests, writing effective bug reports, documenting test ideas, creating test tools, etc. The amount of time needed to do all of these is infinitely greater than the time testers have. You only have time to do a small sample of this work and the time you spend on one task will no longer be available for the others. Inflexible directives, like “You must write down an expected result for every test,” are unreasonable because a huge amount of work on one testing task is demanded without considering what other testing tasks will be left undone as a result. The optimal tradeoffs will vary on a project-by-project basis.

The key student activities in this Lesson (apart from lectures, quizzes and study guide) are:

1. The exam coaching lab
2. The oracle heuristics assignment, phase 3

## 5.0 Administrative tasks

A few days before the start of exam week, the lead instructor, with the assistance of the instructor team, should complete the following two tasks:

- Prepare the final exam.
- Prepare the course evaluation.

### 5.0.1 Prepare the final exam

Select questions for the exam from the study guide. The typical exam has six or seven questions, three or four short and three long. Students are much more likely to do well on the short answer questions. The long answer questions reveal much more about students’ understanding of the material.

- Choose among the available questions in the exam pool to maximize coverage of the course and diversity among the questions. Some questions overlap in their coverage of the course material; some overlapping may be acceptable, but it is generally undesirable to choose similar questions for the same exam.
- If you are teaching this course as part of a sequence, you are not just managing your own course. You are teaching one of the core BBST prerequisites, laying down expectations for all future courses. Your choice of exam questions will influence study strategies for the rest of the series.
- Especially in *BBST Foundations* and *BBST Bug Advocacy*, it is desirable to choose a question no one has attempted in the *Exam Cram* forum and another question the students addressed poorly in the *Exam Cram* forum if you posted a caution/question about it.
- Do not choose a question if instructor comments (feedback on the forum) make the question ambiguous or would lead students to a weak answer.

- Every question in the study guide is fair game for the final exam.
- Please choose questions to have some overlap with questions from exams in previous courses so we may compare performance across groups. However, this redundancy should be limited. As a general guideline, we suggest an overlap of no more than three questions with either of the previous two final exams.
- A few days before the exam starts, remind students and give them an idea of how it will work.

### **5.0.2 Prepare for course evaluation by students**

We provide suggested questions for the course evaluation in an appendix. However, your institution may require a specific course evaluation form. Instructors will determine how to distribute these surveys, which should be released in the middle of the coming week.

## **5.1 Exam coaching lab**

### **Preparation**

Review instructions for this phase. Write your own practice answer. If you are co-teaching with other instructors, compare notes and peer review each other's answers.

### **Activity description**

Students will write an answer to a long-answer essay question and peer review other students' answers.

### **Purpose**

The purpose of this exercise is to better prepare students for the exam. We want those students who do fail the exam to fail because they don't understand the material, not because they are unskilled in exam writing.

Many students are ineffective at essay answers (and more generally, at written communication). This is as true for Computer Science undergraduate and graduate students as it is for practitioners who haven't written exams for a decade. This exercise will give students a clearer idea of what is expected and (by teaching students to outline their answers in advance) a strategy to help them meet that expectation.

This exercise will also motivate some students to watch the course videos on exam grading and prepare additional sample answers.

### **Tools**

Course discussion forum

### **Core readings**

Kaner's essay on *Answering essay questions* available at <http://www.testingeducation.org/BBST>.

The course slides and videos: *How we grade essay exams*.

## Facilitation roles and strategies

Urge students to draft their essay early, so other students have time to peer review. Read the answers when submitted to gather notes for your feedback.

Don't provide feedback on the initial essay during the activity to avoid interfering with students' work as peer reviewers.

Do provide feedback (mainly, pointed questions) on the peer reviews.

Be ready to post your comments as soon as Lesson 6 starts—or earlier if most students have completed the task.

Many of the exam answers will be incomplete. Point out this trend as one of the most common causes for poor exam performance: failing to answer the question asked, often by simply missing some of the question parts.

Many of the peer reviews will be superficial and worthless. Make it clear a peer review only saying "good work" or assigning an unreasonable grade provides no value.

Some instructors heavily emphasize style and formatting issues. We like headings and subheadings and bulleted lists, *but we don't demand them*. You shouldn't demand them either.

If you can easily understand a student's answer and clearly understand how it is organized, then the answer is adequately organized and written. If that structure is not what you would have used, but it is clear enough to be understandable, use it as an example of a good alternate structure. Don't penalize it.

We usually allow 10% of the grade for an answer to be driven by style and structure. Some instructors allow 20%; that's a lot. Don't go above that—leave the rest for the content—and tell students what your allowance is so they can prepare appropriately.

## Variations of the activity

This activity can vary a lot by varying the question students use to practice. We often select a difficult question or one that hasn't received enough of the students' attention in the *Exam Cram* forum.

## 5.2 Oracle heuristics lab assignment: Phase 3

### Preparation

Review instructions for this phase. Assign students to complete a heuristic analysis—dividing the class across an array of the heuristics.

### Activity description

Students again use the guiding questions in the handout to analyze one of the consistency heuristics. This time each student is on her or his own, working with a consistency heuristic they haven't worked with before. Students work individually and then peer review each other's work.

## **Purpose**

This should enable students to work through all of the consistency heuristics on their own, making it possible for them to apply the heuristics intelligently at work.

## **Tools**

Course discussion forum

## **Core readings**

Hoffman's *Exhausting your test options* paper

Kaner's *Impossibility of complete testing* paper

Bolton's (2005) *Testing without a map* is a useful reference throughout all phases of this assignment

## **Facilitation roles and strategies**

Monitor the unfolding discussions and field questions as appropriate. Guide students to use the questions in the assignment handout to assist them in completing the task. Compliment and correct students' efforts as appropriate.

## **Variations of the activity**

The BBST courses use the gaming industry to highlight the diversity of images within it. You can vary this activity by changing the product or industry to which the consistency heuristics are applied. Provided there is striking diversity within the industry, the learning objectives would be met.

## **5.3 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **5.4 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate



# Lesson 6 Tasks

	Quiz for Lecture 6	Exam Cram Forum	
<b>Preparation</b>	Ensure quiz and video are available to students and set to close at the end of the deadline. Take the quiz if you have not already.	Post questions for study guide, if necessary, and enable forum.	
<b>Description</b>	Students complete quizzes while watching videos.	Students collaborate to prepare for final exam.	
<b>Outcomes</b>	Increased understanding	Students draft answers for study guide questions.	
<b>Tools</b>	Quiz, videos, slide sets	Course discussion forum	
<b>Core readings</b>	See course	None	
<b>Communication</b>	Encourage participation. Field questions.	Encourage participation in <i>Exam Cram</i> forum.	

	Quiz 5 Discussion Forum	Instructor Feedback	
	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Course discussion forum	Course announcements and email	<b>Tools</b>
	None	None	<b>Core readings</b>
	Respond to student questions in Quis Q&A as appropriate. Provide additional feedback for frequently missed questions/	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 6

# Overview

Lesson 6 introduces students to software metrics. This is a necessarily brief introduction. By this point, students should be busy preparing for the exam. This is not the time to hammer students with a heavy workload.

The lesson presents four key concepts:

- *Measurement*: the empirical, objective assignment of numbers to attributes of objects or events according to a rule derived from a model or theory with the intent of describing them;
- *Construct validity*: the basis for believing a measure actually describes the attribute. For example, the question, “Why do you think a tester’s bug count is a measure of her skill as a tester?” is a challenge of the construct validity of bug counts as a description of skill. According to the lecture (and to research published by Kaner & Bond), very few papers or books on software metrics evaluate the construct validity of the metrics they suggest. The lecture implies (and we believe) very few of the software engineering metrics, including testing metrics, have any construct validity;
- *Surrogate measures*: A surrogate measure ascribes numbers to attributes but without the benefit of an underlying model or theory. In practice, we use surrogate measures when we don’t know how to measure an attribute, but think the surrogate is correlated with the attribute. Surrogates often measure a narrow aspect of an attribute. For example, a tester’s bug count might be one aspect of their skill or productivity but it misses how interesting those bugs are, how well described the bug reports are, how hard-to-find those bugs were, how well the tester crafted or used tools to find bugs like this, how well the tester covered the area of the program the bug was found in, how well the tester coaches other testers, etc. If we focus too much on bug counts, we might cause testers to spend less time on these other aspects, which might be more important than the bug counts.
- *Measurement dysfunction*: People will optimize their behavior to improve the scores they get when they are measured. This normal human behavior is what makes management-by-measurement possible. What you measure guides how they allocate their time, attention, and improvement-efforts. If you measure the wrong things, they work on the wrong things. Sometimes, measuring something can make the attribute worse than it would have been if there had been no measurement. This is measurement dysfunction.

The lesson presented two examples involving bug counts. One is the risk (futility) of using bug counts to measure the skill (productivity, effectiveness, value) of testers. The other is the risk of using bugs-per-week as a measure of project progress and, in particular, using this in conjunction with a statistical model that is easily proved to be completely invalid.

Some students interpret this lecture as a condemnation of all metrics or all test-related metrics. It's not. Rather, this is more like a lesson on gun safety. There are legitimate reasons for owning and using guns. But if you don't know how to use them safely, very bad things will happen.

## 6.1 Ongoing activities: lectures; exam cram; and quizzes & discussions

The key student activity during this Lesson is exam preparation. No assignments are due, no labs, and the quiz is either short or non-existent. Later BBST courses will use Lesson 6 more aggressively but in this first course in the series, students need this time for their exam.

## 6.2 Send *Weekly Feedback* post

Your weekly feedback must reach students by Friday morning because the exam starts early Sunday morning. Students need time to notice and read the post before the exam. The main topic of this post is probably your feedback on the exam preparation exercise.

## 6.3 Send *Highlights of the Coming Week* post

In the *Highlights of the Coming Week* post emphasize the exam and exam procedures.

## 6.4 Record grades as appropriate

There should be no new grades to record.

In university courses, students will want to know their term grades (the grade they have up to the final exam). They need this information to optimally allocate exam preparation time across their courses. They also need it to allay their anxiety. If you have not already advised students of their grades, do it now.

In professional development courses, you won't have a number for the term grade. You will probably have a mix of numbers and qualitative evaluations. If you have time, it can be useful to scan through these records to determine:

- whose term work was so good they will pass the course even if they fail the exam (unless they cheat on the exam or write an appallingly bad exam);
- whose term work is so weak they will pass the course only if they write a very good exam
- who will pass if they write a good exam and might pass (based on their term work) if their exam is disappointing (failing, but not awful)

In a large professional development class, these notes will help you focus your exam-grading time.

# Lesson 7 Tasks

## ACADEMIC

## PROFESSIONAL DEVELOPMENT

	<i>Exam Cram Forum</i>	<b>Instructor Feedback</b>	<b>Final Exam</b>	<b>Course Evaluation</b>	<b>Instructor Feedback</b>
<b>Preparation</b>	Post questions for study guide if necessary and enable forum.	Monitor course progress and note items to mention in feedback.	Post exam questions and instructions to course site. Hide all resources per instructions in course.	Prepare course evaluation and send instructions to students.	Monitor course timeline and prepare notes.  Remind students of tasks and procedures.
<b>Description</b>	Students collaborate to prepare for final exam.	Lesson feedback from instructor	Students independently complete final exam.	Students share their perceptions of the course design and content.	Instructor feedback
<b>Outcomes</b>	Students draft answers for study guide questions.	Establishes instructor presence and guides student learning.	Demonstrate proficiency with course materials	Information can help instructors revise and improve the course.	Establishes instructor presence and guides student learning.
<b>Tools</b>	Course discussion forum	Most feedback during this lesson will be in the discussion forums.	Course discussion forum	Instructor selects the tool	Course announcements and email
<b>Core readings</b>	None	None	None	None	None
<b>Communication</b>	Encourage students to participate in the <i>Exam Cram</i> forum.  Provide feedback as necessary.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate.  Explain exam procedures as needed.	Explain exam logistics and field questions as needed.	Provide information regarding course evaluation to students.	Provide information about course logistics.

## Lesson 7

# Overview

Welcome to Exam Week.

BBST instructors run the exam in two common ways, which we'll call Professional Development and Academic.

In the typical Professional Development course, students write the exam during Lesson 7. Students peer review the exam in Lesson 8 and the instructor evaluates both the exams and the peer reviews after Lesson 8. This is the structure of the AST courses.

In the typical Academic course, Lesson 7 is a study break and students write the exam during Lesson 8. There is no peer review phase. The instructor grades all of the exams and gives feedback to all of the students. In many academic courses, students submit the exams privately, using an assignment dropbox rather than a visible-to-the-class discussion forum. The exam grades and comments are also private.

The names "professional development" and "academic" are shorthand and not necessarily accurate labels. For example, we already know of one professional development course following the "academic" exam structure. Choose the approach that works best for your context.

## 7.0 Administrative tasks

### 7.0.1 Release the course evaluation

Release the course evaluation along with instructions letting students know where to find it, where to submit it, and when it is due.

### 7.0.2 Hide the course content (professional development course)

During the exam, we hide the content. We hide the links to content (videos, slides, quizzes and quiz forums, most discussion forums). We normally leave the *Help* forum open. However, if students have posted a lot of content to the *Help* forum, we create an *Exam Period Help* forum so students can ask for exam-appropriate help without being exposed to inappropriate content.

## 7.1 Final exam for professional development courses

### Preparation

Select and add questions for the final exam to the exam block in your course management system. At the start of the final exam period, unhide the exam content and hide all other resources including discussion forums and lesson tabs. Send an email message letting students know the exam is ready and reminding them of exam procedures.

### Activity description

Students independently complete the final exam designed by the instructor.

### Purpose

The final exam provides a summative assessment opportunity for both students and instructors to determine how well students can apply knowledge gained from the course to problems posed in the final exam.

### Tools

Discussion forum

### Core readings

None

### Facilitation roles and strategies

Encourage students to complete the exam. Field questions as appropriate.

### Variations of the activity

Instructors can customize the exam by choosing different subsets of questions from the exam pool.

## 7.2 Exam cram forum for academic courses

During Lesson 7, students in academic courses should participate extensively in the *Exam Cram* forum. Monitor the ongoing discussion—offering feedback and encouragement to students and trying to engage those who are not participating. Remember the purpose of your feedback should be formative. Allow students in the course to wrestle with conceptual challenges of the questions.

# Lesson 8 Tasks

	ACADEMIC			PROFESSIONAL DEVELOPMENT		
	Final Exam	Course Evaluation	Instructor Feedback	Final Exam Grading	Course Evaluation	Instructor Feedback
Preparation	Post exam questions and instructions using tools and procedures determined by your organization.	Prepare course evaluation and send instructions to students.	Monitor course timeline and prepare notes.  Remind students of tasks and procedures.	Unhide resources.  Assign two reviewers per exam.	Prepare course evaluation and send instructions to students.	Monitor course timeline and prepare notes.  Remind students of tasks and procedures.
Description	Students independently complete final exam.	Students share their perceptions of the course design and content.	Instructor feedback	Students peer review exam answers submitted by classmates.	Students share their perceptions of the course design and content.	Instructor feedback should focus attention on the peer review process and course logistics. Provide individual feedback on exam performance as appropriate.
Outcomes	Demonstrate proficiency with course materials.	Information can help instructors revise and improve the course	Establishes instructor presence and guides student learning.	Demonstrate proficiency with course materials.	Information can help instructors revise and improve the course.	Establishes instructor presence and guides student learning.
Tools	Course discussion forum	Instructor selects the tool	Course	Course discussion forum	Instructor selects the tool	Course discussion forum or other tool
Core readings	None	None	None	None	None	None
Communication	Explain exam logistics and field questions as needed.	Provide information regarding course evaluation to students.	Provide information about course logistics.	Explain peer review logistics and field questions as needed.	Provide information regarding course evaluation to students.	Provide information about course logistics.

## Lesson 8

# Overview

Academic students write the exam in Lesson 8.

Professional development students wrote the exam in Lesson 7, now peer review each other's exams.

### 8.1 Final exam (academic courses)

#### Preparation

Select and post questions for the final exam in the appropriate place in the course. Send an email message letting students know the exam is ready and remind them of the exam procedures.

During the exam, we hide the content. We hide the links to content (videos, slides, quizzes and quiz forums, most discussion forums). We normally leave the *Help* forum open. However, if students have posted a lot of content to the *Help* forum, we create an *Exam Period Help* so students can ask for exam-appropriate help without being exposed to inappropriate content.

#### Activity description

Students independently complete the final exam designed by the instructor.

#### Purpose

The final exam provides a summative assessment opportunity for both students and instructors to determine how well students can apply knowledge gained from the course to problems posed in the final exam.

#### Tools

Discussion forum or assignments. We typically have students upload a Word, OpenOffice or PDF file to an assignment ("upload a single file") dropbox.

#### Core readings

None

#### Facilitation roles and strategies

Encourage students to complete the exam. Field questions as appropriate.

#### Variations of the activity

Instructors can customize the exam by choosing different subsets of questions from the exam pool.

## 8.2 Final exam peer reviews (professional development courses)

### Preparation

Assign two reviewers for each exam and post those assignments to the course discussion forum. To the extent possible, be sure each exam is reviewed by one of the stronger students.

Unhide course resources for students to use as reference materials throughout the review period.

### Activity description

Students review and critique at least two of their peers' final exam answers. After they do their review and their exam answers are reviewed, students post a *reflection* for each of their answers. The typical (good) reflection considers the strengths and weaknesses of their exam answer and describes how they would answer the question now.

### Purpose

To gain additional insight by reading and reviewing others' work and to provide feedback to peers.

### Tools

Course discussion forum

### Core Readings

None

### Facilitation roles and strategies

Some students may express discomfort with the exam review task:

Some students have been socialized to never speak critically of the work of their peers. (What are these people doing as testers?)

Some people think teachers should do all of the assessment in a course and it's inappropriate for students to evaluate each other's work.

Some people find the task intimidating and look for any rationale to avoid it.

The professional development courses may rely heavily on peer review:

People learn a lot from doing peer reviews. Some report they learned more from reading and critiquing peers' answers than they did from studying to prepare their own responses.

It is impractical to have volunteer instructors do the majority of assessment in the course. In groups like the Association for Software Testing, a project like the BBST project would be unsustainable if the students didn't do most of the assessment.

The model of expert teacher and inadequate, inexperienced, naïve student was a good one back when these students were children. However, they are now professionals and the BBST courses are not beyond their reach. The point of the class is to help students develop as professional-level

critical thinkers in the field. They must attempt that or they are wasting their time and their teachers’.

Encourage all students to complete the review task to the best of their ability, pointing out they may review other people’s exams for additional perspectives, draw on their own experiences, and refer to the course materials to complete this task. Providing critical review in the “safe” environment of the online class is good practice for the software tester’s work world where testers must frequently write reports and critically respond to others. In the work place, the stakes are often much higher than they are in the online classroom.

### **Variations of the activity**

None

### **Grading (professional development courses)**

It is up to you to do the final evaluation of the exams and peer reviews, and make the complete/non-complete decisions.

We start adding comments as soon as the assigned peer reviewers have made their comments and the student has posted her or his reflection.

We also will comment on the peer reviews. This is important for students who will pass the course. They will progress to *BBST Bug Advocacy* and *BBST Test Design*. Instructors in those courses will expect students to have some experience and skill at peer review and will deal with the lazy or unskilled peer reviewer with less patience.

We normally post some feedback for each student. If the exam has 6 questions, every student has a comment on at least one question. Ideally, every instructor posts one feedback per student and so in a class with three co-instructors, each student gets instructor feedback on at least three answers.

We normally spend more attention (and add more comments) on grading the weaker exams. If there are multiple instructors, usually only one instructor posts a comment to the same question by the same student. It is not uncommon to see comments on all 6 answers of a borderline student. Many of these students come back for a second try at the course. Good feedback can help them pass next time.

Failing students who dismiss sound peer-review criticisms of their work often get less feedback. If they aren’t going to accept feedback, there is no point spending a lot of time writing it.

Some students write failing exams but then give insightful peer reviews and reflections. In the professional development courses, we will allow a student to pass the course based on excellent peer-review-and-reflection work, even if their exam was inadequate.

In general, our bias is toward passing students. Most professional-development students who have come this far in the course have invested a lot of time and probably have learned a lot. However, some students just don’t learn very much from the course. Some are too tightly wrapped up in their preconceptions to hear what the course is teaching. We don’t insist they agree with us. We do insist that they pay enough attention to understand what we are saying.

Some are gambling they can pass by staying to the end of the course even if they do little work or very shoddy work. Some believe they can do nothing then intimidate or flatter the instructor into passing them. We hope you will exercise some critical judgment here. Every closed-minded fool and lazy ignoramus who passes this course will diminish the reputation of the course. The issue is not the percentage of people who pass the course. We are happy to have classes in which every student completes the class successfully. The issue is some people will say things about testing that will cause listeners to wonder how good BBST courses could be if *this* person can pass them. A student who would discredit the course should flunk it.

Another factor in the complete/non-complete decision is the assessment of their ability to complete *BBST Bug Advocacy* or *BBST Test Design*. Those courses assume more effective study skills, time management skills, peer review skills and analytical/communication skills needed to complete more difficult assignments and exams than *Foundation's*. Letting an incapable or unwilling student through *BBST Foundations* is a disservice to their future classmates and instructors.

Sometimes you will meet a student who worked hard in *BBST Foundations* but will not succeed in *BBST Bug Advocacy* or *BBST Test Design*. You might reasonably decide the best thing to do with that student is to allow them to complete this course but with a letter recommending they stop at *BBST Foundations* and not enroll in the next courses.

### **Grading (academic courses)**

It is up to you to do the final evaluation of the exams, assign grades to each answer, and communicate an exam grade to each student.

We create grading charts like the ones we describe in the *How we grade exams* slides and videos. We don't publish the grading structure but we can explain our grading to students who ask.

### **Variation: Interactive grading (professional or academic)**

When we teach this course with local academic students, we meet face-to-face with each student and interactively grade the midterm exam (equivalent to a BBST final). We have started doing interactive grading with professional students, who tell us they like it.

We plan to start using interactive grading for *BBST Foundations* exams in online professional development courses because students in this course (the ones who pass and the ones who don't) need detailed feedback. The quality of feedback they get in peer reviews is variable—the students are still learning how to do peer reviews. Too many of the peer reviews are vague and flattering; or hypercritical with an emphasis on superficial details (such as formatting), or content-challenged because the student is not sufficiently knowledgeable and is not taking the time to get more knowledgeable as part of the grading process. One of the key complaints of *BBST Foundations* students is insufficient feedback from the instructors. Interactive grading of the exam can go a long way toward changing that feeling.

Set up your interactive grading session so the student can see your screen. In a face-to-face meeting, set up a dual-monitor system so the student can watch what is on your monitor without having to look over your shoulder. Remember that eyesight (and convergence distance on reading glasses) varies. If you look at one screen side-by-side with a student, she or he

might not be able to read the screen. In a two-display system, she or he can move the display to a better place and angle. In a Skype meeting, alternate between sharing your screen and displaying live video of you as you talk to the student.

Make a copy of the exam answers for yourself and urge the student to print out a copy as well. You will want to be able to refer to this without switching your screen from the grading spreadsheet to the exam itself. You will sometimes switch to a view of the exam; make this a matter of choice rather than necessity.

Set up a table or spreadsheet with a section for each question. For a given question, break it into parts; allocate points for each part and decide what the student has to do to achieve points (full or partial) for that part. Each part gets its own column. In the top row, describe the part. For example, from the example question in Lesson 5, you might create headings like “Stopping Rule 1” and “Tradeoffs for Rule 1.” Include a column for style and organization. In the second row, show how many points you allocate to each part. We allocate 10% of the grade for style and organization or for our subjective impression of the quality of the answer. Most of the essay questions are open-ended. Students can answer them in different ways and reach different conclusions. In the process, they might make different arguments or cite different facts. Allow for this diversity in your grading structure. To allow for this, your total might add up to more than 100%. That’s OK. Let the points take you to 90%. Reserve the last 10%, no matter how high the point count, for your overall subjective assessment of the answer.

Kaner illustrates this in the grading videos at <http://www.testingeducation.org/BBST/takingexams/> (these are probably already in your course resources). If you have included these videos and pointed students to them (for example in the exam practice activity in Lesson 5), students will already expect this structure for grading and not be surprised by it. In our experience, they are intrigued to see it applied to their work.

*Please do not give your students a copy of your grading chart. It will get posted to the internet almost immediately and will distort performance in the classes. We have a lot of experience in academic courses with students who study from grading structures or sample answers other people created for them; the students learn very little and often flunk the course. Despite this, many students are attracted to these materials, relying on them instead of puzzling through the questions (doing some learning) as their own cognitive activity.*

We recommend you grade at least one course worth of exams using this type of grading structure before trying to do this in interactive grading. These tables are not perfect. Some students will give good answers that don’t map well to your table but that deserve a high grade anyway. Some of these answers will prompt you to revise the table while you are grading. Get that experience behind you, in private, before trying this as a live activity.

For interactive grading, create a separate copy of the table to use with each student. Don’t show any student the assessments of other students’ work.

Do not read the student’s exam answers before the interactive grading session. Part of the value of the session comes from showing your confusion and surprise at what the student says. It is entirely appropriate, in fact it is highly desirable, to make comments like the following (if they are justified):

- I don't understand what you are saying here? Can you explain it?
- What were you thinking?
- How does this relate to the question?
- Aren't you telling me the same thing you already said in this part? Am I missing a difference?
- Can you explain what you think the question was asking here? I don't understand how this comment responds to the question.
- How does this conclusion follow from this argument, or these facts?
- Why do you think this is true?
- Was this claim made somewhere in the lecture? If not, what is your source for saying this?
- Do you want to elaborate on that?
- Can you draw a diagram and explain it to me?

During the interactive grading session, we typically do the following:

- Go through the exam one question at a time. Start with a short-answer question to set the tone, but go to the long-answer questions next and come back to the short answers at the end. Don't fall into the trap of using all your time on the much-easier short answers.
- Explain the grading structure in the context of the first short-answer question. If you structured the exam well for interactive grading, the first short-answer question will have a few parts but it won't be very difficult. It will serve as a nonthreatening introduction to the grading structure and the interactive grading process.
- Give the student constant feedback on what you are reading and doing. If you are showing the student's answer on the screen, highlight the section you are reading. If you are showing the grading structure on the screen, consider reading the answer out loud, stopping to make comments or ask questions. Or just give status reports like, "I am reading your third paragraph."
- When you see something mapping (well or poorly) to your grading structure, note it. Consider making qualitative notes (such as "incorrect", "weak", "confusing", "OK", "strong")
- As you read, you will often see something shown in one column in your grading chart is split into disjointed bits in the answer. You might change your note several times, perhaps from "weak" to "weak+" to "OK". This type of thing happens often in disorganized answers. If the answer is actually disorganized (rather than being well-organized but differently from your structure), comment to the student on how hard it is to follow this answer for grading. If the answer is good but organized differently from your ideal

answer, compliment the student on their structure. Show the student you understand and are OK with it even though different from what you initially had in mind.

- If the student makes an error, such as an incorrect statement or an unsupported assertion, we count that against the answer's grade. If the student made an error in a relevant part of the answer, make a note or take off points in the appropriate column. If the student made an error in an irrelevant part of the answer (a shotgun answer) add a new column and put a negative number in it. Some students will protest they shouldn't be penalized for errors in something not necessary to the answer. We disagree. We think a student who doesn't know relevant from irrelevant (or correct from incorrect) is demonstrating cluelessness, and we think the grade should reflect that. You will have to set your own standards on this. Set them in advance. Don't let an obnoxious student bully you into setting the grading standard.
- If the student has already given peer review feedback on other students' answers, you might find it interesting to review and ask the student to explain their feedback. If their feedback doesn't communicate their thinking well or if the grade they assign is inconsistent with their opinion, give them feedback on how they could have said it better. If this student continues to other BBST courses, training him or her to give better feedback will be an important service for future peers.
- After you have made notes on each part, consider asking the student what grade they would assign to the answer. You are not bound by their grade, but it is informative to know what they think.
  - Some students are too harsh on their work. If a student gives a "D", but you think it's a "B", say so and explain why.
  - Other students are remarkably generous to themselves. Be cautious in your interpretation. Cultural diversities are in play here and something seemingly outrageous to you might be normal haggling to the student. That said, when a student tries to give a high grade to a lousy answer, this often reflects a serious lack of comprehension of the material and/or an unwillingness to learn through constructive criticism. *IF* that is your assessment, and *IF* this happens on more than one question, you are probably going to treat the exam as an indicator the student should not complete (professional development) or fail (academic) the course.
- Some students refuse to take constructive criticism, argue with every critical comment, and try to intimidate the grader.
  - If you are an academic grader, you have experience in dealing with this and you have a department chair to advise you. Do what is appropriate at your school.
  - If you are teaching a professional development course, you probably don't have much experience with this. Our advice is you don't have to put up with this. In the volunteer-instructor case (such as teaching for AST), stop the session once you see a clear and irritating pattern. Assign an appropriate grade (complete or not) without giving the student further input into the grading process.

- If this is a paid professional development engagement with a company employing this student, you may have a client management problem. But if you are skilled enough to be teaching this course to paying clients, you already know how to manage your clients.

At the end of the interactive grading session, invite the student to give you feedback on the session and how you managed it, and overall feedback on the course. End the session so the student has the last word, especially if it was a difficult session.

In our experience, most students are appreciative. (Actually, in our experience *so far*, EVERY student has been appreciative. The online students and the face-to-face academic students have thanked us, even the ones who failed the exam or assignment miserably. But we know this is too good a streak to continue, so by the time you read this, we expect our experience will have become, MOST students are appreciative.) Most students tell us they learned a lot from the exercise. We believe we are seeing improvement in performance in academic courses on software testing and software metrics because of this process. But we also think it takes a lot of preparation. Our results with students have been good *because* we were well prepared, clear in our communication, attentive to their reasoning, flexible, and confident rather than defensive.

### **8.3 Send *Wrapup* post**

At the end of the exam period, send a message thanking students for their participation in the class and advising them when you anticipate having the exams graded and ready for them to review.

Please do not post sample answers for each exam question. Over time, this will lead to a bank of “approved” answers on the internet, destroying the value of these questions in our courses.

# Ongoing tasks

## 9.0 Administrative tasks

### 9.0.1 Monitoring student progress

The timeliness of student assignments is very important to the success of any online course. Instructors should monitor student submissions. If a student is late, depending on the late policies announced to the class, the instructor can make contact to:

- encourage the student.
- see if special circumstances require emotional or logistic support.
- make the student aware they are late and it matters.
- figure out whether this student actually has dropped.

Personal and work circumstances can give good cause for a student to fall late. When that happens, it's important to intervene as soon as possible to help that student. Often, the circumstances that led to falling behind will be too complicated to resolve for a short course. If that is the case, the instructor in a professional development course should let the students go with a smile. After all, these might be our students for now but they will be our colleagues soon. How an instructor terminates students could have long-term interpersonal consequences.

## 9.1 Lectures and quizzes

### Preparation

If you are teaching from a master copy of the course, you will need to review the quiz questions and answers. If you are creating your own course, you will need to populate the course with quiz questions. Most course management systems allow you to provide feedback for students' quiz attempts. We recommend you take advantage of that powerful capability.

We plan to create a BBST student edition including quiz questions and feedback. Once published, you might choose to use questions in that book for your own courses. You might also choose to create your own quizzes. If you write your own questions, we suggest the question writing standards we present in Chapter 6.

We also recommend setting up a discussion forum for each quiz. In our courses, we pre-populate the forums with individual threads—each including one question and its answer. The quiz forum is hidden from student view until after they take the quiz. Once the quiz is over, the students have an organized structure for discussing aspects of the course material they found challenging. Our students report such discussions are very valuable for them.

## Activity description

Students watch course videos and complete the corresponding quizzes in parallel. Quizzes are intended to focus student attention on important aspects of the lecture. The course management system provides automatic feedback for each question but students may discuss challenging questions or controversial answers in the quiz discussion forum.

## Purpose

In the BBST courses, quizzes are used formatively to focus students' attention on important information presented in readings and lectures. Answers are expected to come from the course materials. Neither students nor instructors should emphasize quiz grades. The learning from taking the quizzes is more important.

The testing field has many different perspectives and we encourage debate on these perspectives in the quiz discussion forums. However, quiz scores will not change as a result of those debates.

## Tools

Quiz and discussion forum

## Core readings

None

## Facilitation roles and strategies

Please encourage students to complete the quizzes as they watch the videos. Some students are dismayed by their performance on the quizzes. Consider sharing the *Philosophy of Quizzes* with your class to help them understand how the quizzes are used and why they are used that way. See a sample post in the *Fieldstones* appendix.

Although our quizzes provide automatic feedback for quiz answers, we invite students to visit the quiz discussion forum to discuss and/or challenge the questions from the quizzes. If you are teaching from a master copy of the course, the quizzes and *Quiz Q&A* may already be in place. If you don't understand or agree with an answer, consider removing it from your quizzes.

Instructors should monitor the unfolding discussion in the quiz discussion forum. A few days after the quiz closes, one of the instructors can post comments to the discussion forum. Most instructors like to make comments on any of the questions a majority of students answered poorly. Be sure to check the quiz automatic responses for the question before posting a comment so you don't repeat what they've been told. Many times, the quiz response is clear and the instructor does not need to comment in the forum. To find out how the group did on specific quiz questions in Moodle, go to Quizzes —> Quiz N —> Results —> Item Analysis.

