Eosc114 Instructor Guidelines

Contents

1. Introduction

When a course is taught using different teachers for each of several sections, some aspects of logistics and pedagogy become much more challenging than if only a single instructor was involved. Student opinion about multiple instructors has been pretty consistent for many years. Some 60% like it and 40% either don't like it or are ambivalent. Student feedback has provided insight about what is liked and what is not liked. Also, studies on post secondary learning of sciences tell us a fair bit about what contributes to successful learning and what gets in the way. This document tries to take into account all this student feedback, and precedent from the literature, as it outlines strategies aimed at maximizing the benefits of multiple instructors while minimizing the difficulties that can compromise effective student learning.

2. General Guidelines

Multiple instructors and variety versus consistency:

With different instructors for each module, students appreciate every effort that adds consistency to the lecture experience. Here are some ways to promote consistency. Remember that students cannot focus on concepts while figuring out new cues and habits for each module.

1. The best and easiest way to learn how the course works and how to teach it is to sit in on some of the first module lectures (Fragile System). This also helps you know what background content is covered in that section of the course, thus avoiding repeating material.
2. There will be three instructor-team meetings to help keep everyone on the same page. One very near start of term, one a month later, and one at when classes are over. All members of the eosc114 instructing team are expected to attend and contribute. The lead instructor will keep you informed about when, where, and agendas.
3. The lead instructor and other experienced eosc114 instructors and TAs will happily mentor new instructors. **Plan** to make use of their experience to help ensure a consistent and productive learning experience for all students.
4. All content, class & home learning, and assessments should target Learning Goals outlined in the next section. Keep a copy visible as you work on homework and exam questions, clicker questions and lectures.
5. A disaster "scenario" is part of the last few days of class. Students seem to like this, and it is even more effective if aspects can be discussed at other times during the course.
6. It is beneficial to keep in mind the pedagogic principles listed **Appendix II**.
7. Use icons and cartoons provided by the lead instructor to help ensure students see content and ideas delivered in a consistent way throughout the term. This is not to stifle individuality – just try to use consistent cues.
8. The generic module outline below is an important template to help avoid some of the pitfalls we have learned about in the 8 years of offering this course.
9. Instructing in eosc114 should be more about designing opportunities for students to practice the types of thinking you expect (homework and in class) and less about presenting the necessarily broad range of content much of which is in the text.
10. Instructors should not need to interact with the eosc114 Vista WebSite. Please ask the administrator to do this.
11. Check out the seven (!) appendices for complied tips, tricks, and other advice.

Text book

1. The custom text was produced for our own course. PLEASE make sure you know your section(s) of the text, and try to make use of what's in it while preparing lectures and assessments.
2. Students will be expected to read most of it. We should help students synthesize that learning by incorporating text content into class-time learning. Don't cover content again, and be sure to make refer explicitly to material they should have read.
3. Useful consistent additions in every chapter include objectives (on each chapter's first page), and Summary, Key Terms, Review Questions, Critical Thinking Questions, and Web Resources.
4. There are also appendices on minerals, rocks, maps, geologic time, and a respectable glossary.

3. Learning Goals for EOSC114

Please see http://www.eos.ubc.ca/courses/eosc114/EOSC114home/coursegoals.html for overall and lesson-specific learning goals.

Appendix VII contains a matrix that correlates Department approved service course goals with the course-level learning goals for eosc114. Please keep a copy of these goals visible as you work on developing homework and in-class activities.

4. Generic module outline: ideas for consistent components for all modules

These notes provide ideas and guidelines. They are not prescriptive. Use any imaginative ways you know of to increase motivation, vested interest, rapid feedback, and active, inclusive engagement with the concepts. However, try to avoid making students have to figure out what's going on every time a new module begins.

Prior to Day 1 of the module:

1. At the start of the *course*, point the online diagnostic test used to find weaknesses in background knowledge.
2. For all other modules, the relevant readings should have been started, and students should working on the relevant homework (warmup exercises); see section 4 below.
3. Check out the 2pg summary called "**First Day of Class**" on the CWSEI website at http://www.cwsei.ubc.ca/resources/instructor_guidance.htm

Day 1:

1. Some instructors run a video, DVD, YouTube or a song during student's arrival.
2. Expect some students to arrive as much as 10 minutes late (our campus is huge !) THEREFORE never do very important things in the first 10 mins.
3. First 5 minutes of day1:
   a. Introduce yourself, and add something personal, such as "*what excites me about my discipline*", or an anecdote etc.
   b. Instead of the usual module and daily outlines, consider a "learning goals matrix".
   c. HOWEVER don't spend time stating goals or topics. We have data that shows students tune out during this type of information. BUT show the learning goals briefly, and ensure they are in the student's copies of notes.
   d. Also outline expectations, and remind students of the reading assignments.
4. ~40mins of lecture, clickers, video, other activities. Referencing goals is a good thing when relevant.
5. It is **recommended** that you explicitly tie your module to previous work, even if it's only some aspect of the diagnostic test students took.
6. Last ~5mins**:** Remind students of readings and homework (with due dates).
7. Some wrap-up or synthesis can be good SO LONG as it's done as an activity (series of clickers for example). Students will have left the room before you're finished if you simply re-state goals or show a bullet list of what was "covered".

Day2:

1. Video or other starter (eg music)
2. Module (module / course goals matrix?) and lesson goals (briefly only).
3. Ask if there are any quick hands up questions? But as for all such open questions to the students, count to 10-15 before moving on. Nobody (not even you) processes the opportunity to ask a question in zero seconds.
4. ~40 mins of lecture, clickers, video other activities.
5. On one of the days, consider including ~10mins for a current-events spot. Students like to see local, or current events – it helps with motivation.
6. Reminder when homework set is due.

Day 3:

1. Starter as above.
2. If possible, feedback on homework (see Homework below) questions if students were given the opportunity to do it as part of homework.
3. Consider explaining aspects of the pedagogy (clickers, active learning, etc.)
4. ~35mins lecture etc.

Day 4 or 5 (if NOT the last day):

1. Starter and goals as above.
2. ~45mins lecture etc.

Last Day:

1. Starter and goals as above
2. ~30mins Lecture
3. ~15min summary and synthesis ESPECIALLY if you can build connections to up-coming modules.
4. ~2mins End with reminder of reading and homework requirements for the upcoming module.

5. Lectures and use of i>clickers.

Use of the *i>clicker* system is central to how this course operates. A complete guide to using clickers to enhance learning can be found online at http://www.cwsei.ubc.ca/resources/clickers.htm. There you will find a complete resource guide with chapters on Why, Approaches for use, Writing effective questions, Startup, Logistics, answers to 13 FAQ's, and examples. The website also has video clips of students using clickers in classrooms, and numerous

references on how and