## Variations of the activity

None

## 9.2 Exam cram forum

### Preparation

We recommend setting up the exam study forum with a post titled *Using This Study Guide*. Following that, you should have one discussion thread for each question. Each thread should have titles like “Long 1” (referring to the first Long Answer question in the study guide). You can find *Using This Study Guide* and study guide questions at <http://www.testingeducation.org/BBST>.

### Activity description

The exam study forum is for students to discuss study guide questions with their peers and instructors. Students engage with their peers and the course materials to build their own answers to potential exam questions.

### Purpose

Providing exam questions ahead of time allows instructors to require better answers from all students. It is especially helpful for students who are using a second or third language throughout the course.

### Tools

Course discussion forum

### Core readings

None

### Facilitation roles and strategies

Instructors should monitor discussions on the exam study forum but refrain from providing answers to questions appearing on the exam. Several types of feedback to students are useful:

#### Organization and structure

Whether or not an answer is complete. For example, students sometimes skip parts of a question. You may respond to a draft answer by asking, “Where is X?” or “Have you addressed all parts of this question?” Similarly, if the question asks for multiple arguments or examples, and the student answer provides only one, you might post a comment like, “This gives one example; the question asks for 3.”

Sometimes a question uses material from the slides but misses key relevant material from the lecture or the assigned readings. In that case, your response might ask, “Does this use the necessary source material? What about the readings?”

If students are leaving a question unanswered and the relevant lecture(s) has passed, the instructor might post a very short note, like “No answer?”

If an answer is going in the wrong direction, the instructor might query, “Does anyone have a comment on this?”

The instructor should not post a comment on every question. Don't give the impression you'll catch every big mistake or bad direction.

**Variations of the activity**

None

# Ending the course

## 10.0 Administrative tasks

### 10.0.1 Grading

Grading standards will vary widely. At the end of the course, determine and privately communicate grades to students. Depending on your institutional context, you may choose to send an email to each student, post to an institutional grade reporting system, or send certificates of completion. No matter the context, it's important to complete the grading process in a timely fashion.

### 10.0.2 Review course evaluations

After the course is complete and all grading obligations are met, instructors should review the course evaluation data looking for opportunities to improve the course. Make notes and updates as appropriate. In addition to course evaluation data, Fiedler recommends you review postings from the *Help! Discussion* and course emails looking for areas of confusion to clarify by revising instructions for assignments or course materials.

For more details on grading and course evaluation, please consult Section One of this *Instructor's Manual*.

# SECTION 3

## TEACHING THE BUG ADVOCACY COURSE

## Preface to section 3

This section of the *Instructor's Manual* is about teaching *BBST Bug Advocacy*, the second four-week course in the three-course BBST series. Throughout this section, we write to a general audience about things they may decide to do to customize the course. If you are teaching for an organization, you may not have the privileges or the freedom to make these changes. If that is the case for you, please speak to the appropriate personnel about any changes you wish to make.

### Organization of this section

#### **Chapter 9: Preparing to teach the *BBST Bug Advocacy* course**

Even if you have the lectures on tape and have developed homework, quizzes and exams, online courses require a lot of preparation before the official start date. In our experience (and the experience of countless colleagues), thorough preparation before the start of class is important for online courses and online courses are more likely to fail badly in the hands of a poorly organized instructor.

Chapter 9 lays out the tasks we urge you to complete before the first day of class. For discussion focused on how and why to do tasks like these, please see Section One of this manual.

#### **Chapter 10: Teaching the *BBST Bug Advocacy* course**

We divide the course into eight lessons each spanning half-week segments. Each segment includes a weekend day and some weekdays: (a) Sunday to Wednesday and (b) Thursday to Saturday. Many students do most coursework on the weekends and this schedule gives them a weekend day for every lesson.

Tasks are due on the last day of the segment. Most tasks start the first day of the lesson and some tasks run two or more lessons. As lessons complete, give students feedback on their performance, alert them to what's coming in the next lesson, and assist those who are having trouble making the progress needed to move into the next lesson.

Chapter 10 lays out the instructor tasks on lesson-by-lesson timelines. The chapter has sections for each lesson, ongoing tasks, and end-of-course tasks. Be certain to read each section of the chapter. Please see Section One of this guide for more information about how or why these tasks are important.



## Chapter 9

# Preparing to Teach the *BBST Bug Advocacy Course*

### Set up your online classroom

Good teachers prepare their classrooms before students arrive. Commercial instructors make sure technical equipment is working, arrange for lunch, and familiarize themselves with the locations of restrooms and water fountains so they can keep attendees comfortable. Kindergarten teachers make many of the same arrangements and also decorate bulletin boards, set up play areas, and make nametags for the little ones. In their own ways, all of these instructors are making their classrooms a welcoming and comfortable space for the students.

Similarly, online instructors have a set of tasks to prepare their online classrooms for their students. This chapter describes these tasks.

### Review course structure, policies and content

Familiarize yourself with the course objectives and instructional strategies. The resources available to the students include videos, readings, grading guides, and quizzes with feedback. You can find additional instructor-support materials at [testingeducation.org/BBST](http://testingeducation.org/BBST). Be sure to review these resources as you prepare to teach your own class. If you have not watched them recently, view the videos. Take the quizzes. If you know other instructors, consult with them as you have questions—to do this effectively, you will have to prepare for the course in advance. Give yourself enough time to discover you are confused, to ask questions, to get answers and to work with those answers until you can deal appropriately with that part of the course.

The quizzes, in particular, bring grief to underprepared instructors. The questions have been carefully written and polished over time. They are intentionally difficult. Many students are accustomed to easy quizzes and expect to get high grades with minimal study. Our quizzes are open-book, but it is common for students to score 40% to 70% in their first few BBST quizzes because they have to develop better test-taking skills (such as, more careful reading). Students who are used to getting A's (90% in the United States) may be shocked by these low grades. Some will consider dropping the course. Others will protest, sometimes quite vigorously. If you are not prepared to respond knowledgeably and confidently, you will lose credibility with your students.

To prepare for this, you must work through the quizzes yourself, in advance. Question them. If you cannot defend the answer and the analysis in one of the quiz questions, drop it from your course before students see it. Putting yourself into a position of having to apologize for the questions or join the students in disagreeing with them will reduce the credibility of the course, reduce your credibility, and diminish the value of the course to your students. Similarly, it is important to understand the course assignments; what distinguishes strong from weak performance; and the exam study guide questions. What you can't work with, replace.

## Review and modify the course

If you are teaching for an organization, you may receive a “copy” of the course to use for your class. Once you have access to your course, familiarize yourself with everything in the course. It is particularly important to check all links in the course to be sure none have broken as the Internet continues to grow and evolve. Fix any broken links. Delete any content you don’t want to use for the class you will be teaching and add content as appropriate.

The course you receive was likely created as a copy of an earlier course or from a course backup. You may find remnants of the earlier course needing to be removed. In particular, pay attention to the following areas:

- List of students—remove any not in your section of the course.
- Discussion forums—Your set of discussions will have some generic posts describing tasks or policies. You may need to edit some of these to fit your circumstances. The forums may also have posts submitted by previous students and non-generic instructor responses. Delete these.

If you are teaching an AST-approved version of this course, you must not delete content, significantly modify the assignments, or substitute examination questions without prior AST approval. Contact the chair of the AST’s Education SIG to discuss any changes you wish to make.

If you are developing a course for the first time, you can acquire most resources you will need from <http://www.testingeducation.org/BBST> or the National Science Digital Library at <http://www.nsdll.org>.

## Determine your policies

Setting and communicating your policies is important to help students know what you expect of them. *Moodle* users can take advantage of *Moodle’s* Choices capability to share policies. Publish the policy as a Yes/No Choice and ask students to respond. If your Course Management System doesn’t have a similar capability, consider posting your policy in a discussion forum and ask students to reply to your post indicating their agreement. The students’ responses document you have provided them with the policy information. Once all students have agreed to the policies, you can hide the forums or choices section to keep your online classroom uncluttered. Do not delete the responses in the event you need the documentation later.

Consider sharing some or all of the following types of policies with your students and posting them before the course starts. See Chapter 2 for a brief discussion of these policies:

- Late work policy
- Academic integrity policy
- Acceptable use policy
- Privacy policy

## Set up discussion forums

Class discussions are more easily organized if you have a variety of discussion forums to handle them in an organized way. Some discussion forums will focus on specific course content or assignments. Some will support students' study efforts by providing a place to ask for help or talk about course content in an ungraded format. Others will provide workspace for groups. Still other discussion forums provide opportunities to socialize. In *BBST Bug Advocacy*, start with the following discussion forums and add others as needed:

1. Course Announcements (this is for instructor use only)
2. Help! Forum
3. Hallway Hangout (A social forum)
4. Exam Cram Forum (Ungraded)
5. Meet & Greet (A social forum)
6. Exercise 1a: What's a Bug?
7. Exercise 1b: What is Quality?
8. Exercise 2: Your Experience With Bug Reporting
9. Assignment Phase 1 & 2: Bug Evaluations
10. Exercise 3: Problem Summary
11. Exercise 3: Follow-up Tests
12. Assignment Phase 3 & 4: Bug Evaluations
13. Quiz 1 Q/A & Discussion (Ungraded) (Initially hidden)
14. Quiz 2 Q/A & Discussion (Ungraded) (Initially hidden)
15. Quiz 3 Q/A & Discussion (Ungraded) (Initially hidden)
16. Quiz 4 Q/A & Discussion (Ungraded) (Initially hidden)
17. Quiz 5 Q/A & Discussion (Ungraded) (Initially hidden)
18. Quiz 6 Q/A & Discussion (Ungraded) (Initially hidden)

## Working with co-instructors

If you plan to work with one or more co-instructors, spend some time working out details about how the instructor role will be divided among the instructors. Designate a lead instructor and use a task-tracking list to coordinate the tasks. At the time of writing, instructors for the Association for Software Testing used *Google's* document sharing service for this. Remember that timely feedback is critical—particularly in short courses.

## Publish the course task list

Providing students with a single document listing course tasks and deadlines helps them manage their time and work load. We have provided a sample task list for each class in the Appendices of this book. Create a similar document for your course and post it online.

Depending on the course management system (CMS) you are using, you may be able to build the course schedule using a CMS tool. For example, if you use *Moodle* 1.9 (and newer) you can install an extra module called *Progress Tracker*, allowing students to check off tasks they've completed. Visit [Moodle.org](http://Moodle.org) for more information on *Progress Tracker*.

## Quizzes

Most course management systems allow you to designate start and end dates for quizzes. Once your course task list is updated with the appropriate dates, set quiz dates in the CMS to correspond with the published dates.

We recommend having all quizzes open at the start of class so students can work ahead if their personal and professional schedules require it. Set the quiz close dates to enforce deadlines posted in the course materials.

We provide an opportunity for students to discuss quiz questions after the quiz has closed. Prepare the quiz discussion forum for each quiz by populating it with quiz questions and answers—one thread per question. In the *BBST Foundations* course, we set each forum to open once the quiz ends or open the quiz discussion forums manually. Some instructors follow the same policy for *BBST Test Design*. Others (including Kaner) open all forums at the start of the *BBST Test Design* course, so students can post comments on a quiz as soon as they finish the quiz. If you manage the quiz forums this way, be sure to remind students to stay out of a quiz forum until they have taken the quiz.

## Prepare for grading

Tracking student progress is an important instructor responsibility. Most course management systems have a gradebook function to streamline this task. Alternatively, you can set up a spreadsheet. Be sure to set up grading space for each graded assignment and anything else you'd like to track. If you don't want to use the traditional A, B, C, D, and F letter grades, think about what you can do as an alternative. You can set up customized grading scales. Possible alternatives include:

- Fail / Pass
- Incomplete / Complete
- No Credit / Credit
- Not Done / Weak / Acceptable / Good / Excellent
- Nothing submitted / Substantially incomplete / Unresponsive / Insufficient / Weak / Adequate / Good / Excellent / Instructor quality (*This is the scale Kaner uses.*)

For professional development classes, we avoid using *Fail* because we recognize students are often pulled away from the class for more important or urgent projects at work. Instead, we prefer to report the student performance as *Incomplete*.

*Tracking progress* does not necessarily require a detailed evaluation of each submitted piece of work. For example, in a professional development course, it is usually enough to note whether the student submitted a lab and if so, whether it was adequate. This will tell you whether the student is keeping up with the course. You might look at individual pieces of work in much greater detail, but you may have time only to look in detail at a few students' work each week.

This inconsistency will not work in an academic course. University students reasonably expect that every piece of their work will be formally graded. Academic grades are high-stakes. Access to scholarships and future jobs can depend on a transcript (the record of grades). But in a professional development course, the student is under no such pressure. The student needs feedback, not a grade. You have to manage your time in a way to give students sufficient feedback. On the professional development schedule and rate of pay, you cannot afford to waste hours arguing with professional development students about whether a piece of work deserved a "C" or a "B". Changing the letter-grade will not change the quality of the work that was submitted. Give them feedback about their quality that you believe they will find most useful.

If you use a Course Management System's gradebook, you can set it to show the students their grades. We do this as a matter of routine in academic courses. However, in professional development courses, we treat the gradebook or the grading spreadsheet as a place for private notes for the instructor.

## **Post your introduction**

Just as commercial instructors and Kindergarten teachers arrive early to welcome their students, online instructors should prepare their classrooms to be a welcoming space. Be sure to post a friendly introduction in the *Meet & Greet* forum. In it, include your name, your location, your employment, hobbies or interests, and a digital photo. Try to craft a message conveying your professional credentials while letting some of your personality shine through. Doug Hoffman did this by talking about his love of adventurous dining:

## **SUBJECT** Introduction

I'm Doug Hoffman, located in Silicon Valley. I'm an independent management consultant (for many years now) and before that an employee for one or another company for a long time, too. I have done many different jobs in the software engineering field for a broad spectrum of companies, giving me experience working and creating solutions in many different contexts. I've been teaching the BBST class (stand-up) for over 10 years, instructing the *BBST Foundations*, and leading the *BBST Bug Advocacy* courses for AST. I'll be leading this one, too.

I spend a lot of my time working in the professional community: President of AST, instructor, Fellow of ASQ, invited speaker chair for PNSQC, Auditor for SSQA, senior member ACM and IEEE, speaking at conferences, writing papers, giving talks, and other such stuff.

I've been very fortunate with the professional people I've met and with whom I've had the opportunity to share ideas. AST and many LAWST style workshops have been some of the best mechanisms for networking. I enjoy teaching because of all I learn from it. I'm looking forward to learning a lot more again in this class.

When I get a chance I like to do pencil puzzles, but my favorite hobby is trying different local foods when I travel. I like most foods, so I judge how much fun I had by the number of new foods I discovered that I didn't like. (The more I didn't like, the more different foods I tried. )

I think this class is going to be fun and I'm really looking forward to it.

Be sure to return to the *Meet & Greet* forum to greet students as they join the class and post their introductions.

## **Make a first impression**

Depending on your individual circumstances and your access to student contact information, we recommend sending at least one—and possibly two—messages before the course starts. In your message, try to convey a warm welcome to students as well as the logistical information (web address, user name, enrollment keys or passwords, etc.) students need to begin the course.

We also find it useful to set students' expectations on workload and to remind students about routine housekeeping matters such as updating antivirus software, downloading appropriate media players, updating system software, and paying attention to a backup strategy for course work. Be sure to coordinate messages with any course registration correspondence to avoid duplication.

## **Set the rhythm of the course**

Our professional development courses are designed keeping the typical work day/weekend day structure in mind. Each week has two lessons. The first lesson runs from Sunday to Wednesday and the second from Thursday to Saturday. Each lesson includes a weekend day, so

students who can only work on the weekend can complete the lesson work. You can reinforce this segmentation with well-timed messages.

Generally speaking, the student week looks like this:

**Sunday through Wednesday**—Students work on a lesson with their initial posting due no later than Wednesday.

**Thursday to Saturday**—Students work on another lesson requiring them to frequently review and respond to other students. If assigned, students complete one or more peer reviews of work submitted in the first part of the week.

You might make some posts during this period, but the goal is to acknowledge and encourage progress, rather than to make a substantial contribution. Most instructor feedback during the exercises is in the form of directing questions rather than critiquing or answering the exercise question. The course is designed so much of the student's learning comes from discussing course content with other students, giving and receiving peer review, and attempting quizzes and assignments. Reading and receiving instructor feedback also contributes to student learning. Often instructor feedback is given to the group as a whole and not always to specific individuals. The online course is not individual tutoring.

The instructor's week proceeds as described here:

Log in to the course every day. Be sure to check the *Help!* forum and handle any problems blocking students from making progress. Alternatively, you might prefer to subscribe to all postings in the *Help!* forum so messages come directly to an email account you read frequently. Most course management systems have this capability.

Other than *Help!*, there is no need to respond to students each day—or to spend a lot of time reading the daily posts. However, a daily login allows you to monitor student progress and to intervene if a discussion thread goes off track.

We recommend you make at least two posts each week (*Highlights of the Coming Week and Weekly Feedback*) to maintain a sense of instructor presence in the minds of the students and to reinforce the rhythm of the class. These posts should go in the course announcements forum with all students subscribed via email.

## Highlights of the coming week

Posted on Saturday or Sunday, this instructor posting gives students an overview of the coming week and highlights particularly interesting or difficult areas about the content they will encounter in the coming week. If the workload for the coming week is a bit heavier than usual, this post is a good opportunity to warn students. Making this post also gives you a chance to remind students how to correct persistent problems you have noticed in previous weeks or to tell students what aspects of their performance you will be watching closely. You may also share additional resources especially relevant to student efforts for the coming week.

## Weekly feedback

The weekly feedback post is exactly what it sounds like and should generally be posted on Sunday or Monday. This is sometimes combined with *Highlights of the Coming Week* in a single posting. In this post, you can point out broad themes you identified over the course of the past week; draw attention to individual contributions particularly insightful or noteworthy; or invite further participation in an especially engaging thread. Use this post to identify and correct any broadly held misunderstandings you've noticed (but never in a way that would embarrass individual students). To correct misunderstandings, you can ask students to review a particular chunk of course content; point them to additional resources; or create another resource for them. If at all possible, start and end this post on a positive note.

In some cases, you may choose to address an individual's substandard work in a private email.

## Pre-course checklist

- Set up a private discussion group / mailing list with your co-instructors.  
There are several free alternatives to accomplish this.
- Decide how instructors will share course tasks.
- Check to make sure all links in the course are working.
- Check course content for updates and modifications.
- Finalize and post course policies.
- Accept the course policies yourself.
- Set up discussion forums for the course.
- Confirm existing posts (such as those in the *Exam Cram* forum) display in the student view.
- Set up gradebook items.
- Update course task list with deadlines.
- Post updated course task list.
- Update quiz start/end dates.
- Post introductions from all instructors.
- (Optional) Send welcome message to all students introducing yourself and providing log-in instructions.
- (Optional) Send pre-course reminder.
- (Optional) Schedule final exam if necessary.

# Chapter 10

## Teaching the *BBST Bug Advocacy* Course

This chapter details learning objectives for the *BBST Bug Advocacy* course and offers guidance on facilitating learning activities.

For each lesson, we provide a summarizing table of tasks and a more detailed description of the activities you will facilitate. The table serves as an overview for the lesson and as a checklist to help you ensure all tasks are completed on time. You may need to modify the pace. We anticipate the task lists will be useful but (unless you are teaching the AST version of the course) will require modification for your situation.

### Learning objectives for *BBST Bug Advocacy*

This course helps students improve their technical communication skills. A vital part of communication is understanding your audience (the people you are communicating with). What information do they need? What details do they need to make that information useful? If you are presenting information your audience will find uncomfortable or expensive to deal with, why should they believe you? How can you protect the credibility of your reports?

In this course, we want students to understand the underlying facts of the bug report come from their initial tests (the one that exposed a bug) but understanding the information needs of their audience leads testers to search for additional facts—this is what guides the troubleshooting testers do to make the bug report more effective. The troubleshooting is done in the service of improving the communication about the bug and its significance.

## Course Objectives Anderson/Krathwohl (2000) level

1	Define key concepts (such as software error, quality, and the bug processing workflow)	Remember
2	Understand and explain the scope of bug reporting (what to report as bugs, and what information to include)	Understand
3	Recognize bug reporting as persuasive writing	Analyze
4	Investigate bugs to discover harsher failures and simpler replication conditions	Apply
5	Make bugs reproducible	Apply
6	Understand excuses and reasons given for not fixing bugs	Understand
7	Understand lessons from the psychology of decision-making: bug-handling as a multiple-decision process dominated by heuristics and biases.	Understand
8	Evaluate bug reports written by others	Evaluate
9	Revise / strengthen reports written by others	Analyze
10	Write more persuasive bug reports (considering the interests and concerns of your audience)	Create
11	Participate effectively in distributed, multinational workgroup projects slightly more complex than the one in <i>BBST Foundations</i>	Apply



# Lesson 1 Tasks

	Course Policies	Welcome and What time is it? Posts	Meet & Greet	Course Orientation Review	Join <i>OpenOffice</i> Test Team
<b>Preparation</b>	Posted before course.  Removed from main menu page after 2 or 3 days.	None	Discussion forums and instructor intros posted before course start .	None	Join the team so you are familiar with the process. Check for updated documentation and share info with students.
<b>Description</b>	Students ask questions about and agree to policies.	Sample announcements available in Appendix F.	Students introduce themselves and respond to others.  Instructor(s) greet(s) all.	Course orientation web pages and video	Join the <i>Open Office</i> test team in preparation for major course assignment.
<b>Outcomes</b>	Students understand expectations.  Unenroll or otherwise follow up with students who fail to agree early in the week.	Information only	Students get acquainted with instructor and students. Creates a welcoming online space.	Students become familiar with course objectives and background.	Student membership in OOO team, familiarity with issue tracker and conventions regarding bug handling.
<b>Tools</b>	Moodle Choices or course discussion forums	Course announcements	Course discussion forums	Web pages in course management system	<i>OpenOffice</i> website
<b>Core readings</b>	Policies	None	None	Orientation pages	<i>OpenOffice</i> documents on how to write a bug report are needed for quiz.
<b>Communication</b>	Email non-responders urging them to respond. Notify those who have been removed from the course of their removal.	None beyond publishing these announcements.	None beyond instructor responses to individual introductions.	None	Remind students to complete this task. Point out updates to the links as needed.

	Lecture 1 Orientation Exercises	Quiz for Lecture 1	Exam Cram Forum	Quiz Discussion Forum	Instructor Feedback	
	Review assignment instructions.	Ensure quiz and video are available to students. Take the quiz if you have not already.	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Quiz Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Preparatory exercise for material presented in course videos and reflection afterward.	Students complete quizzes while watching videos.	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Discussion raises awareness of the subjective nature of “bug” and “quality.”	Increased understanding	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstanding.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Course discussion forum	Quiz, videos, slide sets	Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
	None	See course	None	None	None	<b>Core Readings</b>
	Monitor discussions and provide feedback.  Encourage insight, written communication, and presentation skills.	Encourage participation.  Field questions.	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 1

# Overview

This lesson introduces the student to the basics of bug reporting, including definitions of the key concepts (quality, software error, bug, failure, fault, bug report). It describes how development groups process bug reports, from the initial report through final resolution.

As in so much of testing, a key recognition is there is controversy at the core. We follow Weinberg in viewing quality as subjective—quality is value to some person. The same aspects of the same product might increase the value of the product (and thus the quality) for one person while decreasing it for another. Other views see quality as objective—quality is an attribute of the product itself, independent of the evaluator. This distinction has profound implications for bug reporting. Rather than relying on an objective standard of quality to empower their bug reports, testers must recognize their reports encourage influential people to take action to change the product and those people will make their own judgments of value and risk.

From this perspective, Lesson 1 considers the *scope* of bug reporting (what should testers report as bugs?). Later lessons will consider how to make those reports more effective.

The key student activities in this Lesson (apart from lectures, quizzes and study guide) are:

1. Introducing themselves to the other students in *Meet & Greet*;
2. Participating in two orientation exercises—posting their preferred definitions of *bugs* and *quality* and noting the variety of definitions among their classmates.
3. Joining the *OpenOffice* Project

## 1.0: Administrative tasks

### 1.0.1 Course policy agreements

At the beginning of each course, students should read and agree to the policies identified prior to the start of the course. Immediately after the course begins, monitor students' responses to the policies. Send a reminder of this important obligation. Set a close deadline for students to complete this task.

Adhere to your institution's guidelines for dealing with students who do not agree to the policies. The Association for Software Testing requires instructors to remove from the course any enrollees who have not agreed to the policies shortly after the deadline passes. Be certain to notify students of any actions and, if appropriate, invite them to return for a course at a later time.

The timing of policy enforcement is important. It lays the groundwork and expectations throughout the rest of the course. Once the time for policy agreements has expired, edit the front page of the course to remove the course agreements blocks. Those policies and documentation of students' agreements to them will be available in the lefthand navigation bar if you are using Moodle.

Here is a sample notification:

**SUBJECT** <insert course name here> Course Policies

**MESSAGE**

I see that you're registered in our course. Welcome!

This note is a reminder we have course policies you **MUST** agree to, to participate in any BBST course. Please log into the course, review these policies, and indicate your agreement right away. If you have questions or concerns, please contact <<THE INSTRUCTOR>>, <<EMAIL ADDRESS>>.

The students who join this course participate with the expectation everyone else in the course has agreed to these policies. If you do not accept them by Tuesday of the first week of class, we must suspend your access to the course.

Cordially,

### 1.0.2 Welcome

Here is a post you might use to welcome students to the *BBST Bug Advocacy* class. This message points out the pace of the *BBST Bug Advocacy* is a bit more demanding than students faced in *BBST Foundations of Software Testing*.

**SUBJECT** Welcome to *BBST Bug Advocacy*

**MESSAGE**

Week 1 started pretty gently in *BBST Foundations*, with a friendly *Meet & Greet* and a relatively short video.

In *BBST Bug Advocacy*, we know that you already know how to navigate a course management system, you've learned how to communicate with peers online, and you've figured out how to configure your video player.

It is still important to meet your colleagues, so *Meet & Greet* is an opening assignment. In addition, this class starts with a heavy workload compared to *BBST Foundations*:

- Video 1 is 35 minutes
- Three required readings, short but not trivial
- Thirty multiple choice questions in quiz 1
- Two-part orientation exercise
- A task (*OpenOffice* registration)

And that's just the first half of the week.

- Video 2 is 27 minutes
- Quiz 2 is 16 questions
- A multi-part orientation exercise requiring some discussion
- An assignment. The instructions alone are 5 pages. This is a much harder assignment than in *BBST Foundations*.

As always, there is much to challenge in the videos.

We're all testers here. Challenging things is what we do. Critical thinking is our strength. Bug reports are among our favorite tools. Don't be shy.

As in *BBST Foundations*, we (the instructors) will not answer most comments right away. Please, discuss the questions among yourselves for a while. After discussion, one of us will post additional notes.

### **1.0.3 What time is it?**

One of the many challenges in online courses (and off-shore development) is time zone diversity. We use a post for this, titled *What time is it?* The full text is located in the *Fieldstones* appendix. You should post one like it early in your course if your students are likely to have time zone challenges.

## **1.1 Meet and Greet**

### **Preparation**

Prepare for the *Meet and Greet* activity by completing the following list of tasks:

- Set up a new discussion forum titled *Meet and Greet*.
- Post your introduction. (Co-instructors, if any, do the same.) If you can, attach a digital photo, audio, or video file to your post. (Co-instructors, if any, should do the same). Adding multimedia elements to your introduction gives students a richer picture of who you are and introduces them to the possibilities of multimedia communication.

- Optionally, use the course announcement tool to remind students of this activity, tell them how to participate, remind them of the deadline, and encourage participation.

### **Activity description**

Students introduce themselves and respond to each other's posts. Typically, instructors ask students to include information about their experience with the class topic, and encourage them to share information about hobbies and outside interests. Invite students to include pictures of themselves if they would like.

### **Purpose**

Some students will feel more connected to their classmates after they have seen a picture and come to know them better.

### **Tools**

Course discussion forum. Your course management system (CMS) may call these discussion boards or threaded discussion groups. Throughout this book, we will refer to these as course discussion forums.

### **Core readings**

None

### **Facilitation roles and strategies**

Although an instructor should not respond to every post throughout the class, try to make each and every student who offers an introduction feel welcome by posting a response to their introduction.

If you notice students spending too much time in *Meet and Greet* (at the expense of course content), you may need to remind them to practice good time management skills. This may become an issue at the end of the first week and beginning of the second.

### **Variations of the activity**

There are many icebreaker activities published in books and on the Web. Many of them can be modified to work in an online environment.

## **1.2 Join the *OpenOffice* test team**

### **Preparation**

Review instructions for the assignment and relevant links to the OpenOffice.org (OOo) project. Check the version of the current development build. The development build is the most recent version, typically more recent and more buggy than the latest stable build or beta version. Check for updates to the bug tracking documentation. Check the links to the OOo project. At the time of publication, the main OOo page is <http://incubator.apache.org/openofficeorg/>. This is in transition as Apache integrates *OpenOffice*. As the instructions on bug reporting and joining the OOo QA team move and change, you will need to update the links in your course.

Decide which *OpenOffice* application you want your students to work with. You might search the database for unconfirmed bugs (include enhancement requests in your search) to see which applications have lots of interesting unconfirmed bugs. We strongly recommend you pick one application for the whole class to use, rather than leaving individual students to choose whichever application they like. It will be hard on the peer reviewers if they have to learn details about several applications instead of just one. These students are working on a tight schedule—leaving the choice of application open adds to the complexity of the task, and will add time to the task.

### **Activity description**

Students will

- download and install the current development version of *OpenOffice*.
- sign on to the *OpenOffice* team.
- share their *OpenOffice* user name IDs with the classmates.
- learn the *OpenOffice* conventions for handling bug reports..
- acquaint themselves with the bug database.
- become familiar with basic queries of the bug database.

### **Purpose**

The *OpenOffice* project (or an appropriate replacement) provides a live project for students to complete the multi-phase bug reporting assignment throughout the course. Joining the project lays the groundwork for the centerpiece assignment of this course.

### **Tools**

Discussion forum and *OpenOffice* resources

### **Core readings**

*OpenOffice* project overviews and project protocols

Documentation on the *OpenOffice* issue tracker

### **Facilitation roles and strategies**

Identify and notify students about which build they should use as they complete the assignments and activities in this course. Students may need some assistance completing these tasks. From time to time, procedures change on the *OpenOffice* project. You may need to update assignment instructions if the changes are substantial.

### **Variations of the activity**

*OpenOffice* is in transition. It has moved from Sun through Oracle to Apache. We hope the transition will go well, but even if it does, the project might not be active enough to support several BBST classes running in parallel.

Some OOO applications have been more heavily used in BBST courses than others. For example, at this time (January 2012), *OpenOffice Impress* has been used in many more BBST courses than the OOO *Base* (database), *Calc*, or *Draw* applications. You might prefer to choose one of these because they will probably have more unconfirmed bugs with BBST student comments on them yet.

We have conducted this exercise with other open source projects. We recommend open source projects because students can later use their bug reports during job interviews to demonstrate the impact they've had on a well-known project. However, please be mindful of the instructional objectives for that project and the ability of the development team to provide appropriate training for your students. The project must be sufficiently well-organized to accept and respond promptly to students' bug reports in a meaningful way. Developers must also be patient enough to deal with students' varied inputs.

- Read through several bugs in their database to gain a sense of content and person-to-person interactions before selecting a project. In our experience, some other groups are less responsive than *OpenOffice*; or have bug reports written in jargon most students cannot understand; or have an informal bug tracking process too weak for students to practice on.
- If you are teaching a course in-house, you might prefer to switch this task to your company's own bug tracking database.

## 1.3 Lecture 1 orientation exercises

### Preparation

Review instructions for the exercise.

Remind students to complete this exercise BEFORE they watch the video.

Be sure two forums are set up; one for the definition of a bug, the other for the definition of quality.

### Activity description

Students post their definitions of a bug and quality. They comment on a few other students' definitions and respond to comments their peers make on their work.

### Purpose

The definitions of *bug* and *quality* vary from one person to another and across organizations. These discussions expose that variation to the students and give them (and you) a sense of the diversity of views in the class. This discussion might give you useful insights into comments some students make later in the course or on their exam.

Some of the students will have strongly-held views. This course will not change their minds; nor should it. However, it might teach some a greater awareness of other views and perhaps more tolerance or respect for them.

### Tools

Discussion forum

## **Core readings**

None

## **Facilitation roles and strategies**

Monitor the discussion forum, noting particularly insightful contributions or interesting dialogues. Also notice who is participating and send a note to those who are not. Monitor the unfolding discussion to prepare for your feedback note at the end of the exercise.

In previous versions of the course, we would collect the different definitions mentioned in the forum and list them in the instructor's feedback. The current version of the slides already provides a list (collected across courses). You might point students to the slide and highlight differences among a few of the definitions.

## **Variations of the activity**

None

## **1.4 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **1.5 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate



# Lesson 2 Tasks

	Lecture 2 Orientation Exercises	Assignment: Phase 1	Quiz for Lecture 2	
<b>Preparation</b>	Review assignment instructions.	Review instructions. Assign reviewers. Post a few days before the start of Phase 2.	Ensure quiz and video are available to students. Take the quiz if you have not already.	
<b>Description</b>	Preparatory exercise for material presented in course videos and reflection afterward.	Students comment on OOo bug and post critique of bug report to discussion forum.	Students complete quizzes while watching videos.	
<b>Outcomes</b>	Discussion brings out the diversity of students' experiences with bug reporting and dev teams' reactions to bug reports.	Increased understanding	Increased understanding	
<b>Tools</b>	Course discussion forum	OOo issue tracker and course discussion forum	Quiz, videos, slide sets	
<b>Core readings</b>	None	None	See course	
<b>Communication</b>	<p>Monitor discussions and provide feedback.</p> <p>Encourage insight, written communication, and presentation skills. Summarize students' experience to class.</p>	<p>Advise students on which build to install.</p> <p>Monitor discussions and provide assistance as students join project and learn the bug database.</p>	Encourage participation. Field questions.	

	<b>Exam Cram Forum</b>	<b>Quiz Discussion Forum</b>	<b>Instructor Feedback</b>	
	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Quiz Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstanding.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
	None	None	None	<b>Core readings</b>
	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 2

# Overview

Lesson 2 introduces the idea of *follow-up testing*: When you find a bug, what additional information can you gather to make your report more effective?

Across the lectures, we will present a 6-factor approach to follow-up testing and description we abbreviate as RIMGENT. We consider each of these throughout the course, but some lessons emphasize a particular factor:

- **Replicate**: Determine what is needed to make the bug appear any time that you want to demonstrate it, or determine it is not reproducible-on-demand and describe the factors increasing the probability of appearance. Lesson 3.
- **Isolate**: Find the smallest set of actions needed to replicate the bug and report the bug simply (one failure per bug report) so the reader sees a tightly-focused description of what brings about a single failure. Lesson 6.
- **Maximize**: Find the most serious symptoms of this bug. Lesson 2.
- **Generalize**: Determine the range of circumstances under which this bug will cause a failure. If possible, show the problems caused by this bug will appear often, on many common configurations, when processing realistic data. Lesson 2.
- **Externalize**: Consider the consequences of this bug. How will it affect people? How will it affect the company's reputation? From points of view outside of the development group or the company, how important is this bug? Lessons 4 and 6.
- **Neutral tone**: Keep the report factual or speculative in a constructive way. Don't criticize or insult people. Don't say things that will irritate people unless essential to a description of the problem and its failure conditions. Lessons 4 and 5.

The key student activities in this Lesson (apart from lectures, quizzes and study guide) are:

1. An orientation exercise requiring participation and responses to questions about their experience with bug reporting.
2. Phase 1 of the Assignment (Replicate & Edit Bugs).

## 2.0: Administrative tasks

### 2.0.1 Post quiz-related fieldstones

Post the *BBST Philosophy of Quizzes* fieldstone at the end of first quiz. The *BBST Philosophy of Quizzes* fieldstone is available in the *Fieldstones* appendix.

## 2.1 Lecture 2 orientation exercises

### Preparation

Review instructions for the exercise.

Remind students to complete this exercise *before* they watch the video.

### Activity description

Students answer questions about their experiences writing bug reports and getting feedback from the development team.

### Purpose

Companies differ widely in their responses to bug reports. Some groups expect extensive troubleshooting support from testers and reject an incompletely-reported bug immediately, without reading it. Other groups put most of the troubleshooting burden on the programmers. Similarly, some groups try to fix most bugs while others defer non-urgent failures and non-critical design limitations. Many of our students have no idea how diverse the field is and thus, how relevant the course is. This discussion gives them external context.

### Tools

Discussion forums

### Core readings

None

### Facilitation roles and strategies

Monitor the discussion forums, noting insightful contributions or interesting dialogues. Also notice who is participating and send a note to those who are not. Monitor the unfolding discussion to prepare for the instructor's feedback note at the end of the exercise.

Emphasize the importance of effective written communication for the course. Provide guidance when necessary by asking questions rather than stating answers.

This exercise asks for students' experience. The only "wrong" answers don't actually describe the student's experience.

Look for ethical issues in the discussions. If you are comfortable, highlight them. Are there contextual issues making some acts or decisions ethical in some cases but reprehensible in others?

### Variations of the activity

None

## 2.2 Phase 1 of the bug reporting assignment

### Preparation

You did most of the preparation for this assignment in Lesson 1. Students will work on the project you instructed them to sign up for in Lesson 1. You reviewed project suitability for this assignment in Lesson 1 or before the course started.

Review instructions for the assignment. In Phase 2, each student will review the work of two other students. Publish the reviewer assignments now so students can start Phase 2 as soon as possible.

### Activity description

The assignment spans four phases:

- In Phase 1, each student locates an unconfirmed bug report in the bug tracking database. The student attempts to replicate the bug, run further follow-up tests and add constructive comments to the bug tracking database. Students must *never* make statements critical of the bug reporter or the developers in these public comments. The student also posts to the class an evaluation of the quality of the bug report he or she worked with, appraising its accuracy, technical competence and communication effectiveness—this private note to us can be as critical as the student chooses. Students should organize their critique using Exhibits 1 and 2 of the assignment as a guide.
- In Phase 2 (Lesson 3), each student will evaluate the Phase 1 work of two other students, using assignment Exhibits 3 and 4 as guides.
- In Phase 3 (Lesson 4), each student will do a Phase 1 task with another bug. In this case, however, the student will work with a partner who reviews the student's work (comments to the database, critique to us) before the student submits them. The Phase 3 report also considers whether this peer review was helpful and worth the time.
- In Phase 4 (Lesson 5), each student evaluates the Phase 3 work of one other student.

Students must complete these phases on time.

### Purpose

*BBST Foundations* covered a lot of material at a superficial level. *BBST Bug Advocacy* presents conceptual material too, but wraps it around this assignment, which focuses on developing students' skills and judgment.

- Learning how to tell, in detail, the differences between good bug reports and weak ones, will help students write better reports of their own.
- Learning how to extend reports written by others (and getting feedback on the quality of their work) gives students experience in a task many testers perform frequently.
- Learning to coach others in their bug report evaluation and writing is a piece of test-group supervisory training.

This project also builds experience more general than bug-reporting:

- It builds the students peer-reviewing skills, which are important throughout the BBST series and in many other learning environments—both formal and informal.
- It introduces testers to qualitative assessment. In later courses, we will refer to this example as we develop a broader approach to qualitative assessment of tester performance in the workplace.

## Tools

Bug tracking database for the selected software under test and the course discussion forum.

## Core readings

The bug reporting assignment, including its accompanying exhibits.

## Facilitation roles and strategies

Please stress to students they should not post their critiques in the bug tracking database, and more generally, should never say anything critical of other people (bug reporters, programmers or anyone else) in that database. The project database is a permanent public record. Public negative statements will not only anger or discourage people who are criticized (these are often project volunteers who are not professional testers), they also reflect badly on the person who makes the statements.

Students must not fall behind in this assignment. Monitor the discussion forum actively. Make a few comments praising what students write, to make it obvious you are watching. Send private notes to students who appear to be running late. Lateness on Phase 1 will sabotage the two students who have to work with this in Phase 2.

Monitor the unfolding discussion to prepare for the instructor’s feedback note at the end of the exercise.

The most common student problems in this phase are:

- Some students cannot figure out the bug tracking system. A little bit of coaching is appropriate for these students, but students who have repeated and seemingly-insurmountable problems building simple search queries are unlikely to succeed in the course. In a course oriented toward training students for replacement careers, more patience is needed with this lack of search skill, but eventually students will need to be able to do this on their own.
- Many students search only for “defects” and find 20 recent unconfirmed “defect” reports. The students then squabble over who started working on which of these few bugs, first. It’s important for students to search through the “enhancements” as well. There is usually a backlog of a few hundred of these, making collisions in students’ efforts less likely. We keep revising the assignment instructions to suggest this without forcing on students the insight “bugs” includes design issues.
- Many students will reiterate comments without acknowledging them. Suppose Joe writes the original report, and it is unclear. Then Jane writes a follow-up clarifying Joe’s work. Then Jeff writes a follow-up. This all happened before our course started. Now our

student, Sid, writes his comments to the bug report and his evaluation. His comments repeat Jane's and Jeff's work without adding anything new. This is worthless to the project. His report to us copies the original report (Joe's crummy bug report), forgets to mention Jane and Jeff, and then presents his comment. You will not realize this is what is happening unless you read the original bug report yourself. We always go back to the original reports, reading the comments preceding Sid's work and any comments that later people (e.g. the project manager) wrote in response to Sid's work. When we see this, we make it clear to the student that we consider it unacceptable.

- Many unconfirmed bugs are virtual duplicates of bugs already appearing in the database. Some "bugs" have been reported and rejected dozens of times. For example, if you enter 1a2 in a numeric input field, *OpenOffice* will treat this as 12. The OOo team sees this as a feature. Plenty of people have reported this as a bug. The student should look (and you should look) through the bug database, at closed bugs as well as open ones, to see whether bugs like this have been processed already. You will probably find more examples of duplication than the student, because you are more experienced. As you teach the course, you'll also come to know the database better. Use this as a teaching opportunity to demonstrate troubleshooting to the student.
- In the ideal case, a student will pick one coding error (Phase 1 or 3) and one enhancement. In practice, many students will pick enhancements for both phases once they understand this is an option. This is acceptable.
- The assignment instructions point out many other common problems to avoid. Keep them in mind as you review student work, and draw students' attention to them. It is appropriate to draw attention to some of these *during Lesson 2*, so students can upgrade their Phase 1 submissions before the start of Phase 2. You might do this attention-drawing by pointing specifically at problem work or by mentioning the problem in a *Course Announcements* post without saying who has the problem, only you are seeing the problem and think people should watch for it or fix it in their work.

### **Variations of the activity: Fewer reviews**

We have conducted this exercise with one less round of review although we do not recommend that strategy.

You also can vary this activity by changing the software development project you and your students will join. On that, see our notes in Lesson 1.

### **Variations of the activity: Interactive grading**

When we teach this course with local students, we meet face-to-face with each student and interactively grade their Phase 1 work. To make time for this, we adjust the schedule so Phase 2 is due at the end of Lesson 4, Phase 3 in Lesson 5 and Phase 4 in Lesson 6. We have not tried interactive grading of this assignment via Skype videocalls, but we have done other interactive grading via Skype and expect it to work for this assignment.

Set up your interactive grading session so the student can see your screen. In a face-to-face meeting, set up a dual-monitor system so the student can watch what is on your monitor

without having to look over your shoulder. Remember eyesight (and convergence distance on reading glasses) varies. If you look at one screen side-by-side with a student, he or she might not be able to read the screen. In a two-display system, the student can move the display to a better place and angle. In a Skype meeting, alternate between sharing your screen and displaying live video of you as you talk to the student.

During the interactive grading session, we typically do the following:

- Pull up the bug report the student is critiquing. We read this bug, in front of the student, and ask questions. Often we ask the student to summarize the report and replicate the bug.
- Read the student's comments in the bug database and ask about them.
- Search the database for similar bug reports and discuss the search strategy and the results.
- We invite the student to evaluate the report. This will probably be an overview of the evaluation they sent to the class, but sometimes what they say face-to-face is more sophisticated than what they wrote. Some students are more willing to make sharp criticisms orally than in a written report. And a few students will have nothing useful to say, which creates a context for interpreting their written report.
- Now we read the critique the student posted to our class and ask questions.
- Sometimes we bring up Exhibits 1-4 and critique the student's work by reference to those exhibits. When we do, we make the point we are doing this to train the student for Phases 2 through 4. Reactions of practitioners to this might vary. In our experience in the academic course (where this assignment counts significantly toward their final grade), students appreciate this type of coaching.
- We give a final summary evaluation of the work we've seen. Students will get additional evaluations from their Phase 2 peer reviewers and be better prepared to give Phase 2 evaluations of other students.

If you are going to do an interactive grading of this assignment, we think it is essential to do it before Phase 2 is due, so students can get good practice in peer reviews and be ready to do a much better job on Phase 3.

## **2.3 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **2.4 Send *Weekly Feedback* announcement**

Throughout the week, you should review the orientation exercises and Phase 1 of the Bug Reporting activity, making notes of problem areas, interesting approaches, and general trends. Your notes will inform the *Weekly Feedback* you send as soon as ready. This posting should be made as early as possible during Week 2.

In your note to students, provide feedback on content, and clarity of presentation. Emphasize the value of both peer and self-reviews, noting they are required. Where possible, note an exemplary sample of each.

## 2.5 Send *Highlights of the Coming Week* announcement

You are welcome to craft your own announcements for the coming week or customize the note we regularly use to prepare students for Week 2 of the *BBST Bug Advocacy* class.

### **Rationale:**

We send students a note at the start of each week to prepare them for the next week's work. This is a model for that note.

**SUBJECT** Great Start! What's Coming?

### **MESSAGE**

#### **Last Week**

Overall, you've made a great start.

The first set of orientation exercises brought y'all into the discussion even more than I expected. There's lots of great and thoughtful interaction. I think everyone reflected on ideas different from their starting points.

It looks as though the conversations stimulated by these two questions (what's a bug? what's quality?) are still of strong interest—there's ongoing discussion, even today. I like that, but I am concerned it is distracting you from making progress in the course. Relatively few of you joined the next set of discussions, in Orientation Exercise 2, "Your experience with bug reporting."

I think Orientation Exercise 2 has significant potential value for us getting to understand each other's contexts. The question has already come up about Lecture 2, "Is it really appropriate to do things that way?" and the answer is to a significant degree context-dependent. Please, share your context and your background.

Most of you have submitted a bug evaluation. I haven't reviewed them all yet, but they look both promising and incomplete. That's what I expect at this point in the assignment, which is why we do this one in 4 waves:

1. Review a bug (edit the bug report and post an appraisal on our forum).
2. Evaluate two other students' reviews.
3. Pair up with someone and each review a bug and review each other's work.
4. Grade the bugs reviewed by some other pairs.

My expectations are based on experience with variants of this exercise in about 10 university courses and 2 or 3 commercial (face-to-face) courses.

Final comment on last week: the quizzes. It looks as though the class, on average, is doing pretty well. There hasn't been much comment on questions in the quiz discussions. More comments are certainly welcome.

The intent of the *BBST Bug Advocacy* quizzes is to bring forward everything we feel is significant and can be addressed well in a multiple-false format.

## COMING UP

### a. Finish assignment Phase 2

The biggest task this week is to review two bug report evaluations. Expanding your search to include items labeled as "enhancements" will give you a larger universe to explore. Remember in the context of this course a bug is not just a code related issue but can include anything decreasing the value of the software product you are testing.

You should budget 1 hour each for the two reviews you are about to do.

A few people have not submitted their initial evaluations. If you are scheduled to review PersonX's evaluation of an OOO bug, but PersonX hasn't submitted one, pick someone else's bug and work on that. If you're ready to do your task and someone else hasn't submitted their work on time, don't let yourself be held up by them.

### b. Assignment Phase 3

Between now and Wednesday, please work with your assigned partner on Phase 3.

Phase 3 is similar to Phase 1: each of you finds an unconfirmed bug, replicates it, thinks about it, and prepares to (a) improve the report at the OOO database and (b) file an evaluation in our course forum. The difference is partners peer review each other's work before they file anything at the OOO database or to the forum. If it hasn't been reviewed by your partner, please don't file it.

Phase 4 will look a lot like Phase 2: once the comments are filed at OOO and in our forum, you will evaluate those comments. There is no need to have your Phase 4 comments reviewed by your partner. My bet is you will find the peer-reviewed work in Phase 3 is substantially better than the original Phase 1 work.

We're walking through this full process because it illustrates an efficient way to train staff to improve bug reporting, as well as, introduces a style of qualitative employee performance evaluation.

c. One more orientation exercise

The third orientation exercise could have fit anywhere in the course. There might be more to discuss in that task than you initially think—it will be interesting to see whether that prediction comes true....

d. Study guide questions

I strongly suggest you work through the study guide questions. Don't focus on the short answer questions. Focus on the questions addressing where we are in the course. So take care of all the questions on the Lecture 1 topics (what is quality, etc.) before moving to the Lecture 2 topics. If you don't have enough time to do all of them, try the long answers. They provide a richer basis for discussion.

e. Lectures and quizzes

Lectures 3 and 4, coming up. Hope you enjoy them.

## **2.6 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate.



# Lesson 3 Tasks

	Lecture 2 Orientation Responses	Lecture 3 Orientation Exercises	Lab Assignment: Phase 2	Quiz for Lecture 3	
Preparation	Started in the previous week	Review instructions for assignment.	Review instructions for assignment. Assign each student two other students to review.	Ensure quiz and video are available to students. Take the quiz if you have not already.	
Description	Students return to the definitions they submitted and modify as appropriate.	Students write a summary for the bug report detailed in the handout and, if time, notes on what follow-up tests they would create to improve the report.	Students evaluate the Phase 1 efforts of two other students.	Students complete quizzes while watching videos.	
Outcomes	Students understand the diverse perspectives about what is perceived as quality.	Students experience a few of the classic challenges of effective bug reporting.	Ongoing development of skills needed to mentor others in bug reporting.	Increased understanding	
Tools	Course discussion forum	Course discussion forum	Bug tracker for selected project and course discussion forum	Quiz, videos, slide sets	
Core readings	None	None	Task instructions	See course	
Communication	Remind students to update their submissions based on what they learned from the class discussion.	Provide feedback to students about classic traps and shortcomings in this task. Note any exemplary submissions.	Monitor course discussions, providing assistance as needed.  Ongoing encouragement to participate in all phases of the bug reporting assignment	Encourage participation. Field questions.	

<b>Exam Cram Forum</b>	<b>Quiz Discussion Forum</b>	<b>Instructor Feedback</b>	
Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Quiz Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstanding.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
None	None	None	<b>Core readings</b>
Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 3

# Overview

Lesson 3 considers failures difficult to recreate. If a program fails and you can't get it to fail that way again, the underlying problem is you don't know what conditions are essential for triggering the failure. Irreproducibility often is blamed on sloppy testing. The idea is if you could better remember what you did, you could replicate the bug. *IF* that's the problem, test scripts (manual or automated) can prevent it. But our experience is these failures often are caused by an interaction of the test we designed with some unintended event or system state. The lecture suggests over 30 conditions testers often overlook when they design tests or try to troubleshoot hard-to-reproduce failures.

The key student activities in this Lesson (apart from lectures, quizzes and study guide) are:

1. Participating in an orientation exercise. The exercise presents a failure; the student writes a summary of the failure then suggests some follow-up tests. This is preparation for Lesson 6 and support for the main assignment.
2. Phase 2 of the Assignment (Replicate & Edit Bugs).

### 3.0: Administrative tasks

Review instructions for the exercise.

### 3.1 Respond to the Lesson 2 orientation exercise

Review the appropriate section from lesson 2 for details on the lecture 2 orientation.

### 3.2 Orientation exercise with lecture 3

#### Preparation

Review instructions for the exercise.

#### Activity description

Students review a handout describing a testing session. The report presents a sequence of actions and program responses with screenshots. Students then propose a summary for the bug report, comment on other students' summaries, and post suggestions for follow-up tests.

## Purpose

The most important part of a bug report is its summary. That's what people will see as they search the database or read reports about what bugs are open, deferred, or recently closed. You can reinforce this by reminding students of how confusing it (probably) was for them to hunt for bugs related to the one they worked on in Phase 1. The search function in the bug database yielded a list of bug summaries, probably a long and confusing list. This exercise gives students some practice and an example to use to think about how to write an effective summary.

## Tools

Course discussion forum

## Core readings

Bug report orientation handout

## Facilitation roles and strategies

Monitor the discussion forum, noting worthwhile approaches to solving the problem and common traps to be avoided. Also notice who is participating and send a note to those who are not. Monitor the unfolding discussion to prepare for the instructor's feedback note at the end of the exercise.

Be careful not to give away the answers before the peer and self-assessments are completed.

## *The bug summary*

Many students write answers with the following weaknesses:

- *Vagueness.* Any summary, including “doesn't work”, “something wrong with”, “fails”, “responds erroneously”, etc, is providing a vague description that could apply to almost every bug in the database.
- *Only one report.* The exercise sets them up for this failure, but experienced testers (who are suckers for this) should know better because there are *two* observed failures:
  - In one case, the tester attempted to cut something but the selected area didn't go away
  - In the other case, the tester attempted to cut something but instead of cutting the area selected, the program cut a different area

The heuristic we urge is every visibly different failure should get its own failure report. In this case, combining the two failures almost inevitably leads to a vague summary because the symptom descriptions are inconsistent.

- *Weak writing.* The journalist's heuristic is to get the most important material at the front of the article because people will stop reading at unpredictable times, and as soon as the article seems to have lost its urgency or entertainment. We advocate the *Fails...When* protocol:
  - Describe the failure first

- Then describe the conditions triggering or constraining the failure

Here are two short summaries following the Fails ... When protocol, and presenting the difference between the two failures:

- Cut doesn't cut (zoom, freehand selection)
- Cut cuts the wrong area (zoom, freehand selection, grow window)

### ***The follow-up test suggestions***

Some questions to ask as students do this task are:

- What hypotheses are the students considering and how do the tests relate to them?
- Are the students designing any tests that might prove the hypotheses wrong?
- How redundant are the tests?
- Do the tests ignore things we already know? For example, according to the description of the tests, the failures are fully reproducible. Also, between every test, the tester exited the program and restarted it. Because of that, nothing happening in a previous test had any impact on what happened next. Some testers entertain hypotheses involving long sequences of probably unreasonable test steps, while the failures could be demonstrated with very simple, short tests.

### **Variations of the activity**

You could assign this activity in Lesson 4, 5 or 6 instead of Lesson 3. The timing should reflect your sense of workload. We think it is relevant here because it helps some students with the assignment. If we applied the activity in Lesson 6 (the natural place given the Lesson 6 material), it would be too late to be useful.

You can shorten the activity by asking students only to write summaries. The follow-up tests sometimes lead to an interesting discussion, which doesn't take much additional time because the students already are thinking about these bugs. However, it is not essential.

## **3.3 Phase 2 of the assignment (replicate & edit bugs)**

### **Preparation**

In Lesson 2, you published reviewer assignments. Each student reviews the Phase 1 work of two others. If any student neglected to submit Phase 1 assignment, you probably should adjust the Phase 2 assignments to reflect that.

Phase 3 will require partner assignments. Before a student submits comments on the bug to the bug database or the class, the student's partner will review it. Post the partner assignments during Phase 2 to avoid delaying students' work in Phase 3. Create a triplet pairing or pair with an instructor if there is an odd number of students. Avoid pairing the weakest performing students together.

Phase 1's bugs were probably all (or mainly) "defects." Send a note to the class suggesting they think about enhancements for Phase 3. Send this early in Phase 2, so students have time to adjust their search for Phase 3.

### **Activity description**

Students evaluate the Phase 1 efforts of two other students.

### **Purpose**

See the description in Lesson 2.

### **Tools**

See the description in Lesson 2.

### **Core readings**

See the description in Lesson 2.

### **Facilitation roles and strategies**

See the description in Lesson 2.

### **Variations of the activity**

See the description in Lesson 2.

## **3.4 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **3.5 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate.

# Lesson 4 Tasks

	Lab Assignment: Phase 3	Quiz for Lecture 4	Exam Cram Forum	
Preparation	Review instructions for assignment. Assign partners for this phase of the assignment several days before the start of Phase 3 or let students choose their own partners.	Ensure quiz and video are available to students. Take the quiz if you have not already.	Post questions for study guide, if necessary, and enable forum.	
Description	Each student identifies and reviews a bug from the chosen project and submits his or her work for a partner's review before posting to the bug-tracker or course discussion forum.	Students complete quizzes while watching videos.	Students collaborate to prepare for final exam.	
Outcomes	Ongoing development of skills needed to mentor others in bug reporting.	Increased understanding	Students draft answers for study guide questions.	
Tools	Bug tracker for selected project and course discussion forum	Quiz, videos, slide sets	Course discussion forum	
Core readings	Handout	See course	None	
Communication	Monitor course discussions, providing assistance as needed. Ongoing encouragement to participate in all phases of the bug reporting assignment.	Encourage participation. Field questions.	Encourage participation in <i>Exam Cram</i> forum.	

	Quiz Discussion Forum	Instructor Feedback	
	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Quiz Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Students check their own understanding and clarify misunderstanding.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Course discussion forum	Course announcements and email	<b>Tools</b>
	None	None	<b>Core readings</b>
	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 4

# Overview

Lesson 4 continues to look at resistance to fixing bugs. People sometimes reject bug reports because they believe what is reported has no customer impact or not worthy of being called a bug for some other reason.

This lesson advises students to look past their test results to the people who are affected by them. Customer impact is not just a matter of opinion. Ask the customer or study what they do and determine how the bug would interfere with it. The same is true for the impact on any stakeholder.

The lesson also reminds students of Bach and Bolton's oracle heuristics. If you dispute the design of the product, you have a reason for thinking it's wrong. The oracle heuristics are an organizing framework to help you understand your reason(s). With what expectation(s) of yours is the program operating inconsistently? Once you understand what the expectations are, can you explain them to show others why they are reasonable?

The key student activities in this Lesson (apart from lectures, quizzes and study guide) are:

1. Phase 3 of the Assignment (Replicate & Edit Bugs)t

## 4.0: Administrative tasks

None.

## 4.1 Phase 3 of the assignment (replicate & edit bugs)

### Preparation

Review instructions for the lab activity.

Review and update your partner assignments for Phase 3 to exclude inactive students. Alternatively, pair inactive students with each other. It is unfair to the active students to make them rely on students who are not actively participating in the course.

Assign reviewers for Phase 4. Pair inactive students. If a strong student has been repeatedly paired with weak ones, assign her or him to a stronger student. Give the better students a chance to learn from their peers.

### Activity description

Phase 3 is similar to Phase 1 except students in the course pair up so they can peer review each other's work before submitting to the bug tracking database or course discussion forum.

## **Purpose**

See the description in Lesson 2.

## **Tools**

See the description in Lesson 2.

## **Core readings**

See the description in Lesson 2.

## **Facilitation roles and strategies**

If you did extensive grading and feedback in Phase 2, especially interactive grading, then there isn't much more to do this time. The students have your feedback and should be on their way to a final round of peer review. Look for a few good examples to post in your feedback, make notes on the work of students who seem likely to be borderline at the end of the course, but otherwise, spend your time on quizzes and the *Exam Cram* forum.

If your feedback was less extensive during Phase 2, provide personalized feedback to the students whose work you have not yet reviewed.

## **Variations of the activity**

We have conducted this exercise with one less round of review, although we do not recommend that strategy. You also can vary this activity by changing the software development project you and your students will join.

## **4.2 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **4.3 Send *Highlights of the Coming Week* post**

Send students a note at the start of the week to prepare them for the next week's work.

## **4.4 Send *Weekly Feedback* post**

Throughout the week, you should plan to review the orientation exercises and bug reporting activity, making notes of problem areas, interesting approaches, and general trends. Your notes will inform the *Weekly Feedback* you send as soon as ready.

In your note to students, provide feedback on content and clarity of presentation. Emphasize the value of both peer and self-reviews, noting they are required. Where possible, note an exemplary sample of each.

## **4.5 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate.

# Lesson 5 Tasks

	<b>Lab Assignment: Phase 4</b>	<b>Exam Coaching Lab</b>	<b>Quiz for Lecture 5</b>	
<b>Preparation</b>	Review assignment instructions. Assign each student one other student to review.	Post one study guide question in coaching forum.	Ensure quiz and video are available to students. Take the quiz if you have not already.	
<b>Description</b>	Students evaluate the Phase 3 efforts of one other student.	Students draft exam answer for peer and instructor feedback.	Students complete quizzes while watching videos.	
<b>Outcomes</b>	Ongoing development of skills to mentor others in bug reporting.	Improved understanding of written communications and exam preparation.	Increased understanding	
<b>Tools</b>	Bug tracker for project and course discussion forum	Course discussion forum	Quiz, videos, slide sets	
<b>Core readings</b>	Handout	Essay Answers Handout	See course	
<b>Communication</b>	Monitor course discussions, providing assistance as needed.	Emphasize participation.	Encourage participation. Field questions.	

	<b>Exam Cram Forum</b>	<b>Quiz Discussion Forum</b>	<b>Instructor Feedback</b>	
	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Quiz Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstanding.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
	None	None	None	<b>Core readings</b>
	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 5

# Overview

Lesson 5 is about decision theory. Bug handling involves many decisions, starting with the decision to report the bug; the decisions about how much added investigation to do before reporting a bug; and continuing decisions by programmers, managers and other stakeholders to have the bug fixed or not. These decisions are all based on uncertain data. They are subject to many biases. Testers can reduce the uncertainty, and the influence of bias, by providing better-researched reports. But that costs time and other resources could be using to find other bugs. We organize the discussion of these decisions and the related biases through the lens of a specific decision theory, signal detection theory.

The key student activities in this Lesson (apart from lectures, quizzes and study guide) are:

1. The signal detection theory exercise.
2. Phase 4 of the assignment (replicate & edit bugs).

## 5.0 Administrative tasks

A few days before the start of exam week, the lead instructor, with the assistance of the instructor team, should complete the following two tasks:

- Prepare the final exam.
- Prepare the course evaluation.

### 5.0.1 Prepare the final exam

Select questions for the exam from the study guide. The typical exam has seven questions, three or four short and three long. Students are more likely to do well on the short answer questions; however, the long answer questions reveal much more about students' understanding of the material.

- Choose among the available questions in the exam pool to maximize coverage of the course and diversity among the questions. Some questions overlap in their coverage of the course material; some overlapping may be acceptable, but it is generally undesirable to choose similar questions for the same exam.
- If you are teaching this course as part of a sequence, you are not just managing your own course. You are teaching one of the core BBST prerequisites, laying down expectations for all future courses. Your choice of exam questions will influence study strategies for the rest of the series.
- Especially in *BBST Foundations* and *BBST Bug Advocacy*, it is desirable to choose a question no student has attempted and another question the students addressed poorly in the *Exam Cram* forum if you posted a caution/question about it.

- Do not choose a question if any of your comments in the forum have accidentally made the question ambiguous or might otherwise lead students to a weak answer.
- Every question in the study guide is fair game for the final exam.
- Please choose questions to have some overlap with questions from exams in previous courses so we may compare performance across groups. However this redundancy should be limited. As a general guideline, we suggest an overlap of no more than three questions with either of the previous two final exams.

A few days before the exam starts, remind students and give them an idea of how it will work.

### **5.0.2 Prepare for course evaluation by students**

We provide suggested questions for the course evaluation in an appendix, however, your institution may require a specific course evaluation form. Instructors will determine how to distribute these surveys, which should be released in the middle of the coming week.

## **5.1 Lab: Signal detection theory**

### **Preparation**

We are still polishing this lab and expect to continue polishing it for a few years to come. Check [testingeducation.org/BBST](http://testingeducation.org/BBST) for the latest version. It is more likely to change frequently than the more mature parts of this course.

Review instructions for the lab activity.

Set up a discussion forum for the lab.

### **Activity description**

Students read through a presentation of the statistical model underlying signal detection theory then answer questions applying the model to the testing-decision problem.

### **Purpose**

The lecture is a good initial presentation of the decision problem and signal detection theory (SDT) but it is not enough. This is not surprising because it is difficult material for students who studied experimental psychology. We are covering it quickly compared to the time often allocated to the teaching of this type of material. The lab is designed to help more students understand how SDT works. At the end of this lab, students will still not be able to do any of the SDT calculations, such as calculating the probability of a false alarm under stated conditions. However, students who successfully work through the lab will have a conceptual understanding of the relationships among several variables and will be able to predict some actions will increase hits or reduce false alarms, misses, or incorrect acceptances.

### **Tools**

The discussion forum.

## **Core readings**

The lab instructions which include a series of annotated graphs.

## **Facilitation roles and strategies**

Monitor the discussion forum, noting novel and/or exemplary approaches to the evaluation activity. Also notice who is participating and send a note to those who are not.

Monitor the unfolding discussion to prepare for your feedback note at the end of the exercise. Provide assistance as needed.

Some students will not understand this material. Some students will be too intimidated by the mathematics to understand it. Some students will feel a need for a little more encouragement and support than in the rest of the course. You may need to be willing to answer questions and straighten out confusions more quickly than usual.

## **Variations of the activity**

We don't yet have recommendations for varying this lab. If you are uncomfortable with this material, make sure you also remove the decision-theory essay questions from the exam study guide.

## **5.2 Phase 4 of the assignment (replicate & edit bugs)**

### **Preparation**

Review the assignments you published in Phase 3. Reassign reviewers if some students have not submitted a Phase 3 for review.

### **Activity description**

This phase is similar to Phase 2. Students peer review work completed by one classmate during Phase 3 of the assignment.

### **Purpose**

Students reinforce their experience in bug evaluation.

### **Tools**

See the description in Lesson 2.

### **Core readings**

See the description in Lesson 2.

### **Facilitation roles and strategies**

Monitor the discussion forum, noting novel and/or exemplary approaches to the evaluation activity. Also notice who is participating and send a note to those who are not. Some students are dropping out or they are away for the week. Identify "pairs" missing one of the pair and reassign the active student who needs a partner. Create triplet pairings or pair with an instructor if there are an odd number of students.

Monitor the unfolding discussion to prepare your feedback note at the end of the exercise. Provide assistance as needed.

### **Variations of the activity**

We have conducted this exercise with one less round of review, although we do not recommend that strategy. You can also vary this activity by changing the software development project you and your students will join.

## **5.3 Exam coaching lab**

### **Preparation**

Review instructions for this phase. Write your own practice answer. If you are co-teaching with other instructors, compare notes and peer review each other's answers.

### **Activity description**

Students will write an answer to a long-answer essay question and peer review other students' answers.

### **Purpose**

The purpose of this exercise is to better prepare students for the exam. We want those students who do fail the exam to fail because they don't understand the material, not because they are unskilled in exam writing.

Many students are ineffective at essay answers and, more generally, at written communication. This is as true for Computer Science undergraduate and graduate students as practitioners who haven't written exams for a decade. This exercise will give students a clearer idea of what is expected and (by teaching students to outline their answers in advance) a strategy to help them meet that expectation.

This exercise will also motivate some students to watch the course videos on exam grading and prepare additional sample answers.

### **Tools**

Course discussion forum

### **Core readings**

Kaner's essay on *Answering essay questions* available at <http://www.testingeducation.org/BBST>.

The course slides and videos: *How we grade essay exams*.

### **Facilitation roles and strategies**

Urge students to draft their essay early, so other students have time to peer review. Read the answers when submitted to gather notes for your feedback.

Don't provide feedback on the initial essay during the activity to avoid interfering with students' work as peer reviewers.

Do provide feedback (mainly, pointed questions) on the peer reviews.

Be ready to post your comments as soon as Lesson 6 starts—or earlier if most students have completed the task.

Many of the exam answers will be incomplete. Point out this trend and one of the most common causes for poor exam performance: failing to answer the question asked, often by simply missing some of the question parts.

Many of the peer reviews will be superficial and worthless. Make it clear a peer review only saying “good work” or assigning an unreasonable grade provides no value.

Some instructors heavily emphasize style and formatting issues. We like headings and subheadings and bulleted lists *but don't demand them*. You shouldn't demand them either

If you can easily understand a student's answer and clearly understand how it is organized, then the answer is adequately organized and written. If the structure is not what you would have used, but it is clear enough to be understandable, use it as an example of a good alternate structure. Don't penalize it.

We usually allow 10% of the grade for an answer to be driven by style and structure. Some instructors allow 20%; that's a lot. Don't go above that—leave the rest for the content—and tell students what your allowance is so they can prepare appropriately.

### **Variations of the activity**

This activity can vary a lot by varying the question students use to practice. We often select a difficult question or one not receiving students' attention in the *Exam Cram* forum.

## **5.4 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **5.5 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate

In university courses, students will want to know their term grades (the grade they have up to the final exam). They need this information to optimally allocate exam preparation time across their courses. They also need it to allay their anxiety. If you have not already advised students of their grades, do it now.

In professional development courses, you won't have a number for the term grade. You probably will have a mix of numbers and qualitative evaluations. If you have time, scan through these records to determine:

- whose term work was so good they will pass the course even if they fail the exam (unless they cheat on the exam or write an appallingly bad exam);
- whose term work is so weak they will pass the course only if they write a very good exam

- who will pass if they write a good exam and might pass (based on their term work) if their exam is disappointing (failing, but not awful).

In a large professional development class, these notes will help you focus your exam-grading time.

# Lesson 6 Tasks

	Quiz for Lecture 6	Exam Cram Forum	Quiz Discussion Forum	Instructor Feedback	
Preparation	Ensure quiz and video are available to students. Take the quiz if you have not already.	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Quiz Q&A forum.	Monitor course progress and note items to mention in feedback.	
Description	Students complete quizzes while watching videos.	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	
Outcomes	Increased understanding	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstanding.	Establishes instructor presence and guides student learning.	
Tools	Quiz, videos, slide sets	Course discussion forum	Course discussion forum	Course announcements and email	
Core readings	See course	None	None	None	
Communication	Encourage participation. Field questions.	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	

## Lesson 6

# Overview

Lesson 6 is about the clarity of the bug report. How well is the report written? How can the tester write reports more clearly? The lesson starts by describing a bug tracking system then describes the structure (what fields we see) in the typical bug report, bringing together the discussions of the RIMGEN series of tasks. With this as background, it considers how to most effectively fill in the fields of the bug report form.

The key student activity in this Lesson (apart from lectures, quizzes and study guide) is:

1. Preparation for the exam

### 6.0 Administrative tasks

A few days before the start of exam week, the lead instructor, with the assistance of the instructor team, should complete the following two tasks:

- Prepare the final exam.
- Prepare the course evaluation.

### 6.1 Ongoing activities: lectures; exam cram; and quizzes & discussions

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

### 6.2 Send *Weekly Feedback* post

Your weekly feedback must reach students by Friday morning because the exam starts early Sunday morning. Students need time to notice and read the post before the exam. The main topic of this post is probably your feedback on the signal detection lab.

### 6.3 Send *Highlights of the Coming Week* post

In the *Highlights of the Coming Week* post, be sure to emphasize the exam and exam procedures for the coming week.

## 6.4 Record grades as appropriate

There should be no new grades to record.

In university courses, students will want to know their term grades (the grade they have up to the final exam). They need this information to optimally allocate exam preparation time across their courses. They also need it to allay their anxiety. If you have not already advised students of their grades, do it now.

In professional development courses, you won't have a number for the term grade. You probably will have a mix of numbers and qualitative evaluations. If you have time, scan through these records to determine:

- whose term work was so good they will pass the course even if they fail the exam (unless they cheat on the exam or write an appallingly bad exam);
- whose term work is so weak they will pass the course only if they write a very good exam
- who will pass if they write a good exam and might pass (based on their term work) if their exam is disappointing (failing, but not awful).

In a large professional development class, these notes will help you focus your exam-grading time.



# Lesson 7 Tasks

## ACADEMIC

## PROFESSIONAL DEVELOPMENT

	<b>Exam Cram Forum</b>	<b>Instructor Feedback</b>	<b>Final Exam</b>	<b>Course Evaluation</b>	<b>Instructor Feedback</b>
<b>Preparation</b>	Post questions for study guide if necessary and enable forum.	Monitor course progress and note items to mention in feedback.	Post exam questions and instructions to Moodle site. Hide all resources per instructions in course	Prepare course evaluation and send instructions to students	Monitor course timeline and prepare notes.  Remind students of tasks and procedures.
<b>Description</b>	Students collaborate to prepare for final exam.	Lesson feedback from instructor	Students independently complete final exam.	Students share their perceptions of the course design and content	Instructor feedback
<b>Outcomes</b>	Students draft answers for study guide questions.	Establishes instructor presence and guides student learning	Demonstrate proficiency with course materials	Information can help instructors revise and improve the course	Establishes instructor presence and guides student learning
<b>Tools</b>	Course discussion forum	Most feedback during this lesson will be in the discussion forums.	Course discussion forum	Instructor selects the tool	Course announcements and email
<b>Core readings</b>	None	None	None	None	None
<b>Communication</b>	Encourage students to participate in the <i>Exam Cram</i> forum.  Provide feedback as necessary.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate.  Explain exam procedures as needed.	Explain exam logistics and field questions as needed.	Provide information regarding course evaluation to students.	Provide information about course logistics.

## Lesson 7

# Overview

Welcome to Exam Week.

BBST instructors run the exam in two common ways, which we'll call Professional Development and Academic.

In the typical Professional Development course, students write the exam during Lesson 7. Students peer review the exam in Lesson 8 and the instructor evaluates both the exams and the peer reviews after Lesson 8. This is the structure of the AST courses.

In the typical Academic course, Lesson 7 is a study break and students write the exam during Lesson 8. There is no peer review phase. The instructor grades all of the exams and gives feedback to all of the students. In many academic courses, students submit the exams privately, using an assignment dropbox rather than a visible-to-the-class discussion forum. The exam grades and comments are also private.

The names "professional development" and "academic" are shorthand and not necessarily accurate labels. For example, we already know of one professional development course following the "academic" exam structure. Choose the approach that works best for your context.

## 7.0 Administrative tasks

### 7.0.1 Release the course evaluation

Release the course evaluation along with instructions letting students know where to find it, where to submit it, and when it is due.

### 7.0.2 Hide the course content (*professional development course*)

During the exam, we hide the content. We hide the links to content (videos, slides, quizzes and quiz forums, most discussion forums). We normally leave the *Help* forum open. However, if students have posted a lot of content to the *Help* forum, we create an *Exam Period Help* forum so students can ask for exam-appropriate help without being exposed to inappropriate content.

## 7.1 Final exam for professional development courses

### Preparation

Select and add questions for the final exam to the exam block in your course management system. At the start of the final exam period, unhide the exam content and hide all other resources including discussion forums and lesson tabs. Send an email message letting students know the exam is ready and reminding them of exam procedures.

**Activity description**

Students independently complete the final exam designed by the instructor.

**Purpose**

The final exam provides a summative assessment opportunity for both students and instructors to determine how well students can apply knowledge gained from the course to problems posed in the final exam.

**Tools**

Discussion forum

**Core readings**

None

**Facilitation roles and strategies**

Encourage students to complete the exam. Field questions as appropriate.

**Variations of the activity**

Instructors can customize the exam by choosing different subsets of questions from the exam pool.

**7.2 Exam cram forum for academic courses**

During Lesson 7, students in academic courses should participate extensively in the *Exam Cram* forum. Monitor the ongoing discussion—offering feedback and encouragement to students and trying to engage those who are not participating. Remember the purpose of your feedback should be formative. Allow students in the course to wrestle with conceptual challenges of the questions.



# Lesson 8 Tasks

	ACADEMIC			PROFESSIONAL		
	Final Exam	Course Evaluation	Instructor Feedback	Final Exam Grading	Course Evaluation	Instructor Feedback
Preparation	Post exam questions and instructions using tools and procedures determined by your organization.	Prepare course evaluation and send instructions to students.	Monitor course timeline and prepare notes.  Remind students of tasks and procedures.	Unhide resources.  Assign two reviewers per exam.	Prepare course evaluation and send instructions to students.	Monitor course timeline and prepare notes.  Remind students of tasks and procedures.
Description	Students independently complete final exam.	Students share their perceptions of the course design and content.	Instructor feedback	Students peer review exam answers submitted by classmates.	Students share their perceptions of the course design and content.	Instructor feedback should focus attention on the peer review process and course logistics. Provide individual feedback on exam performance as appropriate.
Outcomes	Demonstrate proficiency with course materials.	Information can help instructors revise and improve the course	Establishes instructor presence and guides student learning.	Demonstrate proficiency with course materials.	Information can help instructors revise and improve the course.	Establishes instructor presence and guides student learning.
Tools	Course discussion forum	Instructor selects the tool	Course	Course discussion forum	Instructor selects the tool	Course discussion forum or other tool
Core readings	None	None	None	None	None	None
Communication	Explain exam logistics and field questions as needed.	Provide information regarding course evaluation to students.	Provide information about course logistics.	Explain peer review logistics and field questions as needed.	Provide information regarding course evaluation to students.	Provide information about course logistics.

## Lesson 8

# Overview

Academic students write the exam in Lesson 8.

Professional development students wrote the exam in Lesson 7, now peer review each other's exams.

## 8.1 Final exam (academic courses)

### Preparation

Select and post questions for the final exam in the appropriate place in the course. Send an email message letting students know the exam is ready and remind them of the exam procedures.

During the exam, we hide the content. We hide the links to content (videos, slides, quizzes and quiz forums, most discussion forums). We normally leave the *Help* forum open. However, if students have posted a lot of content to the *Help* forum, we create an *Exam Period Help* so students can ask for exam-appropriate help without being exposed to inappropriate content.

### Activity description

Students independently complete the final exam designed by the instructor.

### Purpose

The final exam provides a summative assessment opportunity for both students and instructors to determine how well students can apply knowledge gained from the course to problems posed in the final exam.

### Tools

Discussion forum or assignments. We typically have students upload a Word, OpenOffice or PDF file to an assignment ("upload a single file") dropbox.

### Core readings

None

### Facilitation roles and strategies

Encourage students to complete the exam. Field questions as appropriate.

### Variations of the activity

Instructors can customize the exam by choosing different subsets of questions from the exam pool.

## 8.2 Final exam peer reviews (professional development courses)

### Preparation

Assign two reviewers for each exam and post those assignments to the course discussion forum. To the extent possible, be sure each exam is reviewed by one of the stronger students.

Unhide course resources for students to use as reference materials throughout the review period.

### Activity description

Students review and critique at least two of their peers' final exam answers. After they do their review and their exam answers are reviewed, students post a *reflection* for each of their answers. The typical (good) reflection considers the strengths and weaknesses of their exam answer and describes how they would answer the question now.

### Purpose

To gain additional insight by reading and reviewing others' work and to provide feedback to peers.

### Tools

Course discussion forum

### Core Readings

None

### Facilitation roles and strategies

Some students may express discomfort with the exam review task:

Some students have been socialized to never speak critically of the work of their peers. (What are these people doing as testers?)

Some people think teachers should do all of the assessment in a course and it's inappropriate for students to evaluate each other's work.

Some people find the task intimidating and look for any rationale to avoid it.

The professional development courses may rely heavily on peer review:

People learn a lot from doing peer reviews. Some report they learned more from reading and critiquing peers' answers than they did from studying to prepare their own responses.

It is impractical to have volunteer instructors do the majority of assessment in the course. In groups like the Association for Software Testing, a project like the BBST project would be unsustainable if the students didn't do most of the assessment.

The model of expert teacher and inadequate, inexperienced, naïve student was a good one back when these students were children. However, they are now professionals and the BBST courses are not beyond their reach. The point of the class is to help students develop as professional-level

critical thinkers in the field. They must attempt that or they are wasting their time and their teachers’.

Encourage all students to complete the review task to the best of their ability, pointing out they may review other people’s exams for additional perspectives, draw on their own experiences, and refer to the course materials to complete this task. Providing critical review in the “safe” environment of the online class is good practice for the software tester’s work world where testers must frequently write reports and critically respond to others. In the work place, the stakes are often much higher than they are in the online classroom.

### **Variations of the activity**

None

### **Grading (professional development courses)**

It is up to you to do the final evaluation of the exams and peer reviews, and make the complete/non-complete decisions.

We start adding comments as soon as the assigned peer reviewers have made their comments and the student has posted her or his reflection.

We also will comment on the peer reviews. This is important for students who will pass the course. They will progress to *BBST Test Design*. Instructors in that course will expect students to have some experience and skill at peer review and will deal with the lazy or unskilled peer reviewer with less patience.

We normally post some feedback for each student. If the exam has 6 questions, every student has a comment on at least one question. Ideally, every instructor posts one feedback per student and so in a class with three co-instructors, each student gets instructor feedback on at least three answers.

We normally spend more attention (and add more comments) on grading the weaker exams. If there are multiple instructors, usually only one instructor posts a comment to the same question by the same student. It is not uncommon to see comments on all 6 answers of a borderline student. Many of these students come back for a second try at the course. Good feedback can help them pass next time.

Failing students who dismiss sound peer-review criticisms of their work often get less feedback. If they aren’t going to accept feedback, there is no point spending a lot of time writing it.

Some students write failing exams but then give insightful peer reviews and reflections. In the professional development courses, we will allow a student to pass the course based on excellent peer-review-and-reflection work, even if their exam was inadequate.

In general, our bias is toward passing students. Most professional-development students who have come this far in the course have invested a lot of time and probably have learned a lot. However, some students just don’t learn very much from the course. Some are too tightly wrapped up in their preconceptions to hear what the course is teaching. We don’t insist they agree with us. We do insist that they pay enough attention to understand what we are saying.

Some are gambling they can pass by staying to the end of the course even if they do little work or very shoddy work. Some believe they can do nothing then intimidate or flatter the instructor into passing them. We hope you will exercise some critical judgment here. Every closed-minded fool and lazy ignoramus who passes this course will diminish the reputation of the course. The issue is not the percentage of people who pass the course. We are happy to have classes in which every student completes the class successfully. The issue is some people will say things about testing that will cause listeners to wonder how good BBST courses could be if *this* person can pass them. A student who would discredit the course should flunk it.

Another factor in the complete/non-complete decision is the assessment of their ability to complete *BBST Test Design*. Those courses assume more effective study skills, time management skills, peer review skills and analytical/communication skills needed to complete more difficult assignments and exams. Letting an incapable or unwilling student through a class is a disservice to their future classmates and instructors.

Sometimes you will meet a student who worked hard in class but will not succeed in *BBST Test Design*. You might reasonably decide the best thing to do with that student is to allow them to complete this course but with a letter recommending they not enroll in the next course.

### **Grading (academic courses)**

It is up to you to do the final evaluation of the exams, assign grades to each answer, and communicate an exam grade to each student.

We create grading charts like the ones we describe in the *How we grade exams* slides and videos. We don't publish the grading structure but we can explain our grading to students who ask.

### **Variation: Interactive grading (professional or academic)**

When we teach this course with local academic students, we meet face-to-face with each student and interactively grade the midterm exam (equivalent to a BBST final). We have started doing interactive grading with professional students, who tell us they like it.

We plan to start using interactive grading for *BBST Foundations* exams in online professional development courses because students in this course (the ones who pass and the ones who don't) need detailed feedback. The quality of feedback they get in peer reviews is variable—the students are still learning how to do peer reviews. Too many of the peer reviews are vague and flattering; or hypercritical with an emphasis on superficial details (such as formatting), or content-challenged because the student is not sufficiently knowledgeable and is not taking the time to get more knowledgeable as part of the grading process. One of the key complaints of *BBST Foundations* students is insufficient feedback from the instructors. Interactive grading of the exam can go a long way toward changing that feeling.

Set up your interactive grading session so the student can see your screen. In a face-to-face meeting, set up a dual-monitor system so the student can watch what is on your monitor without having to look over your shoulder. Remember that eyesight (and convergence distance on reading glasses) varies. If you look at one screen side-by-side with a student, she or he might not be able to read the screen. In a two-display system, she or he can move the display

to a better place and angle. In a Skype meeting, alternate between sharing your screen and displaying live video of you as you talk to the student.

Make a copy of the exam answers for yourself and urge the student to print out a copy as well. You will want to be able to refer to this without switching your screen from the grading spreadsheet to the exam itself. You will sometimes switch to a view of the exam; make this a matter of choice rather than necessity.

Set up a table or spreadsheet with a section for each question. For a given question, break it into parts; allocate points for each part and decide what the student has to do to achieve points (full or partial) for that part. Each part gets its own column. In the top row, describe the part. For example, from the example question in *BBST Foundations*, Lesson 5, you might create headings like “Stopping Rule 1” and “Tradeoffs for Rule 1.” Include a column for style and organization. In the second row, show how many points you allocate to each part. We allocate 10% of the grade for style and organization or for our subjective impression of the quality of the answer. Most of the essay questions are open-ended. Students can answer them in different ways and reach different conclusions. In the process, they might make different arguments or cite different facts. Allow for this diversity in your grading structure. To allow for this, your total might add up to more than 100%. That’s OK. Let the points take you to 90%. Reserve the last 10%, no matter how high the point count, for your overall subjective assessment of the answer.

Kaner illustrates this in the grading videos at <http://www.testingeducation.org/BBST/takingexams/> (these are probably already in your course resources). If you have included these videos and pointed students to them (for example in the exam practice activity in Lesson 5), students will already expect this structure for grading and not be surprised by it. In our experience, they are intrigued to see it applied to their work.

*Please do not give your students a copy of your grading chart. It will get posted to the internet almost immediately and will distort performance in the classes. We have a lot of experience in academic courses with students who study from grading structures or sample answers other people created for them; the students learn very little and often flunk the course. Despite this, many students are attracted to these materials, relying on them instead of puzzling through the questions (doing some learning) as their own cognitive activity.*

We recommend you grade at least one course worth of exams using this type of grading structure before trying to do this in interactive grading. These tables are not perfect. Some students will give good answers that don’t map well to your table but that deserve a high grade anyway. Some of these answers will prompt you to revise the table while you are grading. Get that experience behind you, in private, before trying this as a live activity.

For interactive grading, create a separate copy of the table to use with each student. Don’t show any student the assessments of other students’ work.

Do not read the student’s exam answers before the interactive grading session. Part of the value of the session comes from showing your confusion and surprise at what the student says. It is entirely appropriate, in fact it is highly desirable, to make comments like the following (if they are justified):

- I don't understand what you are saying here? Can you explain it?
- What were you thinking?
- How does this relate to the question?
- Aren't you telling me the same thing you already said in this part? Am I missing a difference?
- Can you explain what you think the question was asking here? I don't understand how this comment responds to the question.
- How does this conclusion follow from this argument, or these facts?
- Why do you think this is true?
- Was this claim made somewhere in the lecture? If not, what is your source for saying this?
- Do you want to elaborate on that?
- Can you draw a diagram and explain it to me?

During the interactive grading session, we typically do the following:

- Go through the exam one question at a time. Start with a short-answer question to set the tone, but go to the long-answer questions next and come back to the short answers at the end. Don't fall into the trap of using all your time on the much-easier short answers.
- Explain the grading structure in the context of the first short-answer question. If you structured the exam well for interactive grading, the first short-answer question will have a few parts but it won't be very difficult. It will serve as a nonthreatening introduction to the grading structure and the interactive grading process.
- Give the student constant feedback on what you are reading and doing. If you are showing the student's answer on the screen, highlight the section you are reading. If you are showing the grading structure on the screen, consider reading the answer out loud, stopping to make comments or ask questions. Or just give status reports like, "I am reading your third paragraph."
- When you see something mapping (well or poorly) to your grading structure, note it. Consider making qualitative notes (such as "incorrect", "weak", "confusing", "OK", "strong")
- As you read, you will often see something shown in one column in your grading chart is split into disjointed bits in the answer. You might change your note several times, perhaps from "weak" to "weak+" to "OK". This type of thing happens often in disorganized answers. If the answer is actually disorganized (rather than being well-organized but differently from your structure), comment to the student on how hard it is to follow this answer for grading. If the answer is good but organized differently from your ideal

answer, compliment the student on their structure. Show the student you understand and are OK with it even though different from what you initially had in mind.

- If the student makes an error, such as an incorrect statement or an unsupported assertion, we count that against the answer's grade. If the student made an error in a relevant part of the answer, make a note or take off points in the appropriate column. If the student made an error in an irrelevant part of the answer (a shotgun answer) add a new column and put a negative number in it. Some students will protest they shouldn't be penalized for errors in something not necessary to the answer. We disagree. We think a student who doesn't know relevant from irrelevant (or correct from incorrect) is demonstrating cluelessness, and we think the grade should reflect that. You will have to set your own standards on this. Set them in advance. Don't let an obnoxious student bully you into setting the grading standard.
- If the student has already given peer review feedback on other students' answers, you might find it interesting to review and ask the student to explain their feedback. If their feedback doesn't communicate their thinking well or if the grade they assign is inconsistent with their opinion, give them feedback on how they could have said it better. If this student continues to other BBST courses, training him or her to give better feedback will be an important service for future peers.
- After you have made notes on each part, consider asking the student what grade they would assign to the answer. You are not bound by their grade, but it is informative to know what they think.
  - Some students are too harsh on their work. If a student gives a "D", but you think it's a "B", say so and explain why.
  - Other students are remarkably generous to themselves. Be cautious in your interpretation. Cultural diversities are in play here and something seemingly outrageous to you might be normal haggling to the student. That said, when a student tries to give a high grade to a lousy answer, this often reflects a serious lack of comprehension of the material and/or an unwillingness to learn through constructive criticism. *IF* that is your assessment, and *IF* this happens on more than one question, you are probably going to treat the exam as an indicator the student should not complete (professional development) or fail (academic) the course.
- Some students refuse to take constructive criticism, argue with every critical comment, and try to intimidate the grader.
  - If you are an academic grader, you have experience in dealing with this and you have a department chair to advise you. Do what is appropriate at your school.
  - If you are teaching a professional development course, you probably don't have much experience with this. Our advice is you don't have to put up with this. In the volunteer-instructor case (such as teaching for AST), stop the session once you see a clear and irritating pattern. Assign an appropriate grade (complete or not) without giving the student further input into the grading process.

- If this is a paid professional development engagement with a company employing this student, you may have a client management problem. But if you are skilled enough to be teaching this course to paying clients, you already know how to manage your clients.

At the end of the interactive grading session, invite the student to give you feedback on the session and how you managed it, and overall feedback on the course. End the session so the student has the last word, especially if it was a difficult session.

In our experience, most students are appreciative. (Actually, in our experience *so far*, EVERY student has been appreciative. The online students and the face-to-face academic students have thanked us, even the ones who failed the exam or assignment miserably. But we know this is too good a streak to continue, so by the time you read this, we expect our experience will have become, MOST students are appreciative.) Most students tell us they learned a lot from the exercise. We believe we are seeing improvement in performance in academic courses on software testing and software metrics because of this process. But we also think it takes a lot of preparation. Our results with students have been good *because* we were well prepared, clear in our communication, attentive to their reasoning, flexible, and confident rather than defensive.

### **8.3 Send *Wrapup* post**

At the end of the exam period, send a message thanking students for their participation in the class and advising them when you anticipate having the exams graded and ready for them to review.

Please do not post sample answers for each exam question. Over time, this will lead to a bank of “approved” answers on the internet, destroying the value of these questions in our courses.

# Ongoing tasks

## 9.0 Administrative tasks

### 9.0.1 Monitoring student progress

The timeliness of student assignments is very important to the success of any online course. Instructors should monitor student submissions. If a student is late, depending on the late policies announced to the class, the instructor can make contact to:

- encourage the student.
- see if special circumstances require emotional or logistic support.
- make the student aware they are late and it matters.
- figure out whether this student actually has dropped.

Personal and work circumstances can give good cause for a student to fall late. When that happens, it's important to intervene as soon as possible to help that student. Often, the circumstances that led to falling behind will be too complicated to resolve for a short course. If that is the case, the instructor in a professional development course should let the students go with a smile. After all, these might be our students for now but they will be our colleagues soon. How an instructor terminates students could have long-term interpersonal consequences.

## 9.1 Lectures and quizzes

### Preparation

If you are teaching from a master copy of the course, you will need to review the quiz questions and answers. If you are creating your own course, you will need to populate the course with quiz questions. Most course management systems allow you to provide feedback for students' quiz attempts. We recommend you take advantage of that powerful capability.

We plan to create a BBST student edition including quiz questions and feedback. Once published, you might choose to use questions in that book for your own courses. You might also choose to create your own quizzes. If you write your own questions, we suggest the question writing standards we present in Chapter 6.

We also recommend setting up a discussion forum for each quiz. In our courses, we pre-populate the forums with individual threads—each including one question and its answer. The quiz forum is hidden from student view until after they take the quiz. Once the quiz is over, the students have an organized structure for discussing aspects of the course material they found challenging. Our students report such discussions are very valuable for them.

## Activity description

Students watch course videos and complete the corresponding quizzes in parallel. Quizzes are intended to focus student attention on important aspects of the lecture. The course management system provides automatic feedback for each question but students may discuss challenging questions or controversial answers in the quiz discussion forum.

## Purpose

In the BBST courses, quizzes are used formatively to focus students' attention on important information presented in readings and lectures. Answers are expected to come from the course materials. Neither students nor instructors should emphasize quiz grades. The learning from taking the quizzes is more important.

The testing field has many different perspectives and we encourage debate on these perspectives in the quiz discussion forums. However, quiz scores will not change as a result of those debates.

## Tools

Quiz and discussion forum

## Core readings

None

## Facilitation roles and strategies

Please encourage students to complete the quizzes as they watch the videos. Some students are dismayed by their performance on the quizzes. Consider sharing the *Philosophy of Quizzes* with your class to help them understand how the quizzes are used and why they are used that way. See a sample post in the *Fieldstones* appendix.

Although our quizzes provide automatic feedback for quiz answers, we invite students to visit the quiz discussion forum to discuss and/or challenge the questions from the quizzes. If you are teaching from a master copy of the course, the quizzes and *Quiz Q&A* may already be in place. If you don't understand or agree with an answer, consider removing it from your quizzes.

Instructors should monitor the unfolding discussion in the quiz discussion forum. A few days after the quiz closes, one of the instructors can post comments to the discussion forum. Most instructors like to make comments on any of the questions a majority of students answered poorly. Be sure to check the quiz automatic responses for the question before posting a comment so you don't repeat what they've been told. Many times, the quiz response is clear and the instructor does not need to comment in the forum. To find out how the group did on specific quiz questions in Moodle, go to Quizzes —> Quiz N —> Results —> Item Analysis.

## Variations of the activity

None

## 9.2 Exam cram forum

### Preparation

We recommend setting up the exam study forum with a post titled *Using This Study Guide*. Following that, you should have one discussion thread for each question. Each thread should have titles like “Long 1” (referring to the first Long Answer question in the study guide). You can find *Using This Study Guide* and study guide questions at <http://www.testingeducation.org/BBST>.

### Activity description

The exam study forum is for students to discuss study guide questions with their peers and instructors. Students engage with their peers and the course materials to build their own answers to potential exam questions.

### Purpose

Providing exam questions ahead of time allows instructors to require better answers from all students. It is especially helpful for students who are using a second or third language throughout the course.

### Tools

Course discussion forum

### Core readings

None

### Facilitation roles and strategies

Instructors should monitor discussions on the exam study forum but refrain from providing answers to questions appearing on the exam. Several types of feedback to students are useful:

#### Organization and structure

Whether or not an answer is complete. For example, students sometimes skip parts of a question. You may respond to a draft answer by asking, “Where is X?” or “Have you addressed all parts of this question?” Similarly, if the question asks for multiple arguments or examples, and the student answer provides only one, you might post a comment like, “This gives one example; the question asks for 3.”

Sometimes a question uses material from the slides but misses key relevant material from the lecture or the assigned readings. In that case, your response might ask, “Does this use the necessary source material? What about the readings?”

If students are leaving a question unanswered and the relevant lecture(s) has passed, the instructor might post a very short note, like “No answer?”

If an answer is going in the wrong direction, the instructor might query, “Does anyone have a comment on this?”

The instructor should not post a comment on every question. Don't give the impression you'll catch every big mistake or bad direction.

**Variations of the activity**

None

# Ending the course

## 10.0 Administrative tasks

### 10.0.1 Grading

Grading standards will vary widely. At the end of the course, determine and privately communicate grades to students. Depending on your institutional context, you may choose to send an email to each student, post to an institutional grade reporting system, or send certificates of completion. No matter the context, it's important to complete the grading process in a timely fashion.

### 10.0.2 Review course evaluations

After the course is complete and all grading obligations are met, instructors should review the course evaluation data looking for opportunities to improve the course. Make notes and updates as appropriate. In addition to course evaluation data, Fiedler recommends you review postings from the *Help! Discussion* and course emails looking for areas of confusion to clarify by revising instructions for assignments or course materials.

For more details on grading and course evaluation, please consult Section One of this *Instructor's Manual*

# SECTION 4

TEACHING THE  
*BBST TEST DESIGN*  
COURSE

## Preface to section 4

This section of the *Instructor's Manual* is about teaching *BBST Test Design*, the final four-week course in the three-course BBST series. Throughout this section, we write about things you may decide to do to customize the course. If you are teaching for an organization, you may not have the privileges or the freedom to make these changes. If that is the case, please speak to the appropriate personnel about any changes you wish to make.

### Organization of this section

#### **Chapter 11: Preparing to teach the *BBST Test Design* course**

Even if you have the lectures on tape and have developed homework, quizzes and exams, online courses require a lot of preparation before the official start date. In our experience (and the experience of countless colleagues), thorough preparation before the start of class is important for online courses and online courses are more likely to fail badly in the hands of a poorly organized instructor.

Chapter 9 lays out the tasks we urge you to complete before the first day of class. For discussion focused on how and why to do tasks like these, please see Section One of this manual.

#### **Chapter 12: Teaching the *BBST Test Design* course**

We divide the course into eight lessons, each spanning half-week segments. Each segment includes a weekend day and some weekdays: (a) Sunday to Wednesday and (b) Thursday to Saturday. Many students do most coursework on the weekends; this schedule gives them a weekend day for every lesson.

Tasks are due on the last day of the segment. Most tasks start the first day of the lesson; and some tasks run two or more lessons. As lessons complete, give students feedback on their performance, alert them to what's coming in the next lesson, and assist those who are not making the progress needed to move into the next lesson.

Chapter 12 lays out the instructor tasks on lesson-by-lesson timelines. The chapter has sections for each lesson, ongoing tasks, and end-of-course tasks. Be certain to read each section of the chapter. Please see Section One of this guide for more information about how or why these tasks are important.



## Chapter 11

# Preparing to Teach the BBST Test Design Course

## Set up your online classroom

Good teachers prepare their classrooms before students arrive. Commercial instructors ensure technical equipment is working, arrange for lunch, and familiarize themselves with the locations of restrooms and water fountains so they can keep attendees comfortable. Kindergarten teachers make many of the same arrangements and also decorate bulletin boards, set up play areas, and make nametags for the little ones. In their own ways, all of these instructors are making their classrooms a welcoming and comfortable space for the students.

Similarly, online instructors have a set of tasks to prepare their online classrooms for their students. This chapter describes these tasks.

## Review course structure, policies and content

Familiarize yourself with the course objectives and instructional strategies. The resources available to the students include videos, readings, grading guides, and quizzes with feedback. You can find additional instructor-support materials at [testingeducation.org/BBST](http://testingeducation.org/BBST). Be sure to review these resources as you prepare to teach your own class. If you have not watched them recently, watch the videos. Take the quizzes. If you know other instructors, consult with them as you have questions—to do this effectively, you will have to prepare for the course in advance. Give yourself enough time to discover you are confused, ask questions, get answers and work with those answers until you can deal appropriately with that part of the course.

The quizzes, in particular, bring grief to underprepared instructors. The questions have been carefully written and polished over time. They are intentionally difficult. Many students are accustomed to easy quizzes and expect to get high grades with minimal study. Our quizzes are open-book; it is common for students to score 40% to 70% in their first few BBST quizzes because they have to develop better test-taking skills (such as, more careful reading). Students who are used to getting A's (90% in the United States) may be shocked by these low grades. Some will consider dropping the course. Others will protest, sometimes quite vigorously. If you are not prepared to respond knowledgeably and confidently, you will lose credibility with your students.

To prepare for this, you must work through the quizzes yourself, in advance. Question them. If you cannot defend the answer and the analysis in one of the quiz questions, drop it from your course before students see it. Putting yourself into a position of having to apologize for the questions or join the students in disagreeing with them will reduce the credibility of the course, reduce your credibility, and diminish the value of the course to your students. Similarly, it is important to understand the course assignments; what distinguishes strong from weak performance; and the exam study guide questions. What you can't work with, replace.

Similarly, it is important to understand the course assignments, what distinguishes strong from weak performance, and the exam study guide questions. What you can't work with, replace.

## Review and modify the course

If you are teaching for an organization, you may receive a “copy” of the course to use for your class. Once you have access to your course, familiarize yourself with everything in the course. It is particularly important to check all links in the course to be sure none have broken as the Internet continues to grow and evolve. Fix any broken links. Delete any content you don’t want to use for the class you will be teaching and add content as appropriate.

The course you receive was likely created as a copy of an earlier course or from a course backup. You may find remnants of the earlier course needing to be removed. In particular, pay attention to the following areas:

- List of students—remove any not in your section of the course.
- Discussion forums—Your set of discussions will have some generic posts describing tasks or policies. You may need to edit some of these to fit your circumstances. The forums may also have posts submitted by previous students and non-generic instructor responses. Delete these.

If you are teaching an AST-approved version of this course, you must not delete content, significantly modify the assignments, or substitute examination questions without prior AST approval. Contact the chair of the AST’s Education SIG to discuss any changes you wish to make.

If you are developing a course for the first time, you can acquire most resources you will need from <http://www.testingeducation.org/BBST> or the National Science Digital Library at <http://www.nsdll.org>.

## Determine your policies

Setting and communicating your policies is important to help students know what you expect of them. *Moodle* users can take advantage of *Moodle’s* Choices capability to share policies. Publish the policy as a Yes/No Choice and ask students to respond. If your Course Management System doesn’t have a similar capability, consider posting your policy in a discussion forum and ask students to reply to your post indicating their agreement. The students’ responses document you have provided them with the policy information. Once all students have agreed to the policies, you can hide the forums or choices section to keep your online classroom uncluttered. Do not delete the responses in the event you need the documentation later.

Consider sharing some or all of the following types of policies with your students and posting them before the course starts. See Chapter 2 for a brief discussion of these policies:

- Late work policy
- Academic integrity policy
- Acceptable use policy
- Privacy policy

## Set up discussion forums

Class discussions are more easily organized if you have a variety of discussion forums. Some discussion forums will focus on specific course content or assignments. Some will support students' study efforts by providing a place to ask for help or talk about course content in an ungraded format. Others will provide workspace for groups. Still other discussion forums provide opportunities to socialize. In *BBST Test Design*, start with the following discussion forums and add others as needed:

- Course Announcements (this is for instructor use only)
- Help! Forum
- Hallway Hangout (A social forum)
- Exam Cram Forum (Ungraded)
- Meet & Greet (A social forum)
- Lesson 2: Lab on Risk-Based Testing
- Lesson 3: Assignment 1—Using HTSM to Analyze Specifications
- Lesson 4: Lab on Test Design
- Lesson 5: Lab on Classical Domain Testing
- Lesson 5: Assignment 2—Risk-Based Domain Testing
- Lesson 6: Lab on using the PICT All-Pairs Test Tool
- Quiz 1 Q/A & Discussion (Ungraded)(Initially hidden)
- Quiz 2 Q/A & Discussion (Ungraded)(Initially hidden)
- Quiz 3 Q/A & Discussion (Ungraded)(Initially hidden)
- Quiz 4 Q/A & Discussion (Ungraded)(Initially hidden)
- Quiz 5 Q/A & Discussion (Ungraded)(Initially hidden)
- Quiz 6 Q/A & Discussion (Ungraded)(Initially hidden)

## Working with co-instructors

If you plan to work with one or more co-instructors, spend some time working out details about how the instructor role will be divided among the instructors. Designate a lead instructor and use a task-tracking list to coordinate the tasks. At the time of writing, instructors for the Association for Software Testing used *Google's* document sharing service for this. Remember that timely feedback is critical—particularly in short courses.

## Publish the course task list

Providing students with a single document listing course tasks and deadlines helps them manage their time and work load. We have provided a sample task list for each class in the Appendices of this book. Create a similar document for your course and post it online.

Depending on the course management system (CMS) you are using, you may be able to build the course schedule using a CMS tool. For example, if you use *Moodle 1.9* (and newer) you can install an extra module called *Progress Tracker*, allowing students to check off tasks they've completed. Visit [Moodle.org](http://Moodle.org) for more information on *Progress Tracker*.

## Quizzes

Most course management systems allow you to designate start and end dates for quizzes. Once your course task list is updated with the appropriate dates, set quiz dates in the CMS to correspond with the published dates.

We recommend having all quizzes open at the start of class so students can work ahead if their personal and professional schedules require it. Set the quiz close dates to enforce deadlines posted in the course materials.

We provide an opportunity for students to discuss quiz questions after the quiz has closed. Prepare the quiz discussion forum for each quiz by populating it with quiz questions and answers—one thread per question. In the *BBST Foundations* course, we set each forum to open once the quiz ends or open the quiz discussion forums manually. Some instructors follow the same policy for *BBST Test Design*. Others (including Kaner) open all forums at the start of the *BBST Test Design* course, so students can post comments on a quiz as soon as they finish the quiz. If you manage the quiz forums this way, be sure to remind students to stay out of a quiz forum until they have taken the quiz.

## Prepare for grading

Tracking student progress is an important instructor responsibility. Most course management systems have a gradebook function to streamline this task. Alternatively, you can set up a spreadsheet. Be sure to set up grading space for each graded assignment and anything else you'd like to track. If you don't want to use the traditional A, B, C, D, and F letter grades, think about what you can do as an alternative. You can set up customized grading scales. Possible alternatives include:

- Fail / Pass
- Incomplete / Complete
- No Credit / Credit
- Not Done / Weak / Acceptable / Good / Excellent
- Nothing submitted / Substantially incomplete / Unresponsive / Insufficient / Weak / Adequate / Good / Excellent / Instructor quality (*This is the scale Kaner uses.*)

For professional development classes, we avoid using *Fail* because we recognize students are often pulled away from the class for more important or urgent projects at work. Instead, we prefer to report the student performance as *Incomplete*.

*Tracking progress* does not necessarily require a detailed evaluation of each submitted piece of work. For example, in a professional development course, it is usually enough to note whether the student submitted a lab and if so, whether it was adequate. This will tell you whether the student is keeping up with the course. You might look at individual pieces of work in much greater detail, but you may have time only to look in detail at a few students' work each week.

This inconsistency will not work in an academic course. University students reasonably expect that every piece of their work will be formally graded. Academic grades are high-stakes. Access to scholarships and future jobs can depend on a transcript (the record of grades). But in a professional development course, the student is under no such pressure. The student needs feedback, not a grade. You have to manage your time in a way to give students sufficient feedback. On the professional development schedule and rate of pay, you cannot afford to waste hours arguing with professional development students about whether a piece of work deserved a "C" or a "B". Changing the letter-grade will not change the quality of the work that was submitted. Give them feedback about their quality that you believe they will find most useful.

If you use a Course Management System's gradebook, you can set it to show the students their grades. We do this as a matter of routine in academic courses. However, in professional development courses, we treat the gradebook or the grading spreadsheet as a place for private notes for the instructor.

## Post your introduction

Just as commercial instructors and Kindergarten teachers arrive early to welcome their students, online instructors should prepare their classrooms to be a welcoming space. Be sure to post a friendly introduction in the *Meet & Greet* forum. In it, include your name, location, employment, hobbies or interests, and a digital photo. Try to craft a message conveying your professional credentials to let your personality shine. John McConda did this by talking about a big event in the local news:

## **SUBJECT** Introduction

*I'm not sure how big the Super Bowl of American Football is in other countries, but here in the US, it's like a national holiday. The season is about to start and in February, my city of Indianapolis will be hosting the big game for the first time. It's actually a huge economy boost as well, so that's the big deal around here.*

*As for me, I'm a tester, and have been for ten years now. I've been with Moser Consulting for three years at the same US Government contractor for that time. I'm still having lots of fun there, mostly playing with LoadRunner lately, though it's a big pain to get it working with Siebel!*

*My wife Laura and I have three kids, and number four on the way, due in early January. We don't know the gender yet, but hope to find out in a few weeks.*

*In whatever spare time I can carve out, I like to write songs. I'll be going back to Nashville, Tennessee in a few weeks to pitch one of my songs there. My picture is from our recent trip to Cancun, Mexico. Playing guitar on the beach is probably my favorite place to be, though it doesn't happen often! All my hobby and testing stuff can be found on my website, [mconda.com](http://mconda.com)*

*Don't hesitate to send me a note if you have any questions. We've also got three other seasoned instructors to help out this time: Jane, Karol, and Johan, so you're in good hands!*

*-John*

Be sure to return to the *Meet & Greet* forum to greet students as they join the class and post their introductions.

## **Make a first impression**

Depending on your individual circumstances and access to student contact information, we recommend sending at least one—and possibly two—messages before the course starts. In your message, try to convey a warm welcome to students, as well as logistical information (web address, user name, enrollment keys or passwords, etc.) students need to begin.

We also find it useful to set students' expectations on workload and remind them about routine housekeeping matters, such as updating antivirus software, downloading appropriate media players, updating system software, and paying attention to a backup strategy for course work. Be sure to coordinate messages with any course registration correspondence to avoid duplication.

## **Set the rhythm of the course**

Our professional development courses are designed keeping the typical work day / weekend day structure in mind. Each week has two lessons. The first lesson runs from Sunday to Wednesday; the second from Thursday to Saturday. Each lesson includes a weekend day, so students who only can work on the weekend can complete the lesson work. You can reinforce this segmentation with well-timed messages.

Generally speaking, the student week looks like this:

**Sunday through Wednesday**—Students work on a lesson with their initial posting due no later than Wednesday.

**Thursday to Saturday**—Students work on another lesson frequently requiring them to review and respond to other students. If assigned, students complete one or more peer reviews of work submitted in the first part of the week.

You might make some posts during this period, but the goal is to acknowledge and encourage progress rather than to make a substantial contribution. Most instructor feedback during the exercises is in the form of directing questions rather than critiquing or answering the exercise question. The course is designed so much of the student's learning comes from discussing course content with other students, giving and receiving peer review, and attempting quizzes and assignments. Reading and receiving instructor feedback also contributes to student learning. Often instructor feedback is given to the group as a whole not always to specific individuals. The online course is not individual tutoring.

The instructor's week proceeds as described here:

Log in to the course every day. Be sure to check the *Help!* forum and handle any problems blocking students from making progress. Alternatively, you might prefer to subscribe to all postings in the *Help!* forum so messages come directly to an email account you read frequently. Most course management systems have this capability.

Other than *Help!*, there is no need to respond to students each day—or spend a lot of time reading the daily posts. However, a daily login allows you to monitor student progress and intervene if a discussion thread goes off track.

We recommend you make at least two posts each week (*Highlights of the Coming Week* and *Weekly Feedback*) to maintain a sense of instructor presence in the minds of the students and reinforce the rhythm of the class. These posts should go in the course announcements forum with all students subscribed via email.

## Highlights of the coming week

Posted on Saturday or Sunday, this instructor posting gives students an overview of the coming week and highlights about particularly interesting or difficult content areas they will encounter. If the workload for the coming week is a bit heavier than usual, this post is a good opportunity to warn students of that fact. Making this post also gives you a chance to remind students how to correct persistent problems you noticed in previous weeks or tell students what aspects of their performance you will be watching closely. You also may share additional resources especially relevant to student efforts for the coming week.

## Weekly feedback

The weekly feedback post is exactly what it sounds like and generally should be posted on Sunday or Monday. This is sometimes combined with the *Highlights of the Coming Week* in a single posting. In this post, you can point out broad themes you identified over the course of

the past week; draw attention to particularly insightful or noteworthy contributions; or invite further participation in an especially engaging thread. Use this post to identify and correct any broadly held misunderstandings you've noticed (but never in an embarrassing way for individual students). To correct misunderstandings, you can ask students to review a particular chunk of course content; point them to additional resources; or create another resource for them. If at all possible, start and end this post on a positive note.

In some cases, you may choose to address an individual's substandard work in a private email.

### **Pre-course checklist**

- \_\_\_\_\_ Set up a private discussion group / mailing list with your co-instructors.  
There are several free alternatives to accomplish this.
- \_\_\_\_\_ Decide how instructors will share course tasks.
- \_\_\_\_\_ Check to make sure all links in the course are working.
- \_\_\_\_\_ Check course content for updates and modifications.
- \_\_\_\_\_ Finalize and post course policies.
- \_\_\_\_\_ Accept the course policies yourself.
- \_\_\_\_\_ Set up discussion forums for the course.
- \_\_\_\_\_ Confirm existing posts (such as those in the *Exam Cram* forum) display in the student view.
- \_\_\_\_\_ Set up gradebook items.
- \_\_\_\_\_ Update course task list with deadlines.
- \_\_\_\_\_ Post updated course task list.
- \_\_\_\_\_ Update quiz start/end dates.
- \_\_\_\_\_ Post introductions from all instructors.
- \_\_\_\_\_ (Optional) Send welcome message to all students introducing yourself and providing log-in instructions.
- \_\_\_\_\_ (Optional) Send pre-course reminder.
- \_\_\_\_\_ (Optional) Schedule final exam if necessary.

## Chapter 12

# Teaching the BBST Test Design Course

This chapter details learning objectives for the *BBST Test Design* course and offers guidance on facilitating learning activities.

For each lesson, we provide a summarizing table of tasks and a detailed description of the activities you will facilitate. The table serves as an overview for the lesson and a checklist to help you ensure all tasks are completed on time. You may need to modify the pace. We anticipate the task lists will be useful but (unless you are teaching the AST version of the course) will require modification for your situation.

## Learning objectives for BBST Test Design

In context-driven testing, we choose techniques well-suited to serve the needs of the current context. This requires knowledge of and skill with many techniques. It requires understanding, for each technique, what kinds of problems are more readily exposed by the technique and what other kinds are better hunted with another technique. It requires understanding, for each technique, what skills, what knowledge, what resources, what schedule flexibility are necessary for using the technique, and if these are limited, what other technique might do almost as good a job for less. Without knowledge like this, testers can pay lip-service to context-driven testing, but they won't know what to do.

*BBST Test Design* is a survey course. It presents a large number of test techniques at a superficial level—just enough to give the student a sense of what is possible. Then it focuses on a few techniques that are very different from each other, helping students develop some practical experience with each. The course suggests two frameworks for comparing and contrasting techniques and provides a large collection of references. These can help a student who is trying to decide how to test a particular product scan through the large set of possible techniques and pick a few for more detailed evaluation.

Each of the techniques we focus on has been treated as a silver bullet by some testers or consultants. Each one has been treated as The Most Important Technique, or even The Only Technique or The Fundamental Technique. No testing technique should be given such importance. They all have strengths, weaknesses, and blind spots. We are enthusiastic about all of the techniques that we focus on in this course, but we present challenges and limitations in each case, popping some overinflated claims in the process.

Our treatments of the focus techniques are still superficial. Students won't develop much skill from less than an hour of lecture and a small practice assignment. We are working on more tightly focused courses—one per technique—because we believe an emphasis on the development of skill is what is most missing in most software testing education and what most differentiates much of the education and training available in computer science from what is available in testing. We hope that other instructors in the testing field will also narrow the scope of their courses and concentrate on helping people learn how to do a few things well, rather than learning to describe the many.

## Course Objectives Anderson/Krathwohl (2000) level

1	Gain familiarity with a variety of test techniques	Remember
2	Learn structures for comparing objectives and strengths of different test techniques	Understand
3	Use the Heuristic Test Strategy Model (Bach) for test planning and design	Apply
4	Use concept mapping tools for test planning and specification-based analysis	Analyze
5	Function testing	Apply
6	Risk-based testing	Analyze
7	Specification-based testing	Analyze
8	Domain testing	Create
9	Scenario testing	Understand
10	Multi-variable testing	Apply

# Lesson 1 Tasks

	<b>Course Policies</b>	<b>Welcome and What time is it? Posts</b>	<b>Meet &amp; Greet</b>	<b>Course Orientation Review</b>	
<b>Preparation</b>	Posted before course.  Removed from main menu page after 2 or 3 days.	None	Discussion forums and instructor intros posted before course starts .	None	
<b>Description</b>	Students ask questions about and agree to policies.	Sample announcements available in Appendix F.	Students introduce themselves and respond to others.  Instructor(s) greet(s) all.	Course orientation web pages and video	
<b>Outcomes</b>	Students understand expectations.  Unenroll or otherwise follow up with students who fail to agree early in the week.	Information only	Students get acquainted with instructor and students. Creates a welcoming online space.	Students become familiar with course objectives and background.	
<b>Tools</b>	Moodle Choices or course discussion forums	Course announcements	Course discussion forums	Web pages in course management system	
<b>Core readings</b>	Policies	None	None	Orientation pages	
<b>Communication</b>	Email non-responders urging them to respond. Notify those who have been removed from the course of their removal.	None beyond publishing these announcements. .	None beyond instructor responses to individual introductions.	None	

	Quiz for Lecture 1	Exam Cram Forum	Quiz Discussion Forum	Instructor Feedback	
	Ensure quiz and video are available to students. Take the quiz if you have not already.	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Quiz Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students complete quizzes while watching videos.	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Increased understanding	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstanding.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Quiz, videos, slide sets	Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
	See course	None	None	None	<b>Core Readings</b>
	Encourage participation. Field questions.	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 1

# Overview

This lesson introduces the student to a huge collection of test techniques. It presents most techniques in barebones detail, just enough to help students understand how each technique fits within the first of the course's conceptual organizing structures.

The lesson also looks in greater detail at two techniques (or families of techniques): function testing and testing tours.

The key activity for students in this Lesson (apart from lectures, quizzes and study guide) is:

1. To introduce themselves to the other students in the *Meet & Greet* forum.

The activity load is intentionally light. The breadth of the lecture will leave many students in a state of shock. Let them catch their breath before starting Lesson 2.

## 1.0 Administrative tasks

### 1.0.1 Course policy agreements

At the beginning of each course, students should read and agree to the policies identified prior to the start of the course. Immediately after the course begins, monitor students' responses to the policies. Send a reminder of this important obligation. Set a close deadline for students to complete this task.

Adhere to your institution's guidelines for dealing with students who do not agree to the policies. The Association for Software Testing requires instructors to remove shortly after the deadline passes any enrollees who have not agreed to the policies from the course. Be certain to notify students of any actions and, if appropriate, invite them to return for a course at a later time.

The timing of policy enforcement is important. It lays the groundwork and expectations throughout the rest of the course. Once the time for policy agreements has expired, edit the front page to remove the course agreements blocks. Those policies and documentation of students' agreements to them will still be available in the lefthand navigation bar if you are

Here is a sample notification.

**SUBJECT** <insert course name here> Course Policies

**MESSAGE**

I see you're registered in our course. Welcome!

This note is a reminder we have course policies to participate in any BBST course to which you **MUST** agree. Please log into the course, review these policies, and indicate your agreement right away. If you have questions or concerns, please contact <<THE INSTRUCTOR>>, <<EMAIL ADDRESS>>.

The students who join this course participate with the expectation everyone else in the course has agreed to these policies. If you do not accept them by Tuesday of the first week of class, we must suspend your access to the course.

Cordially,

### 1.0.2 Welcome

The following post welcomes students to the *BBST Test Design* class. It points out important distinctions separating *BBST Test Design* from earlier courses, including the shifting emphasis from study skills to content related knowledge and skills.

**Subject:** Welcome to *BBST Test Design*

**The Message:**

This is the next step in a progression from expository instruction (teaching by explaining) to activity-based instruction focusing on development of testing skill. I think the future relevance of software testing lies in a much greater emphasis on the skills that we bring to our projects. This series of courses is my way of advocating for that future.

In this course, we're going to be a little more focused on course content (software-test-related knowledge) and testing-skill development. For example:

- The assignments are individual tasks this time, not group efforts
- Both assignments and three of the four labs are focused on practice with one or two techniques

- There's a LOT more content. Much of the material (especially in lectures 1 and 2) is present to flesh out a conceptual structure. If you understand the structure, you achieve one of the course's learning objectives. I hope the detailed material will be useful later when you see an opportunity to use a technique at work. You will have to prioritize your time in this course.

We're going to take a closer look at 6 specific techniques (or families of related techniques):

- Function testing and test-related tours
- Risk-based testing
- Specification-based testing
- Scenario testing
- Domain testing
- Multivariable testing

There's an opportunity to practice each of these (except scenario testing) in at least one assignment or lab. The lectures raise some of the complexities or tradeoffs associated with each of the techniques, but there's a lot more to learn in each technique. I see this course as a starting point for adult-level conversation about these techniques and a set of first steps in the development of skill, not a conclusive presentation. This is a bridge, not a terminus.

### **1.0.3 What time is it?**

One of the many challenges in online courses (and off-shore development) is time zone diversity. We use a post for this, titled *What time is it?* The full text of that post is located in the *Fieldstones* appendix. You should post a similar one early in your course if your students are likely to have time zone challenges.

## **1.1 Meet and greet**

### **Preparation**

Prepare for the *Meet and Greet* activity by completing the following list of tasks:

- Set up a new discussion forum titled *Meet and Greet* if you haven't already.
- Post your introduction. (Co-instructors, if any, do the same). If you can, attach a digital photo, audio, or video file to your post. (Co-instructors, if any, should do the same). Adding multimedia elements to your introduction gives students a richer picture of who you are and introduces them to the possibilities of multimedia communication.

- Optionally, use the course announcement tool to remind students of this activity, tell them how to participate, remind them of the deadline, and encourage participation.

### **Activity description**

Students introduce themselves and respond to each other's posts. Typically, instructors ask students to include information about their experience with the class topic, and encourage them to share information about hobbies and outside interests. Invite students to include pictures of themselves.

### **Purpose**

Some students will feel more connected to their classmates after they have seen a picture and come to know their classmates better.

### **Tools**

Course discussion forum. Your course management system (CMS) may call these discussion boards or threaded discussion groups. Throughout this book, we will refer to these as course discussion forums.

### **Core readings**

None

### **Facilitation roles and strategies**

Although an instructor should not respond to every post throughout the class, try to make each and every student who offers an introduction feel welcome by posting a response to their introduction.

If you notice students spending too much time in *Meet and Greet* (at the expense of course content), you may need to remind them to practice good time management skills. This may become an issue at the end of the first week and beginning of the second.

### **Variations of the activity**

There are many icebreaker activities published in books and on the web. Many of them can be modified to work in an online environment.

# Lesson 2 Tasks

	Lab: Risk-based Testing	Quiz for Lecture 2	
<b>Preparation</b>	Review assignment instructions. Set up discussion forum for students to use.	Ensure quiz and video are available to students. Take the quiz if you have not already. Post <i>BBST Quiz Philosophy</i> (available in Appendix F) after first quiz.	
<b>Description</b>	Students create a list of risk ideas for a single variable found in <i>OpenOffice Impress</i> or <i>Writer</i> .	Students complete quizzes while watching videos.	
<b>Outcomes</b>	Students identify a list of risks associated with their chosen variable. Lists should include risks associated with consequences of using certain values of the variable.	Increased understanding	
<b>Tools</b>	OpenOffice.org products or other program Course discussion forum	Quiz, videos, slide sets	
<b>Core readings</b>	None	See course	
<b>Communication</b>	<p>Provide handout to students. Stress the importance of avoiding binary or enumerated variables.</p> <p>Encourage students to be careful in their selection of a variable. This lab is a preliminary exercise for a later assignment.</p> <p>Monitor discussions and provide assistance as students discuss the variables they plan to use.</p>	Encourage participation. Field questions.	

	<b>Exam Cram Forum</b>	<b>Quiz Discussion Forum</b>	<b>Instructor Feedback</b>	
	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Quiz Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor.	<b>Description</b>
	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
	None	None	None	<b>Core readings</b>
	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 2

# Overview

Lesson 2 reviews and extends the concepts of testing context and strategy from *BBST Foundations*. Projects with different sets of resources and information objectives need different sets of test techniques.

Lesson 2 then introduces the family of test techniques we call risk-based testing and breaks these into sub-families:

- *Quicktests*: with a long catalog of examples of quicktests;
- *Guidewords*: as a basis for test design, illustrated in HAZOPS and the Heuristic Test Strategy Model;
- *Failure mode and effects analysis*: how to create catalogs of failure modes and how to test failure modes;
- *Project-level risks*: additional factors that might cause the product to fail.

The key student activity in this Lesson (apart from lectures, quizzes and study guide) is:

1. Laboratory on risk-based testing;

## 2.0 Administrative tasks

### 2.0.1 Post quiz-related fieldstones

Post the *BBST Philosophy of Quizzes* fieldstone at the end of first quiz. The *BBST Philosophy of Quizzes* fieldstone is available later in this chapter.

## 2.1 Lab: Risk-based testing

### Preparation

Choose a piece of software as the basis for this assignment. We recommend *OpenOffice Writer* or *Impress* because these products are reasonably familiar to students. Familiarize yourself with the product and the assignment so you can help students.

## Activity description

Students choose a single variable appropriate for a domain analysis. The assignment handout provides a structure for brainstorming a long list of risks (think of a risk as a way the program can fail) associated with this variable. Students create a list of risks associated with the variable.

Students post their list in the discussion forum and constructively critique lists of two other students.

## Purpose

Although the lecture describes failure mode analysis, it is an abstract concept for most students. In past courses (perhaps 20 over 10 years), we asked students to create failure mode lists as part of other assignments. Their lists were almost always brief and uncreative. The students simply don't know how to start this type of analysis.

This exercise provides a starting point. The list of questions provides scaffolding (a conceptual structure the students will eventually discard).

Many starting points for developing a broad and deep risk catalog exist. Some students come to believe the Heuristic Test Strategy Model (HTSM) is the only good foundation for developing such a catalog. In our previous courses, a few students probably came to this conclusion because we presented the HTSM as a useful tool without showing any others. This exercise illustrates another foundation altogether for risk catalogs.

The lab also lays a foundation for Assignment 2 on Risk-Based Domain Testing. We believe several of our previous students found it overwhelming to try to do all three subtasks (risk analysis, domain analysis, and the integration of them) in one assignment. Splitting the task into a lab and an assignment made the risk-based domain assignment more manageable for both academic (university) and practitioner course students.

## Tools

An application under test: the student picks a variable from an *OpenOffice* application or from some other application of your choice.

Course discussion forum.

## Core readings

None.

## Facilitation roles and strategies

Monitor the unfolding discussion to redirect students as needed and prepare for the instructor's feedback note at the end of the exercise.

Some students will pick an unpromising variable. The lab instructions advise them to avoid binary variables and enumerated variables but a few students inevitably will pick one of these. Testers will be testers, after all. Let the students struggle a bit before suggesting they consider a different variable. If they resist, that's alright too. With the feedback they'll get after the lab

is complete, they almost certainly will switch to another variable for Assignment 2, in effect redoing this lab properly.

During the peer review or in your end-of-lab comments, you should be attentive to these common problems:

- If students choose an unsuitable variable, it might be very hard to think of how specific values of this variable might cause failures. For example, a variable with no lower or upper bounds cannot fail at its boundaries. Point this out. To do the domain testing assignment, they will need a variable with boundaries.
- The answer may manipulate many variables rather than focusing on the single variable a student selected.
- The answer may focus on testing a function rather than on assessing the risks associated with a variable.
- The answer may focus on action rather than on risk. In other words, the student might talk about what they will do to investigate rather than how the program might fail.
- The answer may not consider how the program uses this variable — getting stuck at the input filter.
- The answer may be redundant. For example, the answer might say the program could crash if the input value is too large. The program could print bad results if the input value is too large. The program could display something inappropriate if the input value is too large. The program could catch a cold and sneeze if the input value is too large. Yes, yes, the program could Do-Something-Bad if the input value is too large. That's one risk, even if the student stretches it over 17 items in the 20-risk list. (Interpret this with caution. *Sometimes* a student will have two or three genuinely different theories: the student might have separate and specific reasons for thinking X might lead to a failure of type A OR a failure of type B, making both tests independently interesting. If you see this, praise the student's creativity; don't treat nonredundant ideas as redundant. But other students will be at a loss for ideas and try to stretch one test idea into many because they have nothing else.
- The student may identify the same failure mode (the program might crash if) many times, describing different conditions possibly leading to this. What *other* failures can the student imagine?

### **Variations of the activity**

Although we typically use *OpenOffice* for this assignment, you may prefer to select a different product. If you are teaching this course to in-house developers, your own software might be an appropriate choice.

In a later assignment, students might file bug reports with the project team indicating a benefit in using the same open source application used in *BBST Bug Advocacy*.

## **2.2 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **2.3 Send *Highlights of the Coming Week* post**

We send students a note at the start of each week to prepare them for the next week's work.

## **2.4 Send *Weekly Feedback* post**

Throughout the week, instructors should plan to review student submissions, making notes of problem areas, interesting approaches, and general trends. Instructor notes will inform the *Weekly Feedback* note you send as soon as you can have it ready.

## **2.5 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate.

# Lesson 3 Tasks

	<b>Assignment: Using HTSM to Analyze Specifications, part 1</b>	<b>Quiz for Lecture 3</b>	
<b>Preparation</b>	Review instructions. Identify a mind mapping tool to use for the course and familiarize yourself with it. Set up a discussion forum for students to use.	Ensure quiz and video are available to students. Take the quiz if you have not already.	
<b>Description</b>	Students read about HTSM and create a mind map of the same.	Students complete quizzes while watching videos.	
<b>Outcomes</b>	Students will create a mind map of the HTSM.	Increased understanding	
<b>Tools</b>	Mindmapping tool and discussion forum.	Quiz, videos, slide sets	
<b>Core readings</b>	Bach's Heuristic Test Strategy Model v. 4.8	See course.	
<b>Communication</b>	Respond to student questions as appropriate. Emphasize the freedom students have to customize the HTSM to suit them.	Encourage participation. Field questions.	

<b>Exam Cram Forum</b>	<b>Quiz Discussion Forum</b>	<b>Instructor Feedback</b>	
Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
None	None	None	<b>Core readings</b>
Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 3

# Overview

Lesson 3 is focused on specification-based testing. Key ideas in the lesson include:

- The hardest and most important part of specification-based testing is specification analysis. The central question is “What is the specification and what does it say?”
- Specifications are often long and dispersed over many documents written by different people at different times. They are incomplete and often contradict each other.
- In practice, development groups also rely on implicit specifications. Implicit specifications are not part of the formal specification but the development team treats them as credible sources of information about how the product should work.
- The recommended way to gain a detailed understanding of complex documents is active reading. The lecture presents several different active reading techniques, and illustrates the approach with concept mapping of the specification, using the *Heuristic Test Strategy Model* to provide the map’s structure.

The key student activities in this Lesson (apart from lectures, quizzes and study guide) are:

1. Assignment 1: Using HTSM to Analyze Specifications

## 3.0 Administrative tasks

### 3.0.1 Choose mind mapping software

Identify a mind mapping tool to use for this assignment. Modify the course handouts to reflect your choice and familiarize yourself with the product so you can respond knowledgeably to questions from students.

### 3.0.2 Choose a product to analyze

Identify a product to use for the analysis. In-house trainers may wish to use a product the test team is working on. Instructors working in college or university settings might choose an open source project publishing project specifications. Modify the course handouts to reflect your choices.

## 3.1 Assignment: Using HTSM to analyze specifications, part 1

### Preparation

Familiarize yourself with this assignment and the *Heuristic Test Strategy Model*. Notify students of the mind mapping tool you would like them to use.

### Activity description

Students read about the *Heuristic Test Strategy Model* and create a mind map reflecting its structure. Students then review the specifications of an identified product and populate their map with facts and test ideas gleaned from the specifications. When they reach a time limit, students post their work to the discussion forum and review and comment on a map created by a peer. Finally, students comment on this method of reviewing specifications, including their thoughts on how they would improve it to better meet their needs.

### Purpose

The purpose of this assignment is three-fold: to introduce students to active reading strategies; to introduce them to a specific organizing framework (HTSM) for active reading; and to introduce a useful tool (mind mapping) for note taking.

### Tools

Although there are several mind mapping tools available, we recommend standardizing on one tool so students and instructors can easily review submissions. At the time of writing, we recommend the free version of *Xmind* to our students. For other alternatives, perform an Internet search on “mind mapping” or “concept mapping” AND software.

If you are running this course in-house, consider using qualitative data analysis software, [http://en.wikipedia.org/wiki/Computer\\_Assisted\\_Qualitative\\_Data\\_Analysis\\_Software](http://en.wikipedia.org/wiki/Computer_Assisted_Qualitative_Data_Analysis_Software) (CACDIS). We have had good experience with *Atlas.ti* in general and with this assignment in particular.

### Core readings

Bach's (2006) *Heuristic Test Strategy Model* v. 4.8

### Facilitation roles and strategies

This task is cognitively complex. It requires students to:

- read dense documentation;
- understand what the text means for the product it specifies;
- determine how that information fits within an organizing framework;
- form ideas about how they might test to evaluate the product against the specification they just read;
- identify (and locate if possible) missing information;
- and note their thinking about all of these things.

In addition, students may be simultaneously learning the mind mapping software they're using for the task.

In your interactions with students, encourage them to realize it would be impossible to fully analyze the specifications in the time available in the course. The assignment is time-boxed. They should be able to learn plenty about this type of task in a few hours. The point of the exercise is the learning - not creating a complete analysis.

Encourage students to customize the HTSM to suit their preferences. Encourage them to perform Internet searches to find other lists of risks or dimensions of quality ("quality criteria") they could use to supplement HTSM or replace it.

The assignment does not have much of a peer review phase due to time constraints. In *BBST Test Design*, students are instructed to look at some other work and make comments. This is not like the *BBST Bug Advocacy* assignment, where peer review involved evaluating the assignment in detail using a grading structure. In this assignment, the students will rely on you for feedback.

Kaner prepared a detailed set of feedback slides we suggest you keep hidden until the activity is complete. If you like the slides, make them visible and link to them in your assignment feedback. Kaner uses these as his primary feedback tool for this assignment. The feedback slides are available under the Test Design tab at <http://testingeducation.org/BBST/>.

### **Variations of the activity**

You can vary this activity in several ways:

- Choose another specification—the requirement is for a specification made up of several incomplete documents, not completely authoritative, and not consistent with each other. There are many suitable alternatives you can use for this assignment.
- Choose another organizing framework for specification analysis—the selection of HTSM is convenient, but far from essential. The key point is to apply an active reading strategy to a complex specification.
- Choose another tool for organizing your harvesting of data from the specification—try other concept mappers or some CAQDAS programs like *Atlas.ti*.
- Add a more robust peer review phase, but if you do, modify the course schedule to make room for it.

## **3.2 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **3.3 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate.



# Lesson 4 Tasks

	Assignment: Using HTSM to Analyze Specifications, part 1	Lab Test Design	Quiz for Lecture 3	
Preparation	This assignment was started in Lesson 3.	Familiarize yourself with the assignment.	Ensure quiz and video are available to students. Take the quiz if you have not already.	
Description	Students started working on this assignment in Lesson 3. They should complete it in this lesson. .	Students choose and analyze three techniques according to the 18 core strengths presented in the course materials.	Students complete quizzes while watching videos.	
Outcomes	Students will create a mind map of the HTSM.	A partial analysis of three test techniques and a rationale for the analysis.	Increased understanding	
Tools	Mindmapping tool and discussion forum.	Course discussion forum	Quiz, videos, slide sets	
Core readings	Bach's <i>Heuristic Test Strategy Model</i> v. 4.8	See course	See course	
Communication	Respond to student questions as appropriate. Emphasize the freedom students have to customize the HTSM to suit them.  Review completed submissions and provide feedback as appropriate.	Encourage students to review other submissions and discuss different analyses with their peers to gain a richer understanding of the test techniques presented in the course materials.	Encourage participation. Field questions.	

<b>Exam Cram Forum</b>	<b>Quiz Discussion Forum</b>	<b>Instructor Feedback</b>	
Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
None	None	None	<b>Core readings</b>
Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 4

# Overview

Lesson 4 focuses on scenario testing. It also presents another framework for comparing and contrasting different test techniques.

The controversial part of scenario presentation is the distinction between scenarios and use case-based tests. Some students will challenge this. They correctly will point out conceptual-level descriptions of use cases (perhaps descriptions they learned in survey courses) often are consistent with what we describe as scenario-based design. And as in so many areas of software, fuzzy definitions and multiple definition create blurry lines. Little can be gained from insisting these concepts are fundamentally different.

However, it can be helpful to explain the distinction in terms of classic use-case-based tests. Courses teaching use-case analysis often present simple telephone systems and ATM machines as prototypic examples. They present scenarios like:

- Make a phone call and reach the other party. This is the happy path test.
- Attempt a phone call but fail because of X—each reason for failure (X) can be described as an alternate path through the behavior diagram you could draw to model the use case.
- Withdraw money from the ATM or deposit money or check a balance or fail in one of these tasks because of X.

These are not bad tests of use cases but they are trival scenarios. In the framework of this course, these are function tests, not scenario tests. Scenario tests look at the system in a more realistic and complex way. The lecture presents 17 approaches to creating suites of scenario tests. These approaches are fully consistent with what Kaner (initially trained as a human factors analyst) has studied for years as scenario-based design and course references by Carroll and his colleagues. We have never seen use cases defined at a similar level of complexity and detail.

Ultimately, it doesn't matter what terminology the students adopt. What *does* matter is they see the difference between a simplistic approach to scenario testing and a much richer approach. The richer, more complex approach this course presents is nothing like the other techniques.

The key student activities in this lesson (apart from lectures, quizzes and study guide) are:

1. Complete Assignment 1: Using HTSM to Analyze Specifications
2. Lab on test design

## 4.0 Administrative tasks

None

### 4.1 Assignment: Using HTSM to analyze specifications (continued)

This is the same assignment we described in the notes on Lesson 3. The course spreads it across two lesson-periods because it is too time-consuming to complete in three days. There is only one deadline for this assignment: the end of Lesson 4.

Some students will submit their assignment at the last minute, too late for peer review. Given the workload of the course, we do not have a reasonable alternative to this. Those students just won't get a peer review.

### 4.2 Lab: Test Design

#### Preparation

Familiarize yourself with the assignment.

#### Activity description

In this activity, students will choose three test techniques for analysis. For each technique, they will identify core and desirable strengths from among the 18 possible strengths identified in the course materials. They will explain their analysis.

#### Purpose

This lab requires students to think about how to compare test techniques.

The lab presents a list of 18 possible attributes of a test or test technique. It's tempting to argue all tests should have all 18 of these strengths. This is impractical. Some techniques are better for generating high power tests (for example) while others are better for generating high credibility tests. If the student wants to create a collection of highly motivating tests she or he should pick test techniques good for generating highly motivating tests.

The lab introduces students to appraising test techniques in terms of how they map to potential strengths.

#### Tools

Course discussion forum

#### Core readings

None

#### Facilitation roles and strategies

Many experienced testers would have difficulty completing this task. Help students understand answers for this assignment are subjective—based on their judgment. However, “subjective” does not mean arbitrary. The student must understand and be able to defend the judgments made in this assignment. They will make these types of judgments on the job and sometimes have to defend them.

As the students post their notes, ask why they think X is a core attribute of Y. Many of the paragraphs students submit to explain their reasoning will be incomplete and superficial. Where appropriate, ask for more analysis or challenge the reasoning in the explanation. Do this for as many students as you have time, preferably at least one question per student. In some cases, the students will give superficial answers to your questions. If you have time, ask a follow-up question. It can be useful for your students to understand whether or not they can explain their reasoning.

### **Variations of the activity**

The primary way to vary this activity is by changing the number of techniques you ask students to analyze. We used this as an assignment rather than a lab, requiring students to analyze 8 to 10 techniques. This creates an artifact some students take to job interviews and opportunity for the instructor to appraise the testing knowledge of the student.

It may be tempting to assign students different techniques then compile the answers. We do not recommend this. When compared to a “divide and conquer” approach to analyzing all of the techniques, students will learn more by analyzing each technique for themselves than reviewing reviewing the analysis others provide.

## **4.3 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **4.4 Send *Highlights of the Coming Week* post**

We send students a note at the start of each week to prepare them for the next week’s work.

## **4.5 Send *Weekly Feedback* post**

Throughout the week, instructors should plan to review student submissions, making notes of problem areas, interesting approaches, and general trends. Instructor notes will inform the *Weekly Feedback* you send as soon ready.

## **4.6 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate.



# Lesson 5 Tasks

	Lab: Domain Testing	Assignment: Risk-based Testing, part 1	Exam Coaching Lab	
<b>Preparation</b>	Review instructions. Set up discussion forum for students to use.	Review instructions. Set up discussion forum for students to use.	Post one study guide question in coaching forum.	
<b>Description</b>	Students complete a traditional equivalence class and boundary analysis for questions designed in the handout.	This assignment builds on a list of risks generated in an earlier lesson. Students analyze risks associated with one variable according to a structure provided in the handout.	Students draft exam answer for peer and instructor feedback.	
<b>Outcomes</b>	Practice in applying traditional analysis to a variety of scenarios.	Practice analyzing input and output variables for risk and selecting appropriate test techniques to evaluate software for the identified risks.	Improved understanding of written communications and exam preparation.	
<b>Tools</b>	Course discussion forum.	Course discussion forum.	Course discussion forum.	
<b>Core readings</b>	Course materials.	Course materials.	Essay Answers Handout	
<b>Communication</b>	Respond to student questions as they work on this task.  Review completed submissions and provide feedback as appropriate.	Remind students that the assignment covers two lessons and encourage them to start it early.  Encourage students to refer to course materials to fully complete assignment.	Emphasize participation.	

	<b>Quiz for Lecture 5</b>	<b>Exam Cram Forum</b>	<b>Quiz Discussion Forum</b>	<b>Instructor Feedback</b>	
	Ensure quiz and video are available to students. Take the quiz if you have not already.	Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
	Students complete quizzes while watching videos.	Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
	Increased understanding	Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
	Quiz, videos, slide sets	Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
	See course	None	None	None	<b>Core readings</b>
	Encourage participation. Field questions.	Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions. See the Fieldstones Project wiki for samples.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 5

# Overview

Lesson 5 focuses on domain testing.

Domain testing is the most widely taught test technique and most often described in textbooks. In practice, it is much more complex than the simple presentations. The lecture works through a framework for domain testing developed by Kaner, Hoffman and Padmanabhan.

The key student activities in this lesson (apart from lectures, quizzes and study guide) are:

1. Lab: Domain Testing;
2. Assignment 2: Risk-Based Domain Testing.

## 5.0 Administrative tasks

A few days before the start of exam week, the lead instructor, with the assistance of the instructor team, should complete the following two tasks:

- Prepare the final exam.
- Prepare the course evaluation.

### 5.0.1 Prepare the final exam

Select questions for the exam from the study guide. The typical exam has seven questions, three or four short and three long. Students are more likely to do well on the short answer questions long answer questions reveal more about students' understanding of the material.

- Choose among the available questions in the exam pool to maximize coverage of the course and diversity among the questions. Some questions overlap in their coverage of course material; some overlapping may be acceptable, but it is generally undesirable to choose similar questions for the same exam.
- If you are teaching this course as part of a sequence, you are not just managing your own course. You are teaching one of the core BBST prerequisites, laying down expectations for all future courses. Your choice of exam questions will influence study strategies for the rest of the series.

- We usually choose a question no one has attempted in the *Exam Cram* forum and another question the students addressed poorly in the *Exam Cram* forum and we posted a caution/question about.
- Do not choose a question if instructor comments (feedback on the forum) make the question ambiguous or would lead students to a weak answer.
- Every question in the study guide is fair game for the final exam.
- Please choose questions to have some overlap with questions from exams in previous courses so we may compare performance across groups. However, this redundancy should be limited. As a general guideline, we suggest an overlap of no more than three questions with either of the previous two final exams.

A few days before the exam starts, remind students and give them an idea of how it will work.

### **5.0.2 Prepare for course evaluation by students**

We provide suggested questions for the course evaluation in an appendix. However, your institution may require a specific course evaluation form. Instructors will determine how to distribute these surveys, which should be released in the middle of the coming week.

## **5.1 Lab: Domain testing**

### **Preparation**

Review the instructions for this assignment and relevant course materials.

### **Activity description**

Students complete a traditional equivalence class and boundary analysis for the questions in the assignment handout. Students will post their analyses in the course discussion forum for peer review.

### **Purpose**

Students practice traditional domain analysis. The first several questions are straightforward applications of the material in the lecture. The two FoodVan questions illustrate some of the complexity of domain analysis.

### **Tools**

Course discussion forum.

### **Core readings**

None

### **Facilitation roles and strategies**

As needed, answer questions and coach students as they work. Monitor the unfolding discussion to prepare for the instructor's feedback note at the end of the exercise.

For most of the questions, you can point students back to the lecture.

### **The first FoodVan question**

The question is:

*FoodVan delivers groceries to customers who order food over the Net. To decide whether to buy more vans, FV tracks the number of customers who call for a van. A clerk enters the number of calls into a database each day. Based on previous experience, the database is set to challenge (ask, "Are you sure?") any number greater than 400 calls.*

The confuser in this is numbers greater than 400 are valid but in a different equivalence class from numbers less than 400. Students in previous courses have expected to classify values as valid or invalid. This appears to have become a non-issue with the new slides. Students simply create two valid classes.

### **The second FoodVan question**

*FoodVan schedules drivers one day in advance. To be eligible for an assignment, a driver must have special permission or he or she must have driven within 30 days of the assigned shift.*

We've used this exercise for over 15 years. Most students think this is a reasonably clear specification. But it is quite ambiguous:

- Does "within 30 days" mean "less than 30" or "less than or equal to 30"? (Take a poll. You'll discover your class is split. Even if every student is confident of their answer, the fact they have different answers demonstrates ambiguity.)
- When does the special permission have to have been issued? If the driver wants to drive tomorrow, can you schedule him or her today so long as he or she brings permission tomorrow?
- If you can work tomorrow morning on the basis of permission, can you work tomorrow afternoon on the basis of experience? If you are scheduling today, is tomorrow morning within 30 days of tomorrow afternoon?
- What result if the last day you worked was 28 days ago? 29 days ago? 30 days ago?
- Do we compute 30 days in days or hours (minutes / seconds)? What if someone worked in the evening 30 days ago but wants to work tomorrow morning. Is this more than 30 days? Yes if we look at the calendar, but no if 30 days means 30x24 hours.

Even if an individual student is clear on the answers to these questions (and you can probably think of more easily), should the student believe the programmer and specification writer will come to the same answers?

The exercise demonstrates one of the key reasons for boundary-related errors. Some dummy programmer did not write GE (greater than or equal) instead of GT (greater than) because he or she couldn't tell T from E on the keyboard. Rather the boundary someone decides the program should have has to be written down in a specification and the people who read the specification have to understand it the same way the author meant it. *Good luck!* Many errors occur because someone in the chain of confusion understood a boundary description differently from a previous person.

## Variations of the activity

Vary this activity by allowing students to work individually or with a partner. Customize the assignment by drafting new variables for students to analyze.

## 5.2 Assignment: Risk-based domain testing

### Preparation

Review the instructions for this assignment and relevant course materials. Set up a discussion forum.

### Activity description

This assignment extends the lab from Lesson 2. In that lab, students brainstormed risks associated with a single variable. Now, they combine the analysis with a domain testing approach.

When you do domain testing with a single variable, every test starts with assignment of a value to that variable. Every test asks, “If I set this variable to this value, will there be a failure?”

Think of a risk as a way the program can fail. If you imagine a risk associated with the variable under test, then it’s likely some values of the variable can trigger the failure and other values cannot. These are separate classes. We can treat those values of the variable triggering the failure as belonging in one equivalence class (or a few classes) while the variables not triggering the failure belong in a different class. What is the best representative of the class of values triggering the failure? When you test with that, you have done a domain analysis of the variable in a way that is focused on this specific potential failure.

The assignment requires the student do this kind of analysis several times to obtain 15 different tests and show the analysis on a risk-equivalence table. The student also runs the tests and reports any bugs found.

### Purpose

This gives students an opportunity to practice risk-based domain testing.

### Tools

Course discussion forum.

### Core readings

None

### Facilitation roles and strategies

Encourage students to start on the task right away. As needed, answer questions and coach students as they work. Monitor the unfolding discussion to prepare for the instructor’s feedback note at the end of the exercise.

This is a good exercise for interactive grading. See the discussions of interactive grading in *BBST Foundations* (the exam) and *BBST Bug Advocacy* (Lesson 2, discussing the assignment) for an overall explanation of interactive grading.

In your evaluation of the students' work, you will probably find problems like these:

- Many tests are not domain tests. They do not involve varying the value of this variable. Instead, perhaps they involve testing a function using the variable.
- Many tests vary the variable under test with one or more other variables. Although appropriate, the student should be aware this is multidimensional testing, not just testing of the effect of changing one variable.
- In filling out the table, the student does not specify a test but describes a class of possible tests and doesn't pick one making evaluation of the power of the test impossible.
- In filling out the table, the choice of test has no obvious relationship to the risk.
- In filling out the table, the test value on one row is not near a boundary or otherwise noteworthy. It is not a best representative of its class.
- In filling out the table, the student's explanation of the power of a test describes the relevance of the test or something else appearing to justify it as a "good" test but not necessarily because of its power.
- In filling out the table, the expected result on one of the rows describes the failure the student expects to find with this test rather than the anticipated result if the program is working correctly.
- The student reports a bug reported many times before, wasting the time of the development team. This should count against the student if the other bug reports could have been found with a simple search of the bug tracking system.

### **Variations of the activity**

Vary this activity by allowing students to work individually or with a partner. Choose different products for students to analyze.

## **5.3 Exam coaching lab**

### **Preparation**

Review instructions for this phase. Write your own practice answer. If you are co-teaching with other instructors, compare notes and peer review each other's answers.

### **Activity description**

Students will write an answer to a long-answer essay question and peer review other students' answers.

### **Purpose**

The purpose of this exercise is to better prepare students for the exam. We want those students who do fail the exam to fail because they don't understand the material, not because they are unskilled in exam writing.

Many students are ineffective at essay answers (and more generally, at written communication). This is as true for Computer Science undergraduate and graduate students as it is for practitioners who haven't written exams for a decade. This exercise will give students a clearer idea of what is expected and (by teaching students to outline their answers in advance) a strategy to help them meet that expectation.

This exercise will also motivate some students to watch the course videos on exam grading and prepare additional sample answers.

## Tools

Course discussion forum

## Core readings

Kaner's essay on *Answering essay questions* available at <http://www.testingeducation.org/BBST>.

The course slides and videos: *How we grade essay exams*.

## Facilitation roles and strategies

Urge students to draft their essay early, so other students have time to peer review. Read the answers when submitted to gather notes for your feedback.

Don't provide feedback on the initial essay during the activity to avoid interfering with students' work as peer reviewers.

Do provide feedback (mainly, pointed questions) on the peer reviews.

Be ready to post your comments as soon as Lesson 6 starts—or earlier if most students have completed the task.

Many of the exam answers will be incomplete. Point out this trend and one of the most common causes for poor exam performance: failing to answer the question asked, often by simply missing some of the question parts.

Many of the peer reviews will be superficial and worthless. Make it clear a peer review only saying "good work" or assigning an unreasonable grade provides no value.

Some instructors heavily emphasize style and formatting issues. We like headings and subheadings and bulleted lists *but don't demand them*. You shouldn't demand them either

If you can easily understand a student's answer and clearly understand how it is organized, then the answer is adequately organized and written. If the structure is not what you would have used, but it is clear enough to be understandable, use it as an example of a good alternate structure. Don't penalize it.

We usually allow 10% of the grade for an answer to be driven by style and structure. Some instructors allow 20%; that's a lot. Don't go above that—leave the rest for the content—and tell students what your allowance is so they can prepare appropriately.

## Variations of the activity

This activity can vary a lot by varying the question students use to practice. We often select a difficult question or one not receiving students' attention in the *Exam Cram* forum.

### 5.4 Ongoing activities: lectures; exam cram; and quizzes & discussions

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

### 5.5 Record grades as appropriate

Record grades in your gradebook or spreadsheet as appropriate

In university courses, students will want to know their term grades (the grade they have up to the final exam). They need this information to optimally allocate exam preparation time across their courses. They also need it to allay their anxiety. If you have not already advised students of their grades, do it now.

In professional development courses, you won't have a number for the term grade. You probably will have a mix of numbers and qualitative evaluations. If you have time, scan through these records to determine:

- whose term work was so good they will pass the course even if they fail the exam (unless they cheat on the exam or write an appallingly bad exam);
- whose term work is so weak they will pass the course only if they write a very good exam
- who will pass if they write a good exam and might pass (based on their term work) if their exam is disappointing (failing, but not awful).

In a large professional development class, these notes will help you focus your exam-grading time.



# Lesson 6 Tasks

	<b>Lab: Using the PICT All-Pairs Tool</b>	<b>Assignment: Risk-based Testing, part 2</b>	<b>Quiz for Lecture 6</b>	
<b>Preparation</b>	Review instructions. Set up discussion forum for students to use.	Review instructions. Set up discussion forum for students to use.	Ensure quiz and video are available to students. Take the quiz if you have not already.	
<b>Description</b>	Students download, install, and use Microsoft's PICT tool for all-pairs testing.	Students begin this assignment in Lesson 5 and complete it during Lesson 6.	Students complete quizzes while watching videos.	
<b>Outcomes</b>	Students will experience using a test tool that generates all-pairs tests and will evaluate the solution.	Practice analyzing input and output variables for risk and selecting appropriate test techniques to evaluate software for the identified risks.	Increased understanding	
<b>Tools</b>	Microsoft's PICT	Course discussion forum	Quiz, videos, slide sets	
<b>Core readings</b>	None	Course materials.	See course	
<b>Communication</b>	Encourage participation in the assignment and respond to questions as needed.	Encourage students to refer to course materials to fully complete assignment. Provide feedback and coaching as necessary.	Encourage participation. Field questions.	

<b>Exam Cram Forum</b>	<b>Quiz Discussion Forum</b>	<b>Instructor Feedback</b>	
Post questions for study guide, if necessary, and enable forum.	Before the course starts, determine who will be responsible for this task. Once each quiz closes, open (unhide) the corresponding Q&A forum.	Monitor course progress and note items to mention in feedback.	<b>Preparation</b>
Students collaborate to prepare for final exam.	Students can review quiz questions and answers, and challenge the answers.	Lesson feedback from instructor	<b>Description</b>
Students draft answers for study guide questions.	Students check their own understanding and clarify misunderstandings.	Establishes instructor presence and guides student learning.	<b>Outcomes</b>
Course discussion forum	Course discussion forum	Course announcements and email	<b>Tools</b>
None	None	None	<b>Core readings</b>
Encourage participation in <i>Exam Cram</i> forum.	Respond to student questions in Quiz Q&A as appropriate. Provide additional feedback for frequently missed questions. See the <i>Fieldstones Project</i> wiki for samples.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate. Generally, send a note providing feedback on the lesson just passed and previewing the coming week. Separate into two notes as appropriate.	<b>Communication</b>

## Lesson 6

# Overview

Lesson 6 introduces multivariable testing (also called combination testing). It describes three classes of multivariable techniques: risk-based, scenario-based, and mechanical. All-pairs testing exemplifies a mechanical combination technique. The lecture considers when the technique can and cannot be applied and what alternatives are possible when all-pairs is inapplicable.

The key student activities in this Lesson (apart from lectures, quizzes and study guide) are:

1. Lab: Using the PICT All-Pairs Test Tool;
2. Complete Assignment 2: Risk-Based Domain Testing.

## 6.1 Lab: Using PICT all-pairs test tool

### Preparation

Review the instructions for this assignment. Set up a discussion forum.

### Activity description

This assignment requires students to download, install, and use Microsoft's PICT tool for all-pairs testing.

### Purpose

Students try out a test tool which generates all-pairs tests. They should realize from the exercise it is much faster than an all-pairs analysis done by hand. This tool is more flexible and more able to deal with constraints than a person could readily do without a tool.

### Tools

Microsoft's PICT tool available on the Microsoft website.

### Core readings

Czerwonka's (2008) *Pairwise Testing in the Real World*

## **Facilitation roles and strategies**

This is a straightforward assignment. Students should be able to complete it without much difficulty.

Encourage students to participate in this lab and respond to their questions as needed.

## **Variations of the activity**

If this course is taught in-house, assign combinations of variables the students are already testing.

## **6.2 Assignment: Risk-based testing**

This is a continuation of an assignment started in Lesson 5. There is nothing new in Lesson 6, only the deadline of a task needing more than one lesson-period to complete.

Refer to Lesson 5 for a description of the associated instructor tasks.

## **6.3 Ongoing activities: lectures; exam cram; and quizzes & discussions**

For more details about quizzes, quiz discussion forums, lecture videos and the *Exam Cram* forum, please refer to the *Ongoing Activities* section of this manual.

## **6.4 Send *Weekly Feedback* post**

Throughout the week, instructors should plan to review student submissions, making notes of problem areas, interesting approaches, and general trends. Instructor notes will inform the *Weekly Feedback* you send as soon as ready.

## **6.5 Send *Highlights of the Coming Week* post**

In the *Highlights of the Coming Week* post, be sure to emphasize the exam and exam procedures for the coming week.

## **6.6 Record grades as appropriate**

Record grades in your gradebook or spreadsheet as appropriate.

# Lesson 7 Tasks

## ACADEMIC

## PROFESSIONAL DEVELOPMENT

	<b>Exam Cram Forum</b>	<b>Instructor Feedback</b>	<b>Final Exam</b>	<b>Course Evaluation</b>	<b>Instructor Feedback</b>
<b>Preparation</b>	Post questions for study guide if necessary and enable forum.	Monitor course progress and note items to mention in feedback.	Post exam questions and instructions to class site. Hide all resources.	Prepare course evaluation and send instructions to students	Monitor course timeline and prepare notes.  Remind students of tasks and procedures.
<b>Description</b>	Students collaborate to prepare for final exam.	Lesson feedback from instructor	Students independently complete final exam and post work to site.	Students share their perceptions of the course design and content	Instructor feedback
<b>Outcomes</b>	Students draft answers for study guide questions.	Establishes instructor presence and guides student learning	Demonstrate proficiency with course materials	Information can help instructors revise and improve the course	Establishes instructor presence and guides student learning
<b>Tools</b>	Course discussion forum	Most feedback during this lesson will be in the discussion forums. C2	Course discussion forum	Instructor selects the tool	Course announcements and email
<b>Core readings</b>	None	None	None	None	None
<b>Communication</b>	Encourage students to participate in the <i>Exam Cram</i> forum.  Provide feedback as necessary.	Feedback notes guide students in the course. Compliment and correct (gently) as appropriate.  Explain exam procedures as needed.	Explain exam logistics and field questions as needed.	Provide information regarding course evaluation to students.	Provide information about course logistics.

## Lesson 7

# Overview

Welcome to Exam Week.

BBST instructors run the exam in two common ways, which we'll call Professional Development and Academic.

In the typical Professional Development course, students write the exam during Lesson 7. Students peer review the exam in Lesson 8 and the instructor evaluates both the exams and the peer reviews after Lesson 8. This is the structure of the AST courses.

In the typical Academic course, Lesson 7 is a study break and students write the exam during Lesson 8. There is no peer review phase. The instructor grades all of the exams and gives feedback to all of the students. In many academic courses, students submit the exams privately, using an assignment dropbox rather than a visible-to-the-class discussion forum. The exam grades and comments are also private.

The names “professional development” and “academic” are shorthand and not necessarily accurate labels. For example, we already know of one professional development course following the “academic” exam structure. Choose the approach that works best for your context.

## 7.0 Administrative tasks

### ***7.0.1 Release the course evaluation***

Release the course evaluation along with instructions letting students know where to find it, where to submit it, and when it is due.

### ***7.0.2 Hide the course content (professional development course)***

During the exam, we hide the content. We hide the links to content (videos, slides, quizzes and quiz forums, most discussion forums). We normally leave the *Help* forum open. However, if students have posted a lot of content to the *Help* forum, we create an *Exam Period Help* forum so students can ask for exam-appropriate help without being exposed to inappropriate content.

## 7.1 Final exam for professional development courses

### Preparation

Select and add questions for the final exam to the exam block in your course management system. At the start of the final exam period, unhide the exam content and hide all other resources including discussion forums and lesson tabs. Send an email message letting students know the exam is ready and reminding them of exam procedures.

### Activity description

Students independently complete the final exam designed by the instructor.

### Purpose

The final exam provides a summative assessment opportunity for both students and instructors to determine how well students can apply knowledge gained from the course to problems posed in the final exam.

### Tools

Discussion forum

### Core readings

None

### Facilitation roles and strategies

Encourage students to complete the exam. Field questions as appropriate.

### Variations of the activity

Instructors can customize the exam by choosing different subsets of questions from the exam pool.

## 7.2 Exam cram forum for academic courses

During Lesson 7, students in academic courses should participate extensively in the *Exam Cram* forum. Monitor the ongoing discussion—offering feedback and encouragement to students and trying to engage those who are not participating. Remember the purpose of your feedback should be formative. Allow students in the course to wrestle with conceptual challenges of the questions.



# Lesson 8 Tasks

	ACADEMIC			PROFESSIONAL		
	Final Exam	Course Evaluation	Instructor Feedback	Final Exam Grading	Course Evaluation	Instructor Feedback
Preparation	Post exam questions and instructions using tools and procedures determined by your organization.	Prepare course evaluation and send instructions to students.	Monitor course timeline and prepare notes.  Remind students of tasks and procedures.	Unhide resources.  Assign two reviewers per exam.	Prepare course evaluation and send instructions to students.	Monitor course timeline and prepare notes.  Remind students of tasks and procedures.
Description	Students independently complete final exam.	Students share their perceptions of the course design and content.	Instructor feedback	Students peer review exam answers submitted by classmates.	Students share their perceptions of the course design and content.	Instructor feedback should focus attention on the peer review process and course logistics. Provide individual feedback on exam performance as appropriate.
Outcomes	Demonstrate proficiency with course materials.	Information can help instructors revise and improve the course	Establishes instructor presence and guides student learning.	Demonstrate proficiency with course materials.	Information can help instructors revise and improve the course.	Establishes instructor presence and guides student learning.
Tools	Course discussion forum	Instructor selects the tool	Course announcements and email	Course discussion forum	Instructor selects the tool	Course discussion forum or other tool
Core readings	None	None	None	None	None	None
Communication	Explain exam logistics and field questions as needed.	Provide information regarding course evaluation to students.	Provide information about course logistics.	Explain peer review logistics and field questions as needed.	Provide information regarding course evaluation to students.	Provide information about course logistics.

## Lesson 8

# Overview

Academic students write the exam in Lesson 8.

Professional development students wrote the exam in Lesson 7, now peer review each other's exams.

## 8.1 Final exam (academic courses)

### Preparation

Select and post questions for the final exam in the appropriate place in the course. Send an email message letting students know the exam is ready and remind them of the exam procedures.

During the exam, we hide the content. We hide the links to content (videos, slides, quizzes and quiz forums, most discussion forums). We normally leave the *Help* forum open. However, if students have posted a lot of content to the *Help* forum, we create an *Exam Period Help* so students can ask for exam-appropriate help without being exposed to inappropriate content.

### Activity description

Students independently complete the final exam designed by the instructor.

### Purpose

The final exam provides a summative assessment opportunity for both students and instructors to determine how well students can apply knowledge gained from the course to problems posed in the final exam.

### Tools

Discussion forum or assignments. We typically have students upload a Word, OpenOffice or PDF file to an assignment ("upload a single file") dropbox.

### Core readings

None

### Facilitation roles and strategies

Encourage students to complete the exam. Field questions as appropriate.

### Variations of the activity

Instructors can customize the exam by choosing different subsets of questions from the exam pool.

## 8.2 Final exam peer reviews (professional development courses)

### Preparation

Assign two reviewers for each exam and post those assignments to the course discussion forum. To the extent possible, be sure each exam is reviewed by one of the stronger students.

Unhide course resources for students to use as reference materials throughout the review period.

### Activity description

Students review and critique at least two of their peers' final exam answers. After they do their review and their exam answers are reviewed, students post a *reflection* for each of their answers. The typical (good) reflection considers the strengths and weaknesses of their exam answer and describes how they would answer the question now.

### Purpose

To gain additional insight by reading and reviewing others' work and to provide feedback to peers.

### Tools

Course discussion forum

### Core Readings

None

### Facilitation roles and strategies

Some students may express discomfort with the exam review task:

Some students have been socialized to never speak critically of the work of their peers. (What are these people doing as testers?)

Some people think teachers should do all of the assessment in a course and it's inappropriate for students to evaluate each other's work.

Some people find the task intimidating and look for any rationale to avoid it.

The professional development courses may rely heavily on peer review:

People learn a lot from doing peer reviews. Some report they learned more from reading and critiquing peers' answers than they did from studying to prepare their own responses.

It is impractical to have volunteer instructors do the majority of assessment in the course. In groups like the Association for Software Testing, a project like the BBST project would be unsustainable if the students didn't do most of the assessment.

The model of expert teacher and inadequate, inexperienced, naïve student was a good one back when these students were children. However, they are now professionals and the BBST courses are not beyond their reach. The point of the class is to help students develop as professional-level

critical thinkers in the field. They must attempt that or they are wasting their time and their teachers’.

Encourage all students to complete the review task to the best of their ability, pointing out they may review other people’s exams for additional perspectives, draw on their own experiences, and refer to the course materials to complete this task. Providing critical review in the “safe” environment of the online class is good practice for the software tester’s work world where testers must frequently write reports and critically respond to others. In the work place, the stakes are often much higher than they are in the online classroom.

### **Variations of the activity**

None

### **Grading (professional development courses)**

It is up to you to do the final evaluation of the exams and peer reviews, and make the complete/non-complete decisions.

We start adding comments as soon as the assigned peer reviewers have made their comments and the student has posted her or his reflection.

We also will comment on the peer reviews. This is important for students who will pass the course. They will progress to *BBST Test Design*. Instructors in that course will expect students to have some experience and skill at peer review and will deal with the lazy or unskilled peer reviewer with less patience.

We normally post some feedback for each student. If the exam has 6 questions, every student has a comment on at least one question. Ideally, every instructor posts one feedback per student and so in a class with three co-instructors, each student gets instructor feedback on at least three answers.

We normally spend more attention (and add more comments) on grading the weaker exams. If there are multiple instructors, usually only one instructor posts a comment to the same question by the same student. It is not uncommon to see comments on all 6 answers of a borderline student. Many of these students come back for a second try at the course. Good feedback can help them pass next time.

Failing students who dismiss sound peer-review criticisms of their work often get less feedback. If they aren’t going to accept feedback, there is no point spending a lot of time writing it.

Some students write failing exams but then give insightful peer reviews and reflections. In the professional development courses, we will allow a student to pass the course based on excellent peer-review-and-reflection work, even if their exam was inadequate.

In general, our bias is toward passing students. Most professional-development students who have come this far in the course have invested a lot of time and probably have learned a lot. However, some students just don’t learn very much from the course. Some are too tightly wrapped up in their preconceptions to hear what the course is teaching. We don’t insist they agree with us. We do insist that they pay enough attention to understand what we are saying.

Some are gambling they can pass by staying to the end of the course even if they do little work or very shoddy work. Some believe they can do nothing then intimidate or flatter the instructor into passing them. We hope you will exercise some critical judgment here. Every closed-minded fool and lazy ignoramus who passes this course will diminish the reputation of the course. The issue is not the percentage of people who pass the course. We are happy to have classes in which every student completes the class successfully. The issue is some people will say things about testing that will cause listeners to wonder how good BBST courses could be if *this* person can pass them. A student who would discredit the course should flunk it.

Another factor in the complete/non-complete decision is the assessment of their ability to complete *BBST Test Design*. Those courses assume more effective study skills, time management skills, peer review skills and analytical/communication skills needed to complete more difficult assignments and exams. Letting an incapable or unwilling student through a class is a disservice to their future classmates and instructors.

Sometimes you will meet a student who worked hard in class but will not succeed in *BBST Test Design*. You might reasonably decide the best thing to do with that student is to allow them to complete this course but with a letter recommending they not enroll in the next course.

### **Grading (academic courses)**

It is up to you to do the final evaluation of the exams, assign grades to each answer, and communicate an exam grade to each student.

We create grading charts like the ones we describe in the *How we grade exams* slides and videos. We don't publish the grading structure but we can explain our grading to students who ask.

### **Variation: Interactive grading (professional or academic)**

When we teach this course with local academic students, we meet face-to-face with each student and interactively grade the midterm exam (equivalent to a BBST final). We have started doing interactive grading with professional students, who tell us they like it.

We plan to start using interactive grading for *BBST Foundations* exams in online professional development courses because students in this course (the ones who pass and the ones who don't) need detailed feedback. The quality of feedback they get in peer reviews is variable—the students are still learning how to do peer reviews. Too many of the peer reviews are vague and flattering; or hypercritical with an emphasis on superficial details (such as formatting), or content-challenged because the student is not sufficiently knowledgeable and is not taking the time to get more knowledgeable as part of the grading process. One of the key complaints of *BBST Foundations* students is insufficient feedback from the instructors. Interactive grading of the exam can go a long way toward changing that feeling.

Set up your interactive grading session so the student can see your screen. In a face-to-face meeting, set up a dual-monitor system so the student can watch what is on your monitor without having to look over your shoulder. Remember that eyesight (and convergence distance on reading glasses) varies. If you look at one screen side-by-side with a student, she or he might not be able to read the screen. In a two-display system, she or he can move the display

to a better place and angle. In a Skype meeting, alternate between sharing your screen and displaying live video of you as you talk to the student.

Make a copy of the exam answers for yourself and urge the student to print out a copy as well. You will want to be able to refer to this without switching your screen from the grading spreadsheet to the exam itself. You will sometimes switch to a view of the exam; make this a matter of choice rather than necessity.

Set up a table or spreadsheet with a section for each question. For a given question, break it into parts; allocate points for each part and decide what the student has to do to achieve points (full or partial) for that part. Each part gets its own column. In the top row, describe the part. For example, from the example question in *BBST Foundations*, Lesson 5, you might create headings like “Stopping Rule 1” and “Tradeoffs for Rule 1.” Include a column for style and organization. In the second row, show how many points you allocate to each part. We allocate 10% of the grade for style and organization or for our subjective impression of the quality of the answer. Most of the essay questions are open-ended. Students can answer them in different ways and reach different conclusions. In the process, they might make different arguments or cite different facts. Allow for this diversity in your grading structure. To allow for this, your total might add up to more than 100%. That’s OK. Let the points take you to 90%. Reserve the last 10%, no matter how high the point count, for your overall subjective assessment of the answer.

Kaner illustrates this in the grading videos at <http://www.testingeducation.org/BBST/takingexams/> (these are probably already in your course resources). If you have included these videos and pointed students to them (for example in the exam practice activity in Lesson 5), students will already expect this structure for grading and not be surprised by it. In our experience, they are intrigued to see it applied to their work.

*Please do not give your students a copy of your grading chart. It will get posted to the internet almost immediately and will distort performance in the classes. We have a lot of experience in academic courses with students who study from grading structures or sample answers other people created for them; the students learn very little and often flunk the course. Despite this, many students are attracted to these materials, relying on them instead of puzzling through the questions (doing some learning) as their own cognitive activity.*

We recommend you grade at least one course worth of exams using this type of grading structure before trying to do this in interactive grading. These tables are not perfect. Some students will give good answers that don’t map well to your table but that deserve a high grade anyway. Some of these answers will prompt you to revise the table while you are grading. Get that experience behind you, in private, before trying this as a live activity.

For interactive grading, create a separate copy of the table to use with each student. Don’t show any student the assessments of other students’ work.

Do not read the student’s exam answers before the interactive grading session. Part of the value of the session comes from showing your confusion and surprise at what the student says. It is entirely appropriate, in fact it is highly desirable, to make comments like the following (if they are justified):

- I don't understand what you are saying here? Can you explain it?
- What were you thinking?
- How does this relate to the question?
- Aren't you telling me the same thing you already said in this part? Am I missing a difference?
- Can you explain what you think the question was asking here? I don't understand how this comment responds to the question.
- How does this conclusion follow from this argument, or these facts?
- Why do you think this is true?
- Was this claim made somewhere in the lecture? If not, what is your source for saying this?
- Do you want to elaborate on that?
- Can you draw a diagram and explain it to me?

During the interactive grading session, we typically do the following:

- Go through the exam one question at a time. Start with a short-answer question to set the tone, but go to the long-answer questions next and come back to the short answers at the end. Don't fall into the trap of using all your time on the much-easier short answers.
- Explain the grading structure in the context of the first short-answer question. If you structured the exam well for interactive grading, the first short-answer question will have a few parts but it won't be very difficult. It will serve as a nonthreatening introduction to the grading structure and the interactive grading process.
- Give the student constant feedback on what you are reading and doing. If you are showing the student's answer on the screen, highlight the section you are reading. If you are showing the grading structure on the screen, consider reading the answer out loud, stopping to make comments or ask questions. Or just give status reports like, "I am reading your third paragraph."
- When you see something mapping (well or poorly) to your grading structure, note it. Consider making qualitative notes (such as "incorrect", "weak", "confusing", "OK", "strong")
- As you read, you will often see something shown in one column in your grading chart is split into disjointed bits in the answer. You might change your note several times, perhaps from "weak" to "weak+" to "OK". This type of thing happens often in disorganized answers. If the answer is actually disorganized (rather than being well-organized but differently from your structure), comment to the student on how hard it is to follow this answer for grading. If the answer is good but organized differently from your ideal

answer, compliment the student on their structure. Show the student you understand and are OK with it even though different from what you initially had in mind.

- If the student makes an error, such as an incorrect statement or an unsupportable assertion, we count that against the answer's grade. If the student made an error in a relevant part of the answer, make a note or take off points in the appropriate column. If the student made an error in an irrelevant part of the answer (a shotgun answer) add a new column and put a negative number in it. Some students will protest they shouldn't be penalized for errors in something not necessary to the answer. We disagree. We think a student who doesn't know relevant from irrelevant (or correct from incorrect) is demonstrating cluelessness, and we think the grade should reflect that. You will have to set your own standards on this. Set them in advance. Don't let an obnoxious student bully you into setting the grading standard.
- If the student has already given peer review feedback on other students' answers, you might find it interesting to review and ask the student to explain their feedback. If their feedback doesn't communicate their thinking well or if the grade they assign is inconsistent with their opinion, give them feedback on how they could have said it better. If this student continues to other BBST courses, training him or her to give better feedback will be an important service for future peers.
- After you have made notes on each part, consider asking the student what grade they would assign to the answer. You are not bound by their grade, but it is informative to know what they think.
  - Some students are too harsh on their work. If a student gives a "D", but you think it's a "B", say so and explain why.
  - Other students are remarkably generous to themselves. Be cautious in your interpretation. Cultural diversities are in play here and something seemingly outrageous to you might be normal haggling to the student. That said, when a student tries to give a high grade to a lousy answer, this often reflects a serious lack of comprehension of the material and/or an unwillingness to learn through constructive criticism. *IF* that is your assessment, and *IF* this happens on more than one question, you are probably going to treat the exam as an indicator the student should not complete (professional development) or fail (academic) the course.
- Some students refuse to take constructive criticism, argue with every critical comment, and try to intimidate the grader.
  - If you are an academic grader, you have experience in dealing with this and you have a department chair to advise you. Do what is appropriate at your school.
  - If you are teaching a professional development course, you probably don't have much experience with this. Our advice is you don't have to put up with this. In the volunteer-instructor case (such as teaching for AST), stop the session once you see a clear and irritating pattern. Assign an appropriate grade (complete or not) without giving the student further input into the grading process.

- If this is a paid professional development engagement with a company employing this student, you may have a client management problem. But if you are skilled enough to be teaching this course to paying clients, you already know how to manage your clients.

At the end of the interactive grading session, invite the student to give you feedback on the session and how you managed it, and overall feedback on the course. End the session so the student has the last word, especially if it was a difficult session.

In our experience, most students are appreciative. (Actually, in our experience *so far*, EVERY student has been appreciative. The online students and the face-to-face academic students have thanked us, even the ones who failed the exam or assignment miserably. But we know this is too good a streak to continue, so by the time you read this, we expect our experience will have become, MOST students are appreciative.) Most students tell us they learned a lot from the exercise. We believe we are seeing improvement in performance in academic courses on software testing and software metrics because of this process. But we also think it takes a lot of preparation. Our results with students have been good *because* we were well prepared, clear in our communication, attentive to their reasoning, flexible, and confident rather than defensive.

### **8.3 Send *Wrapup* post**

At the end of the exam period, send a message thanking students for their participation in the class and advising them when you anticipate having the exams graded and ready for them to review.

Please do not post sample answers for each exam question. Over time, this will lead to a bank of “approved” answers on the internet, destroying the value of these questions in our courses.

# Ongoing tasks

## 9.0 Administrative tasks

### 9.0.1 Monitoring student progress

The timeliness of student assignments is very important to the success of any online course. Instructors should monitor student submissions. If a student is late, depending on the late policies announced to the class, the instructor can make contact to:

- encourage the student.
- see if special circumstances require emotional or logistic support.
- make the student aware they are late and it matters.
- figure out whether this student actually has dropped.

Personal and work circumstances can give good cause for a student to fall late. When that happens, it's important to intervene as soon as possible to help that student. Often, the circumstances that led to falling behind will be too complicated to resolve for a short course. If that is the case, the instructor in a professional development course should let the students go with a smile. After all, these might be our students for now but they will be our colleagues soon. How an instructor terminates students could have long-term interpersonal consequences.

## 9.1 Lectures and quizzes

### Preparation

If you are teaching from a master copy of the course, you will need to review the quiz questions and answers. If you are creating your own course, you will need to populate the course with quiz questions. Most course management systems allow you to provide feedback for students' quiz attempts. We recommend you take advantage of that powerful capability.

We plan to create a BBST student edition including quiz questions and feedback. Once published, you might choose to use questions in that book for your own courses. You might also choose to create your own quizzes. If you write your own questions, we suggest the question writing standards we present in Chapter 6.

We also recommend setting up a discussion forum for each quiz. In our courses, we pre-populate the forums with individual threads —each including one question and its answer. The quiz forum is hidden from student view until after they take the quiz. Once the quiz is over, the students have an organized structure for discussing aspects of the course material they found challenging. Our students report such discussions are very valuable for them.

## Activity description

Students watch course videos and complete the corresponding quizzes in parallel. Quizzes are intended to focus student attention on important aspects of the lecture. The course management system provides automatic feedback for each question but students may discuss challenging questions or controversial answers in the quiz discussion forum.

## Purpose

In the BBST courses, quizzes are used formatively to focus students' attention on important information presented in readings and lectures. Answers are expected to come from the course materials. Neither students nor instructors should emphasize quiz grades. The learning from taking the quizzes is more important.

The testing field has many different perspectives and we encourage debate on these perspectives in the quiz discussion forums. However, quiz scores will not change as a result of those debates.

## Tools

Quiz and discussion forum

## Core readings

None

## Facilitation roles and strategies

Please encourage students to complete the quizzes as they watch the videos. Some students are dismayed by their performance on the quizzes. Consider sharing the *Philosophy of Quizzes* with your class to help them understand how the quizzes are used and why they are used that way. See a sample post in the *Fieldstones* appendix.

Although our quizzes provide automatic feedback for quiz answers, we invite students to visit the quiz discussion forum to discuss and/or challenge the questions from the quizzes. If you are teaching from a master copy of the course, the quizzes and *Quiz Q&A* may already be in place. If you don't understand or agree with an answer, consider removing it from your quizzes.

Instructors should monitor the unfolding discussion in the quiz discussion forum. A few days after the quiz closes, one of the instructors can post comments to the discussion forum. Most instructors like to make comments on any of the questions a majority of students answered poorly. Be sure to check the quiz automatic responses for the question before posting a comment so you don't repeat what they've been told. Many times, the quiz response is clear and the instructor does not need to comment in the forum. To find out how the group did on specific quiz questions in Moodle, go to Quizzes —> Quiz N —> Results —> Item Analysis.

## Variations of the activity

None

## 9.2 Exam cram forum

### Preparation

We recommend setting up the exam study forum with a post titled *Using This Study Guide*. Following that, you should have one discussion thread for each question. Each thread should have titles like “Long 1” (referring to the first Long Answer question in the study guide). You can find *Using This Study Guide* and study guide questions at <http://www.testingeducation.org/BBST>.

### Activity description

The exam study forum is for students to discuss study guide questions with their peers and instructors. Students engage with their peers and the course materials to build their own answers to potential exam questions.

### Purpose

Providing exam questions ahead of time allows instructors to require better answers from all students. It is especially helpful for students who are using a second or third language throughout the course.

### Tools

Course discussion forum

### Core readings

None

### Facilitation roles and strategies

Instructors should monitor discussions on the exam study forum but refrain from providing answers to questions appearing on the exam. Several types of feedback to students are useful:

#### Organization and structure

Whether or not an answer is complete. For example, students sometimes skip parts of a question. You may respond to a draft answer by asking, “Where is X?” or “Have you addressed all parts of this question?” Similarly, if the question asks for multiple arguments or examples, and the student answer provides only one, you might post a comment like, “This gives one example; the question asks for 3.”

Sometimes a question uses material from the slides but misses key relevant material from the lecture or the assigned readings. In that case, your response might ask, “Does this use the necessary source material? What about the readings?”

If students are leaving a question unanswered and the relevant lecture(s) has passed, the instructor might post a very short note, like “No answer?”

If an answer is going in the wrong direction, the instructor might query, “Does anyone have a comment on this?”

The instructor should not post a comment on every question. Don’t give the impression you’ll catch every big mistake or bad direction.

### **Variations of the activity**

None

# Ending the course

## 10.0 Administrative tasks

### 10.0.1 Grading

Grading standards will vary widely. At the end of the course, determine and privately communicate grades to students. Depending on your institutional context, you may choose to send an email to each student, post to an institutional grade reporting system, or send certificates of completion. No matter the context, it's important to complete the grading process in a timely fashion.

### 10.0.2 Review course evaluations

After the course is complete and all grading obligations are met, instructors should review the course evaluation data looking for opportunities to improve the course. Make notes and updates as appropriate. In addition to course evaluation data, Fiedler recommends you review postings from the *Help! Discussion* and course emails looking for areas of confusion to clarify by revising instructions for assignments or course materials.

For more details on grading and course evaluation, please consult Section One of this *Instructor's Manual*

# APPENDICES

## **Preface to appendices**

The Appendices include a variety of documents intended to facilitate your use of BBST course materials and introduce you to the major assignments associated with each course. The appendices include rubrics reflecting course grading standards selected study guide questions from each course; the long-form course evaluation instrument; and course tasks checklists from each course. The materials in the appendices are highly customizable. Please feel free to modify to suit your course's learning objectives and the students with whom you work.

# Appendix A: BBST Foundations Course Checklist

BBST Foundations 2.0 Task List		
✓	When*	What
		Agree to course policies
		Official Day 1
Lesson 1		
		Forum: Introduce yourself to the class
		Skim the BBST Orientation on the Start Here tab
		Lecture 1 & quiz
		Forum: Respond to Meet & Greet
		Deadline for all Lesson 1 Tasks
Lesson 2		
		Forum: Describe your role
		Lecture 2 & quiz
		Assignment: Skim the final exam study guide
		Required Reading: Kaner, Hendrickson & Brock's Managing the Proportion of Testers to (Other) Developers
		Assignment: Begin the Mission Assignment with group
		Optional: Participate in Quiz 1 Q&A discussion forum
		Optional Recommended Reading: Bach's Heuristic Test Strategy Model
		Optional Recommended Reading: Kaner's Recruiting Software Testers
		Deadline for all Lesson 2 Tasks
Lesson 3		
		Lecture 3 & quiz
		Assignment: Phase 1 of Using Oracle Heuristics with group
		Forum: Oracles Orientation (Testing a word processor)
		Assignment: Complete Mission of Testing assignment with group
		Assignment: Peer review Mission of Testing answers from other groups (take an additional day or 2 if needed)
		Required Reading: Bach and Bolton's Testing Without a Map
		Optional: Participate in Quiz 2 Q&A discussion forum
		Optional Recommended Reading: Kelly's Using Heuristic Test Oracles
		Optional Recommended Reading: Koen's Engineering Method
		Optional Recommended Reading: Weyuker's On Testing Nontestable Programs
		Deadline for all Lesson 3 Tasks

## BBST Foundations 2.0 Task List

✓	When	What
<b>Lesson 4</b>		
		Lecture 4 & quiz
		Forum: The Impossibility of Complete Testing (Square Root Function) orienting exercise
		Assignment: Phase 2 of Using Oracle Heuristics with group
		Required Reading: Hoffman's Exhausting Your Test Options
		Required Reading: Kaner's Software Negligence and Testing Coverage
		Required Reading: Marick's How to Misuse Code Coverage
		Optional: Participate in Quiz 3 Q&A discussion forum
		Optional Recommended Reading: Goldberg's What every computer scientist should know...
		Optional Recommended Reading: Marick's Experience with the cost of different coverage goals for testing
		Optional Recommended Reading: Charles Petzold (1993)?? Code: the Hidden Language of Computer Hardware and Software. Microsoft Press.
		Deadline for all Lesson 4 Tasks
<b>Lesson 5</b>		
		Lecture 5 & quiz
		Assignment: Phase 3 of Using Oracle Heuristics (individual task)
		Required Reading: Kaner's Impossibility of Complete Testing
		Assignment: Craft answer in Exam Coaching Lab
		Optional: Participate in Quiz 4 Q&A discussion forum
		Optional Recommended Reading: Black's Factors That Influence Estimation
		Optional Recommended Reading: Kaner's Negotiating Testing Resources
		Optional Recommended Reading: Kelly's Estimating testing using spreadsheets
		Deadline for all Lesson 5 Tasks

<b>BBST Foundations 2.0 Task List</b>		
<b>✓</b>	<b>When</b>	<b>What</b>
<b>Lesson 6</b>		
		Lecture 6 (video only)
		Assignment: Peer review answers in Exam Coaching Lab
		Optional: Participate in Quiz 5 Q&A discussion forum
		Optional Recommended Reading: Robert Austin (1996) Measurement and Management of Performance in Organizations
		Required Reading: Kaner & Bond's Software Engineering Metrics: What do they measure and how do we know?
		Optional Recommended Reading: Bolton's Meaningful Metrics
		Optional Recommended Reading: Hoffman's Darker Side of Metrics
		Optional Recommended Reading: Simmons' When will we be done testing?
		Deadline for all Lesson 6 Tasks
<b>Lesson 7</b>		
		Complete and submit the final exam
		Deadline for all Exam Tasks
<b>Exam Grading</b>		
		Review final exams for assigned students
		Complete and submit the course evaluation
		Deadline for all course tasks

\*Note we usually enter a due date for each deadline but not for specific tasks.

## Appendix B: BBST Bug Advocacy Course Checklist

BBST Bug Advocacy Task List		
✓	When*	What
<b>Lesson 1</b>		
		Agree to course policies
		Introduce yourself to the class
		Join the <i>OpenOffice</i> test team
		Orientation exercises for Lecture 1
		Lecture 1 & quiz
		Deadline for all Lesson 1 Tasks
<b>Lesson 2</b>		
		Respond to Lecture orientation exercises
		Skim the final exam study guide
		Orientation exercise for Lecture 2
		Bug Reporting Assignment Phase 1: Submit review
		Lecture 2 & quiz
		Deadline for all Lesson 2 Tasks
<b>Lesson 3</b>		
		Respond to lecture 2 orientation exercise
		Bug Reporting Assignment Phase 2: Submit new review
		Orientation exercise for Lecture 3
		Lecture 3 & quiz
		Post at least one study guide answer
		Deadline for all Lesson 3 Tasks
<b>Lesson 4</b>		
		Respond to Lecture 3 orientation exercise
		Pair with a student for Assignment Phase 3
		Bug Reporting Assignment Phase 3: Submit partner-reviewed report
		Lecture 4 & quiz
		Post/review at least one study guide answer
		Deadline for all Lesson 4 Tasks

## BBST Bug Advocacy Task List

✓	When	What
<b>Lesson 5</b>		
		Bug Reporting Assignment Phase 4: Submit grading
		Lecture 5 & quiz
		Post/review a few study guide answers
		Deadline for all Lesson 5 Tasks
<b>Lesson 6</b>		
		Last chance to submit grading for Bug Reporting Assignment Phase 4
		Lecture 6 & quiz
		Post/review answers to all study guide questions
		Deadline for all Lesson 6 Tasks
<b>Exam</b>		
		Submit final exam
		Deadline for exam
<b>Exam Grading</b>		
		Grade two others' final exams per chart
		Regrade your own exam
		Submit course evaluation
		Deadline for all course tasks

\*Note we usually enter a due date for each deadline but not for specific tasks.

## Appendix C: BBST Test Design Course Checklist

<b>BBST Test Design Task List</b>		
✓	When*	What
		Agree to course policies
		Official Day 1
<b>Lesson 1–Overview &amp; Function Testing</b>		
		Forum Meet & Greet
		Skim the BBST Orientation on the Start Here tab
		Lecture 1 & quiz
		Required Reading: Chapter 3 (Test Techniques) from Lessons Learned in Software Testing
		Required Reading: Kelly’s Taking a Tour through Test Country
		Optional Recommended Reading: Bolton’s Of Testing Tours and Dashboards
		Optional Recommended Reading: Bolton’s Factors of Function Testing
		Optional Recommended Reading: Kelly’s Touring Heuristic
		Forum: Respond to Meet & Greet
		Deadline for all Lesson 1 Tasks
<b>Lesson 2: Risk-based Testing</b>		
		Lecture 2 & quiz
		Required Reading: Bach’s Heuristic Test Strategy Model, v. 4.8
		Required Reading: Hendrickson’s Test Heuristics Cheat Sheet
		Required Reading: Vijayaraghavan & Kaner’s Bug Taxonomies: Use them to Generate Better Tests
		Discussion Forum: A Lab on Risk (See course for details)
		Optional: Participate in Quiz 2 Q&A discussion forum
		Optional Recommended Reading: Edgren’s Little Black Book on Test Design
		Optional Recommended Reading: HAZOP Guidelines
		Optional Recommended Reading: Hunter’s You are Not Done Yet
		Optional Recommended Reading: Kaner & Johnson’s Styles of Exploration
		Optional Recommended Reading: Kaner’s Testing Computer Software appendix
		Deadline for all Lesson 2 Tasks

## BBST Test Design Task List

✓	When	What
<b>Lesson 3–Spec-based Testing</b>		
		Lecture 3 & quiz
		Required Reading: Bach’s Heuristic Test Strategy Model, v. 4.8
		Assignment: Using HTSM to Analyze Specifications
		Optional: Participate in Quiz 2 Q&A discussion forum
		Optional Recommended Reading: Adler & Van Doren’s How to Read a Book
		Optional Recommended Reading: Gause & Weinberg’s Exploring Requirements: Quality Before Design
		Optional Recommended Reading: Mon, Hoffman, Novak & Canas’ Applied Concept Mapping: Capturing Analysing and Organizing Knowledge
		Optional Recommended Reading: McMillan’s Mind Mapping 101
		Optional Recommended Reading: McMillan’s Lean Test Cases
		Deadline for all Lesson 3 Tasks
<b>Lesson 4–Scenario Testing</b>		
		Lecture 4 & quiz
		Required Reading: Bolton’s Why We Do Scenario Testing
		Required Reading: Carroll’s Five Reasons for Scenario-Based Design
		Required Reading: Kaner’s An Introduction to Scenario Testing
		Required Reading: Kaner’s What Good Is A Good Test Case?
		Lab: Test Design Discussion Forum
		Complete Assignment 1: Using HTSM to Analyze Specifications
		Optional: Participate in Quiz 3 Q&A discussion forum
		Optional Recommended Reading: Hackos and Redish’s User and Task Analysis for Interface Design
		Optional Recommended Reading: Buwalda’s Soap Opera Testing
		Optional Recommended Reading: Charles’ Modeling Scenarios Using Data
		Optional Recommended Reading: Collard’s Developing Test Cases from Use Cases
		Deadline for all Lesson 4 tasks

## BBST Test Design Task List

✓	When	What
<b>Lesson 5–Domain Testing</b>		
		Lecture 5 & quiz
		No required readings
		Assignment 2: Begin Risk-Based Domain Testing
		Optional: Participate in Quiz 4 Q&A discussion forum
		Optional Recommended Reading: Hamlet’s Partition Testing Does Not Inspire Confidence
		Optional Recommended Reading: Kaner’s Teaching Domain Testing
		Optional Recommended Reading: Padmanabhan’s Domain Testing: Divide and Conquer
		Optional Recommended Reading; Wikipedia’s article on Stratified Sampling
		Deadline for all Lesson 5 tasks
<b>Lesson 6–Combination Testing</b>		
		Lecture 6 & quiz
		Required Reading: Czerwonka’s Pairwise Testing in the Real World
		Lab: Using the PICT All-Pairs Test Tool
		Complete Assignment 2: Risk-Based Domain Testing (As attachment to discussion post)
		Optional: Participate in Quiz 5 Q&A discussion forum
		Optional Recommended Reading: Bach & Schroeder’s Pairwise Testing: A Best Practice that Isn’t
		Optional Recommended Reading: Bolton’s blog post on Pairwise Testing
		Optional Recommended Reading: Cohen, et al’s AETG System: An Approach to Testing Based on Combinatorial Design
		Deadline for all Lesson 6 tasks
<b>Exam</b>		
		Complete and submit the final exam
		Deadline for all exam submission
<b>Exam Grading</b>		
		Review final exams for assigned students
		Complete and submit the course evaluation
		Deadline for all course tasks

\*Note we usually enter a due date for each deadline but not for specific tasks.

## Appendix D: BBST Responses to Peers Rubric

	Expert	Professional	Amateur	Uninformed
Contribution to the Conversation	Contribution clearly relates to important aspects of the conversation as it unfolds, i.e. evidence the writer considered a substantial number of classmates' postings. Work includes supporting details or provocative questions to extend the discussion.	Contribution relates to some aspects of the conversation as it unfolds, i.e. evidence the writer considered several classmates' postings. Work includes supporting details or questions to further the discussion.	Contribution relates to some aspects of the unfolding conversation. Few examples are given. No attempt made to extend the conversation.	Contribution has little or nothing to do with the classroom conversation unfolding.
Evidence of Expertise	Writing demonstrates command of the relevant professional literature beyond assigned and draws on that knowledge to offer supporting details and/or examples. May also draw on rich, relevant personal experience.	Writing demonstrates knowledge of secondary and web resources beyond the assigned reading. Draws on that knowledge, along with relevant personal experience to offer supporting details and/or examples.	Writing demonstrates knowledge of the assigned reading. Contribution draws on the reading, along with personal experience to offer supporting details and/or examples.	Writing fails to demonstrate any knowledge of required reading, instead relying solely on one's own opinion and personal experience to offer supporting details and/or examples.

	<b>Expert</b>	<b>Professional</b>	<b>Amateur</b>	<b>Uninformed</b>
<b>Quality of Writing</b>	Writing is clearly organized with a thesis statement and carefully written paragraphs (introductory sentence, explanations or details, and concluding sentence) in support of that thesis.	Writing is clearly organized with a clear point. Most paragraphs are carefully written (introductory sentence, explanations or details, and concluding sentence) and contribute to the purpose of the writing.	Writing lacks organization, but manages to convey the intended message. Paragraphs are disorganized, but coherent.	Writing lacks organization and a message.
<b>Citations</b>	Writer attributes ideas to others as appropriate and includes sufficient relevant details and information to allow readers to locate sources.	Writer attributes ideas to others as appropriate and attempts to include relevant details and information to allow readers to locate sources.	Writer attributes ideas to others as appropriate, but fails to include sufficient citation information to allow readers to locate the source.	Writer fails to attribute ideas to others as appropriate.
<b>Mechanics</b>	No grammatical, spelling or punctuation errors.	Almost no grammatical, spelling or punctuation errors.	A few grammatical spelling, or punctuation errors.	A distracting number of grammatical, spelling, or punctuation errors.

# Appendix E: BBST Generic Assignment Rubric

## Responsiveness to the assignment

Expert	Answer to each section clearly relates to the task or question posed by the assignment. Work includes several supporting details and/or examples.
Professional	Answer to each section clearly relates to the task or question posed by the assignment. Work includes few supporting details and/or examples.
Adequate	Answer to each section clearly relates to the task or question posed by the assignment. Few or weak supporting details and/or examples.
Amateur	The submission relates to some aspects of the assignment but details or examples are weak or not directly relevant to the task or question asked.
Inadequate	Information has little or nothing to do with the assignment.

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## Evidence of skill

Expert	To the extent the assignment requires skilled use of a technique, work demonstrates mastery.
Professional	Competent application of the technique.
Adequate	Same as professional.
Amateur	Applies the technique, but not particularly well. Makes mistakes, overlooks relevant information, or wastes time.
Inadequate	Incompetent use of the technique or wrong technique.

---

## Evidence of knowledge

Expert	To the extent the assignment requires knowledge of assigned readings and video, submission demonstrates a clear knowledge of all of the facts and issues in the assigned sources relevant to the question asked or the task assigned.
Professional	Demonstrates knowledge of the relevant facts and issues in the assigned sources.
Adequate	Same as professional.
Amateur	Demonstrates knowledge of some of the relevant facts and issues in the assigned sources but misses points or fails to tie them well to the question asked or the task assigned.
Inadequate	Writing fails to demonstrate any knowledge of required reading, instead relying solely on one's own opinion and personal experience to offer supporting details and/or examples.

## Evidence of background knowledge

Expert	Writing demonstrates command of the relevant professional literature beyond that which was assigned and draws on that knowledge to offer supporting details and/or examples. May also draw on rich, relevant personal experience.
Professional	Writing demonstrates knowledge of secondary and web resources beyond assigned reading. Draws on that knowledge, along with relevant personal experience, to offer supporting details and/or examples.
Adequate	Writing demonstrates a reasonable attempt to gain and use knowledge of professional, secondary, and web resources beyond the assigned reading.
Amateur	Writing demonstrates knowledge of the assigned reading. Contribution draws on the reading, along with personal experience, to offer supporting details and/or examples.
Inadequate	Writing fails to demonstrate any knowledge beyond the required reading.

---

## Answers all parts of the assignment

Expert	Most assignments have multiple parts (questions presented or tasks assigned). If the assignment does not include an explicit breakdown, or doesn't break down finely enough, submission separates the assignment into components. The submission includes a separate section for each component. Each section indicates what question or task it addresses.
Professional	Breaks the assignment into components (or follows the breakdown provided) and provides a separate section for each and every component. If there is no answer for some component, section is clearly labeled and left blank.
Adequate	Almost the same as professional, but a slightly smaller portion of the question is answered.
Amateur	Answers most (or all) parts of the assignment. However, the submission does not address each question or task in a separate section, so it is difficult for the reader to determine what parts of the assignment the student has attempted to answer.
Inadequate	Answers some parts of the assignment but does not tie specific comments to specific parts of the assignment. The submission also includes irrelevant text (comments not directly responsive to any part of the assignment), making it even more difficult to determine what parts of the assignment the student has attempted to answer.

## Quality of writing

Expert	Writing is clearly organized with a thesis statement and carefully written paragraphs (introductory sentence, explanations or details, and concluding sentence) in support of that thesis.
Professional	Writing is clearly organized with a clear point. Most paragraphs are carefully written (introductory sentence, explanations or details, and concluding sentence) and contribute to the purpose.
Adequate	Writing is well organized. Most paragraphs are carefully written and convey the intended message in a logical structure.
Amateur	Writing lacks organization, but manages to convey the intended message. Paragraphs are disorganized, but coherent.
Inadequate	Writing lacks organization and a message.

---

## Mechanics

Expert	No grammatical, spelling or punctuation errors.
Professional	Almost no grammatical, spelling or punctuation errors.
Adequate	Almost no grammatical, spelling or punctuation errors (same as Professional).
Amateur	A few grammatical spelling, or punctuation errors.
Inadequate	A distracting number of grammatical, spelling, or punctuation errors.

---

## Citations

Expert	Writer attributes ideas to others, as appropriate, and includes sufficient relevant details and information to allow readers to locate sources.
Professional	Writer attributes ideas to others, as appropriate, and includes sufficient relevant details and information to allow readers to locate sources. (Same as Expert)
Adequate	Writer attributes ideas to others, as appropriate, and attempts to include relevant details and information to allow readers to locate sources.
Amateur	Writer attributes ideas to others, as appropriate, but fails to include relevant details and information to allow readers to locate sources.
Inadequate	Writer fails to attribute ideas to others as appropriate.

# Appendix F: Fieldstones

## Introduction to Fieldstones

Our use of Fieldstones is inspired by *Weinberg on Writing: The Fieldstone Method* (Weinberg, 2005). In this book, Dr. Weinberg talks about collecting small pieces of well-written content over time. Many of the postings instructors use in BBST courses address previous topics which are likely to come up again. Rather than dash off a quick response each time, spend some time crafting a well-written response you can use over and over. This appendix includes some of the Fieldstones we use in our courses. Many of the sample messages you see throughout the chapters are from our collection of Fieldstones.

## Course Welcome Message

Welcome to the *BBST Foundations* course. As you know, it will be delivered fully online. <INSTRUCTOR NAME(S)> will be facilitating the course. We're looking forward to an interesting and enlightening time as we learn more about software testing.

We know this may be the first online course for many of you. Some of you might even have a touch of the jitters (a perfectly natural feeling) and quite a few questions (also perfectly natural). We're providing this rather long email to answer the questions we suspect you have.

We've included lots of tips and tricks to help you get started on the right foot. Don't let these suggestions overwhelm you. Simply complete a couple each day during the first few days of class and you'll be ready to go.

## Enroll in the Course

One of the first orders of business is to enroll in the course.

<INSERT SPECIFIC INSTRUCTIONS FOR YOUR INSTITUTION HERE>

## Logging Into the Course:

The course is delivered through an open-source course management system named *Moodle*. To view the course website and participate in the discussions, you will need to enroll in the course (see above).

Once you have enrolled, you can return to the course website at any time via the link below: <URL>.

You can review the *Moodle* documentation at [http://docs.moodle.org/en/Main\\_Page](http://docs.moodle.org/en/Main_Page). Bookmark that website so you can refer to it for help with the *Moodle* system.

Be sure to get started on the right foot. Try to log in to the course as soon as you can. This will give us time to get any technical problems straightened out promptly and keep you from falling behind before you get started. We are still building the course website so you may see a few things shift around.

## Course Policies

To participate in the course, you'll need to review and accept two course policies. The first is an Acceptable Use Policy to protect all of us from spammers and other nuisances. The second policy is an Intellectual Policy agreement. Please read it so you understand how we plan to proceed.

Please review these policies and direct any questions you have to one of us. To review these policies, click on the Choices option on the left hand side of your screen under the Activities header. You must agree to these terms by <DEADLINE> or you will not be permitted to continue in the course.

## Our Contact Information

Although we will not meet face-to-face as a class, we think you'll have plenty of communication with each of us. If you need something, you can contact us in one of the following ways:

<INSERT PREFERRED CONTACT INFORMATION>

Please put BBST followed by descriptive text in the subject line of every message you send us. This simple courtesy will let us respond more quickly and accurately.

## Course Materials

The primary resources in the course are the videos, slides, and readings stored at <http://testingeducation.org/BBST>. The resources are linked from the course website for your convenience.

## Expectations

We expect you to visit the class site several times a week while class is in session and spend approximately 12-15 hours on course-related tasks. You can find everything you need at the course site and in this email. If you haven't already done so, set up a special mailbox or file for course-related documents. This will help you conveniently keep up with course communication.

We expect you to "participate" in class by posting in the discussion forums and completing assigned tasks. You should become familiar with the rubric for participation (see course website) to understand what we mean by "full participation." One of us—often all of us—will check the course discussion forums each day, but we will not respond to each and every posting.

We suggest you print the main page of the course website and keep it in a convenient place to track tasks due. You might want to note important deadlines to remember on your personal calendar.

## Software Tools and Tips

Successful participation in an online class entails having and knowing how to use the right tools. We strongly urge you to be sure you have the following software loaded and running before the start of class:

**UP-TO-DATE ANTI-VIRUS SOFTWARE.** Once installed, schedule regular anti-virus definition updates to stay ahead of the newest viruses. We recommend daily updates for Windows users and weekly updates for Macintosh users. Check the software's help files for help. Throughout the course, we'll share ideas, insights, and resources. About the only thing we DON'T want to share during class is a computer virus.

**A WORD PROCESSOR.** There are a number of options for a good word processor. As long as it can save to Rich Text Format (RTF), you'll get along fine.

**SYSTEM SOFTWARE UPDATES.** Schedule your computer to regularly update system software with the latest security patches. Windows users will find Windows Update in the Start menu. Macintosh users should look under the Apple menu.

**A MODERN WEB BROWSER.** We like Mozilla Firefox but it's often handy to have several browsers on the computer at any one time. You should have at least two. Adding Firefox to your computer will be a useful addition to Internet Explorer (Windows users) and Safari (Macintosh users).

Every now and again you run into a website not functioning properly in one browser but fine in another. Having another browser readily available is helpful for troubleshooting browser problems.

**ADOBE READER.** This free utility lets you read files in PDF format. If you don't have it, you can download it at no cost from <http://www.adobe.com/products/acrobat/readstep2.html>.

**VLC MEDIA PLAYER.** This course relies heavily on video lectures. You will need a media player. We recommend the free VLC Media Player available for download at <http://www.videolan.org/vlc/>

## Backup Strategy

Things break. We don't like it when it happens, but it's a fact of digital life. Be sure you have a backup plan in case your computer crashes sometime during the class. Know where you can go to access the course website and complete class activities while you focus on resuscitating your computer. Also, be sure to keep back-up copies of important class-related documents. You'll be glad you did.

We know this message covers a lot of territory. We wanted to give you the information you need to assure a smooth start for your first BBST course.

We'll see you online soon!

<INSTRUCTOR NAME(S)>

## Philosophy of BBST Quizzes

**Rationale:** Students who are new to the BBST series of courses can be dismayed by their performance on quizzes. This post lets them know quizzes are to help them learn the content, not assess their knowledge.

**Subject:** Learning Objectives for Our Quizzes

### The Post

Assessment activities have many possible purposes. Getting a final grade is just one, and in terms of real-world value, probably the least important. When we decide whether you pass or fail the course, your performance on the quizzes will have minimal (probably zero) impact.

The point of these quizzes is to help you focus on the lectures and required readings, check whether you understand what we are saying, and think about whether you agree with us.

We write these questions carefully (not necessarily perfectly, but we try) and are trying to make you think carefully about what you are learning. One of the strategies is to require you to compare possible answers and evaluate them in terms of each other. We do this by structuring our questions so we usually give you simple answers and combinations (A and B, A and C, etc.). This makes the test harder, perhaps harder than other multiple choice tests you have taken. Please don't be dismayed by a low grade. Instead, go back to a question we scored as partially correct or as incorrect, and ask whether it indicates you can learn a bit more from the instructional materials. You might learn from the materials or participating in discussions challenging the lesson the question is trying to point out.

It is very hard to write good multiple-choice questions, partially because we have to set the question up to mark a Right Answer in a field that allows many good answers. We will often disambiguate questions by saying, “According to the lecture, X is true.” In that case, your answer has to be guided by the lecture. When you select X as the best option, that doesn’t mean YOU believe X is true, it means you believe that’s what we said.

You can argue with us about lots of the course content.

- The best opportunity is probably in the *Exam Cram* forum. The study guide posts a series of essay-format questions. The final exam will include some of these. The *Exam Cram* forum is a place where, before the exam, students compare notes on their possible answers to these questions.
- Another welcome place for discussion is the *Quiz Discussion* forum.

## We Are Listening

**Rationale:** Online instructors need to balance competing responsibilities in discussions, leaving space for students to dialog while providing instructor guidance. This post lets students know the instructor is trying to strike such a balance.

**Subject:** We’re Paying Attention

### The Post

This is a good discussion.

You’re unlikely to see many comments from the instructors in this topic for another couple of days. That’s not because we’re not reading with interest--we are. It’s because the instructional value is better for you if we stay silent while you work through the issues, piping in occasionally to ask a question or make a minor clarification, then stepping back out of your way.

After the discussion dies down, one of us might make a longer comment or two; but in many cases, the discussion will resolve itself without a word from us--and that’s a good thing.

## What Time Is It?

**Rationale:** One of the many challenges in online courses (and off-shore development) is the challenge of time zone diversity. We frequently use this post to explain how we handle time zone challenges.

**Subject:** "What Time Is It?"

### Post

This post makes three points:

- This course--all the courses in the BBST series--runs on a rhythm.
- Deadlines are very important in online courses, so important we enforce them even though some of us cheerfully ignored many deadlines when we went to school.
- Deadlines are puzzling when teams work together across time zones. We've adopted a rule that is simple, if not perfect.

Now for the details....

- This course runs on a general schedule:
  - Each week is divided into two parts and each part contains a weekend day.
  - The week starts Sunday morning (just after midnight). It's first part ends Wednesday night at midnight.
  - The second half of the week starts Thursday morning (just after midnight) and ends Saturday at midnight.
- Online courses have to be deadline driven, especially short courses:
  - In face-to-face courses, a lot of personal interactions keep students involved in the course. In online courses, it is easy for people to drift away. The typical dropout rate is very high, often because people fall a little behind then a little more behind--until they have lost contact with the course.
  - In online courses, we have group discussions and group projects. If people aren't keeping up, the discussions don't make sense and projects become the work of only one person.
  - In our courses, students review each others' work. This is a very important part of the learning experience. It can't be done if the work to be reviewed is late. *So like work, we have deadlines.*

- The problem is it is hard to say when Sunday morning starts. *Moodle* can enforce deadlines, but it only understands one time zone, so if I tell *Moodle* “Require people to submit work by 11:59 p.m.,” it will stop accepting submissions at midnight according to the time zone we set in Moodle.
- But which time zone? Bangalore? Florida? California?
- For this course, we set the server clock to GMT, a neutral time (equally inconvenient for Bangalore as for Melbourne, Florida).
- We enforce deadlines at 8:00 a.m. GMT. For example, if a quiz is due by Saturday at midnight:
  - You **SHOULD** complete that quiz by Saturday, midnight in your time zone.
  - *Moodle* will refuse to accept your quiz if you submit it after 8 a.m. GMT (midnight in the Pacific time zone).

Comments? Questions?

## Appendix G: Sample Essay Question Grading

We create a detailed grading guide before we grade exam questions. Our next step is to use the grading guide on answers students submit. We generally grade a student we expect to do well, a student we think might perform poorly, and a student we think of as being a mid-level performer. If our guide is structured well, it should allow us to distinguish between differing levels of student performance. If it does, we use it to grade student answers. If it doesn't, we modify the grading guide until we're comfortable it will help us determine fair and defensible grades.

This appendix contains a sample short answer and long answer question from each course in the BBST series.

### BBST Foundations

#### Sample grading guide for short answer question

##### The question:

A program asks you to enter a password, then asks you to enter it again. The program compares the two entries and either accepts the password if they match or rejects it if they don't. An entry is "valid" if it contains only letters and/or digits and is neither too short nor too long. How many valid entries could you test? (Please show and/or explain your calculations.)

##### Grading Notes

- There are 62 characters: 26 lower case, 26 upper case, and 10 digits. Clearly identifying this is worth up to 3 points.
- There are 62 values for a 1-character password,  $62^2$  for a 2-character password, etc. Students may earn up to 3 points for indicating this in their answer.
- There are:  $N = \text{SUM}(i = \text{LOW to HIGH}) 62^i$  passwords between LOW number of characters and HIGH number. Including this in the answer is worth up to 2 points.
- The question calls for the password twice, so you could enter N different passwords the first time and any one of the N the second time, so the total is  $N*N$ . Identifying this is worth 1 point.
- Students may earn one additional point if their answer accounts for an empty password.

##### Error Cases

- If the student stops at  $62^K$  for a specific K-character password, the maximum points they can earn is 6.
- If the students assumes an unbounded password and doesn't do the 62-character analysis, the maximum grade is 2 points.

- $K^{62}$  is typically worth 2 points but it might be worth up to 5 if the student provides an excellent explanation.
- Deduct 2 points for allowing invalid characters.
- If there is negligible explanation, the answer must be perfect for 9 points.

Students	Total points	62 chars	$62^i$	Sum ( $62^i$ )	$[\text{Sum } 62^i]^2$	Allows empty password	Invalid characters	Discretion
	10	3	3	2	1	1	-2	1

“Discretion” is awarded for organization, style, and demonstration of exceptional insight (or lack of it).

The default grade for discretion is 0. The maximum score with no credit for discretion is 9/10.

## Sample grading guide for long answer question

Suppose a test group’s mission is to achieve its primary information objective. Consider and list three different objectives. For each one, how would you focus your testing? How would your testing differ from objective to objective?

### Grading Notes

This is a straightforward question. The most common reasons for losing points are (a) not remembering three examples of information objectives and (b) poor organization. The question breaks down into:

- List 3 information objectives.
- For each objective, how would you focus your testing?
- How would your testing differ from objective to objective?

Let’s consider these in turn.

### Three information objectives:

The course slides list these. Students are NOT required to pick from this list if they can use other plausible objectives. However, these are examples of what you’ll often see:

- Find important bugs to get them fixed.
- Assess the quality of the product.
- Help managers make release decisions.

- Block premature product releases.
- Help predict and control costs of product support.
- Check interoperability with other products.
- Find safe scenarios for use of the product.
- Assess conformance to specifications.
- Certify the product meets a particular standard.
- Ensure the testing process meets accountability standards.
- Minimize the risk of safety-related lawsuits.
- Help clients improve product quality & testability.
- Help clients improve their processes.
- Evaluate the product for a third party.

Because the answers can be simple memory work, each is worth 2 points. A garbled objective (something incorrectly memorized, not making a lot of sense) is worth 0.

### **For each objective, how would you focus your testing?**

We expect answers to be relevant and plausible. For example, “Finding bugs” is a poor focus for “Help predict and control costs of product support.”

We rarely give full points twice for the same answer. For example, “Hunt for bugs” is a good focus for “Find important bugs to get them fixed” but a mediocre focus for “Assess the quality of the product.” We might give “Hunt for bugs” 2 points (of 3) if the only time it appears is for “Assess the quality of the product.” But if “Hunt for bugs” is given as the focus for both, “Find important bugs to get them fixed” AND “Hunt for bugs”, we’d probably give 3 points the first time and 1 point for the second.

These answers require some thought, so we give each 3 points.

### **How would your testing differ from objective to objective?**

The well-written answer contrasts objective 1 with objective 2, then objective 1 with objective 3, then objective 2 with objective 3. (Order of the contrasts is not important, but they should be separate.)

The poorly-written answer says something about each objective in turn and relies on you to do the actual pairwise comparisons. At best, we give half-points for this. We grade the answer written, without adding our cognition to supplement the student’s answers. Once an instructor starts filling in the blanks for a student, grading inequities become significant because you will give some students more leeway (make stronger assumptions about what the student knows or

means than you give other students). Identical answers from different students would thus get different grades. That’s not fair.

The contrasts are worth 3 points each.

The raw score can total up to 21 points. However, we set 18 as the maximum and reserve 2 points for style and organization and our subjective impression of how thoughtful the answer is. Thus an answer can total 21 points and get 18 as a final score, or an answer can total 18 points but (after 2-point grader’s leeway) get a final score of 20.

Student	Total	Objective 1	Focus 1	Objective 2	Focus 2	Objective 3	Focus 3	Differ: Objective 1 versus 2	Differ: Objective 1 versus 3	Differ: Objective 2 versus 3	Discretion
Points	20	2	3	2	3	2	3	3	3	3	Max 18 plus insight (2)

“Discretion” is awarded for organization, style, and demonstration of exceptional insight.

The default grade for discretion is 0. The maximum score with a discretion = 0 is 18/20.

## BBST Bug Advocacy

### Sample grading guide for short answer question

#### The Question

The lecture presented a 6-factor approach to bug reporting: RIMGEN. What are the factors? (List and briefly describe them. Use a simple example when appropriate.)

#### Grading notes

Students must list each of 6 factors and a brief, accurate description for each. Examples are optional but appreciated.

#### Typical scoring

Each of the six factors listed and explained is worth 1 to 1.5 points.

Examples are worth an additional .5 points.

Up to one point may be awarded at the grader’s discretion for organization, style, and demonstration of exceptional insight (or lack of it). The default grade for discretion is zero.

#### Sample answer below:

- **Replicate** it. Make sure you can consistently reproduce the bug.
- **Isolate** it. Narrow things down by eliminating unnecessary steps or conditions to reproduce the bug. Identify the easiest way to reproduce the bug.

- **Maximize** it. Do follow-up tests to see if you can find worse failures than the original symptoms. To do this, you can make use of the 4 tactics of varying behavior, program settings, inputs and configuration or environment.
- **Generalize** it. Try to show the bug occurs in more general, less specific scenarios. For example, try to reproduce the bug on more popular platforms if the initial bug was found on something less specific. Can also try uncornering corner cases.
- **Externalize** it. Consider the bug from stakeholders' perspectives and show the value lost (and to whom) if the bug remains unfixed. Bug reports citing the needs of influential stakeholders are particularly compelling.
- **Neutral** tone. Make bug reports neutral in tone. Angry, blaming or condescending reports can be more difficult to read and process. They also may discredit the bug reporter or damage the tester / developer relationship.

## Sample grading guide for long answer question

Suppose you find a reproducible failure that doesn't look very serious.

- a) Describe the four tactics presented in the lecture for testing whether the defect is more serious than it first appeared.
- a) As a particular example, suppose the display got a little corrupted (stray dots on the screen, an unexpected font change, that kind of stuff) in Impress when you drag the scroll bar up and down. Describe four follow-up tests you would run, one for each of the tactics you listed above.

### Grading notes

The lectures described four specific tactics and gave examples. This question demands the student review and apply the material:

Here are Kaner's examples of follow-up tests. The bold italics headings, like *Tests related to the steps in my original test*, are tactics the students were taught in class.

- ***Vary my behavior***
  - Enter more text in the document
  - Vary the contents of the document, such as the amount of text versus whitespace on the page / screen
  - Vary the color, alignment, font, line width, etc of the document
  - Repetition
  - Timing

- *Tests related to the failure*
  - What else causes mouse droppings
  - Print preview the screen
- *Tests related to the task that failed*
- *Vary options and settings of the program*
  - Location of the program within the window
  - Whether the program is maximized
  - Default cell format, such as alignment within the cells, font, line width, etc.
- *Vary data loaded to the program*
  - At startup
  - Other data not directly involved in the test
- *Tests related to the configuration (hw or sw)*
  - Different video resolution
  - Different monitors or video cards
  - Different OS (check one of the ports, is this unique? If not, then anything specific to windows might be irrelevant)
  - Different mouse / mouse driver
  - Different memory

NOTE: This is a fair and reasonable question in the study-guide-based exam structure because the student has advance notice of the question and can pay specific attention to this specific material. In an exam not giving the student prior notice this question was possible, your grading standard would be quite different. It seems unreasonable to expect students to memorize this level of detail about “everything” in the course—if they don’t have notice of this as a point of focus. Many good students will perform poorly on this question without that.

### **Scoring:**

- We give students 2.5 points each for remembering and describing a tactic. Some students list a tactic without describing it. This might be worth up to 1 point.
- The examples are a little more difficult for many students, so we give up to 3 points for a good example clearly tied to a specific tactic. Examples not explicitly tied to tactics (the student says “do this” but leaves you to guess what tactic is illustrated) get at most 1.5

points. Examples that cannot be tied to a specific tactic, or duplicates (the second of two examples for the same tactic), get zero.

Total	Vary behavior	Options & Settings	Data loaded to the program	Environment	Example 1	Example 2	Example 3	Example 4	Discretion
20	2.5	2.5	2.5	2.5	3	3	3	3	2

## BBST Test Design

### Sample grading guide for short answer question

Suppose you follow the guidance of the domain testing lecture and assess the consequences of setting a variable to a boundary value. Is this boundary testing still a quicktest? Explain why or why not.

#### Grading Notes

The lectures point out boundary testing is a classic example of quicktesting. This question asks for something beyond that. The lecture emphasizes good domain testing looks beyond the input filter to the ways the program uses the variable. This requires a deeper knowledge of the application under test, therefore probably not a quicktest. If the tester studies the program to find out several consequences of setting the variable to a boundary (the program probably uses a variable in several ways), this is definitely not a quicktest.

#### (a) Decision (1 point)

Is it a quicktest or not? Yes or no. One point either way.

Some answers say “it depends” and then explain. With any level of explanation, I give full credit for the decision.

#### (b) Definition (3 points)

Most good answers define quicktest, either at the start or embedded in the discussion. For knowing what a quicktest is, 3 points.

A sensible application to boundary testing that demonstrates understanding of the definition of quicktesting can get full points even if there is no definition.

#### (c) Evaluation (6 points)

This is a straightforward evaluation. It can't be a quicktest if the tester has to investigate the program beyond a superficial level.

- Full points for an answer pointing this out and saying understanding consequences takes investigation beyond what quicktests expect
- Full points for an answer pointing this out then saying SOME consequence-aware tests are quicktests because the tester already knows the information or it is obvious.
- Failing grade for an answer simply asserting boundary testing is quicktesting (maybe this is worth 1 point of the 6).
- Failing grade for an answer simply asserting domain testing is not quicktesting (maybe this is worth 1 point of the 6).

TOTAL	Decision	Define quicktest	Apply to boundary testing	Fails to recognize this is asking about CONSEQUENCE	Discretion
12/10	1	3	6	F or D, max C	1 default 0

## Sample grading guide for long answer question

You are testing the group of functions that let you create and format a spreadsheet.

Suppose a critical requirement for this release is scalability of the product. What scalability issues might be present in a spreadsheet? List three. For each issue, list two types of failures that could involve scalability. For each type of failure, describe a good test for it and explain why that is a good test for that type of failure. (There are 6 failures, and 6 tests, in total.) (NOTE: When you explain why a test is a good test, make reference to some attribute(s) of good tests, and explain why you think it has those attributes. For example, if you think the test is powerful, say so. But don't stop there, explain what about the test justifies your assertion the test is powerful.)

### Grading Notes

(a) Definition

It's often wisest to start the answer to a question like this with a definition (1 point).

- Different people have different definitions of *scalability*. The student's definition might be different from the one(s) you consider correct; but if the definition doesn't trivialize the question, then you should deduct a few points for bad definition then grade the rest of the answer for the relevance and quality of the test design, given the definition used by the student.
- If the student does not define "scalability" but simply proceeds with the analysis in a way making it difficult to reconcile the answer with any definition of scalability you consider reasonable, do NOT assume the student has a good definition and forgotten to

tell you. (This is often incorrect.) Instead, grade on the basis of relevance and quality to “scalability” as defined in a widely used source, e.g. Wikipedia.

For example, here is our working definition:

(b) *Scalability: How well a solution to some problem will work when the size of the problem increases.*

(i) What scalability issues might be present in a spreadsheet (2 points each, with an expectation of 3 issues, max of 6 points):

In a scalability situation, the user is starting from something that can be done and growing it. For example going from a spreadsheet with 1000 records to a spreadsheet with many more than 1000 records. In these cases, we might see issues like these:

- Inability to scale to the required size. Too many cells, rows, columns, formulas, macros, levels of nesting (a formula using the value of a cell containing a formula using the value of a cell containing a formula, etc.), graphics or other objects inside the cell, rows or columns in a linked database updating values in this spreadsheet, worksheets, pages to print, inches (printed page size), etc.
- Insufficient memory for growth of the spreadsheet.
- Performance cost of growth of the spreadsheet.
- Difficulty in calculating the scaled spreadsheet (e.g. calculation overflow or underflow of a formula too complex to calculate).
- Storage problems, such as overflow of an output file or other file taking data in this spreadsheet as input.
- User interface problems, such as the spreadsheet becoming too hard to use (can't see the tiny print, or can't move from one place to another in a reasonable number of keystrokes) or the spreadsheet causing display problems.

(ii) What's an issue? What's the difference between an issue and a failure?

An issue is a category of risks or problems. As a heuristic, for purposes of this answer, if a student suggests something broad enough they can create 2 reasonably different failures as examples, we'll treat their proposed issue as an issue.

(iii) Weak issues

Some students identify different ways you can scale a spreadsheet and call them separate issues. It's common to see “Spreadsheet too large” as an issue then “Too many cells” as another issue then “Too many rows” or “Too many formulas” or “Formula too large” as separate issues.

We typically give the first one of these 2 points and the rest 0.5 to 1 point each. The more redundant an issue is with previous ones, the fewer points students receive.

The real test of the value of these is whether the student can generate two distinct failure modes (and a test for each) that are direct applications of the idea underlying the “issue.” If there is a pair of good failure modes and a pair of good tests, we are more likely to give 2 points for the “issue.”

(iv) Irrelevant issues

We don’t award points for issues that are not scalability issues. Some students confuse scalability with flexibility. We may award points for a good failure/test/justify of a flexibility issue (especially if the student is going to get a very low grade), but no points for the issue per se.

(c) Failure mode

Award 1 point each for:

- Failure mode (the way the program can fail) as long as it is directly related to the issue. Award nothing for a failure mode not mapped to the issue.
- A test directly related to the potential failure (and nothing for a test not obviously and directly mapped to the failure mode).
- The explanation of why something is a good test (directly related to some attribute of goodness, the student explicitly names).

(d) Totals.

There are 20 points available for this question. As you review student answers, use the suggestions in the grading guide to award a maximum of 18 points. (There might be as many as 25 points—including 1 point for a definition of scalability.) The last two points (to get to 19 or 20) are at your discretion.

Total	Define scalability	Issue 1	Failure Mode, Test & Explain 1.1	Failure Mode, Test & Explain 1.2	Issue 2	Failure Mode, Test & Explain 2.1	Failure Mode, Test & Explain 2.2	Issue 3	Failure Mode, Test & Explain 3.1	Failure Mode, Test & Explain 3.2
20	1	2	3	3	2	3	3	2	3	3

## Appendix H: Student Assessment of Learning Gains

These questions are specifically targeted to collect information about activities within the *BBST Foundations* course. For other courses, the questions are customized to ask students about activities in those courses. Visit <http://www.salgsite.org> for more information about customizing the *Student Assessment of Learning Gains* for your courses.

### **Q1. How much did each of the following aspects of the class help your learning?**

Options: NA, No help, A little help, Moderate help, Much help, Very much help

1. The way in which the material was approached
2. How the class activities, labs, reading, and assignments fit together
3. The pace at which we worked

### **Q2. How much did each of the following class activities help your learning?**

Options: NA, No help, A little help, Moderate help, Much help, Very much help

1. Orienting assignments for the video lectures
2. Informal discussion forums (Help, Meet &Greet, etc.)
3. Taking the quizzes
4. Participating in quiz forum
5. Group assignment
6. Evaluating peer assignments
7. Exam cram study hall
8. Taking the exam
9. Evaluating peer exams

### **Q3. How much did the following aspects of the tests, graded activities and assignments help your learning?**

Options: NA, No help, A little help, Moderate help, Much help, Very much help

1. Opportunities for in-class review
2. The number and spacing of quizzes and exams
3. The fairness of quiz and exam content
4. Instructor guidance on how to take quizzes and exams
5. The mental stretch required of us
6. The grading system used

7. The computer-generated feedback we received on quizzes
8. The peer feedback we received on quizzes, exercises, activities, and exams
9. The instructor feedback we received on quizzes, exercises, activities, and exams

**Q4. How much did each of the following resources of the class help your learning?**

Options: NA, No help, A little help, Moderate help, Much help, Very much help

1. Orientation to the BBST courses
2. Video lectures
3. Course slides
4. Assigned readings
5. Supplemental readings
6. The study guide

**Q5. How much did the information you were given about these aspects of the class help your learning?**

Options: NA, No help, A little help, Moderate help, Much help, Very much help

1. Class activities for each week
2. How parts of the classwork, labs, reading, or assignments related to each other
3. The grading system for the class
4. Learning objectives for tasks or for the course overall

**Q6. How much did each of the following aspects of individual support help your learning?**

Options: NA, No help, A little help, Moderate help, Much help, Very much help

1. The quality of contact with the teachers
2. The quality of contact with peers

**Q7. Overall, how much did the way the class was taught help your learning?**

Options: NA, No help, A little help, Moderate help, Much help, Very much help

**Q8. As a result of your work in this class, how well do you think you now understand each of the following?**

Options: NA, Not at all, A little, Somewhat, A lot, A great deal

1. Familiar with basic terminology and how it will be used in the BBST courses
2. Aware of honest and rational controversy over definitions of common concepts and terms in the field
3. Understand there are legitimately different missions for a testing effort. Understand the argument that selection of mission depends on contextual factors. Able to evaluate relatively simple situations that exhibit strongly different contexts.
4. Understand the concept of oracles well enough to apply multiple oracle heuristics to your own work and explain what you are doing and why.
5. Understand complete testing is impossible. Improve ability to estimate and explain the size of a testing problem.
6. Understand the concept of measurement dysfunction.
7. Improve your ability to adjust your focus from narrow technical problems (such as analysis of a single function or parameter) through broader, context-rich problems.
8. Improve online study skills, such as learning more from video lectures and associated readings.
9. Improve online course participation skills, including online discussion and working together online in groups.
10. Increase your comfort with formative assessment (assessment done to help take your own inventory, think and learn rather than to pass or fail the class).

**Q9. How much has this class added to your skills in each of the following?**

Options, NA, Nothing, A little, Somewhat, A lot, A great deal

1. Evaluate relatively simple situations exhibiting strongly different contexts in terms of their implication for testing strategies.
2. Apply oracle heuristics to your work.
3. Estimate size of a testing task and defend the estimate.
4. Online study skills, including online discussion and working together online in groups.
5. Critically reviewing written materials.
6. Precise reading, as it might apply to specification analysis. Ability to recognize, question or resolve ambiguities or contradictions.
7. Giving peer feedback.

**Q10. To what extent did you make gains in any of the following as a result of what you did in this class?"**

Options: NA, Not at all, A little, Somewhat, A lot, A great deal

1. Understanding the basic terminology.
2. Aware of honest and rational controversy over definitions of common concepts and terms in the field.
3. Understand there are legitimately different missions for a testing effort. Understand the argument that selection of mission depends on contextual factors. Able to evaluate relatively simple situations that exhibit strongly different contexts.
4. Understand the concept of oracles well enough to apply multiple oracle heuristics to their own work and explain what they are doing and why
5. Understand that complete testing is impossible. Improve ability to estimate and explain the size of a testing problem.
6. Familiarity with the concept of measurement dysfunction.
7. Ability to adjust your focus from narrow technical problems (such as analysis of a single function or parameter) through broader, context-rich problems.
8. Online study skills, such as learning more from video lectures and associated readings.
9. Online course participation skills, including online discussion and working together online in groups.
10. Comfort with, and appreciation of, formative assessment (assessment done to help you take your own inventory, think and learn rather than to pass or fail the course).

**Q11. How much of the following do you think you will remember and carry with you into other classes or aspects of your life?**

Answer Options: NA, Not at all, A little, Somewhat, A lot, A great deal

1. Understand the basic terminology.
2. Aware of honest and rational controversy over definitions of common concepts and terms in the field.
3. Understand there are legitimately different missions for a testing effort. Understand the argument that selection of mission depends on contextual factors. Able to evaluate relatively simple situations exhibiting strongly different contexts.
4. Understand the concept of oracles well enough to apply multiple oracle heuristics to your own work and explain what you are doing and why.

5. Understand that complete testing is impossible. Improve ability to estimate and explain the size of a testing problem.
6. Concept of measurement dysfunction
7. Your ability to adjust focus from narrow technical problems (such as analysis of a single function or parameter) through broader, context-rich problems
8. Online study skills, such as learning more from video lectures and associated readings

**Q12. Add additional comments below**

**Q13. In total, how much time did you spend on this course?**

1. more than 60 hours
2. 50-59 hours
3. 40-49 hours
4. 30-39 hours
5. 20-29 hours
6. 10-19 hours
7. less than 10 hours

**Q14. The workload in this course was:**

1. very heavy
2. heavy
3. moderate
4. light
5. very light

**Q15. The workload in this course was:**

1. too heavy
2. reasonable
3. too light

**Q16. Compared to the commercial courses you have taken, this course was:**

1. much more valuable
2. more valuable
3. as valuable
4. less valuable
5. much less valuable
6. (not applicable)

**Q17. Compared to the commercial courses you have taken, this course was:**

1. much more difficult
2. more difficult
3. as difficult
4. less difficult
5. much less difficult
6. (not applicable)

**Q18. Compared to the university courses that you have taken, this course was:**

1. much more valuable
2. more valuable
3. as valuable
4. less valuable
5. much less valuable
6. (not applicable)

**Q19. Compared to the university courses you have taken, this course was:**

1. much more difficult
2. more difficult
3. as difficult
4. less difficult
5. much less difficult
6. (not applicable)

**Q20. Please explain your comparisons with your typical commercial and/or university course experiences.**

**Q21. Did you feel as though the instructors cared about whether you succeeded in the course?**

1. A great deal
2. A fair amount
3. Some
4. A little
5. None

**Q22. Were you aware of plagiarism or cheating by any other students?**

1. Very often
2. Often
3. Sometimes
4. A little
5. Never

**Q23. Did plagiarism or cheating by any other students interfere with your learning in this course or your enjoyment of the course? (Answer "none" if there was no cheating or plagiarism.)**

1. A great deal
2. A fair amount
3. Some
4. A little
5. None

**Q24. How could we improve this course?**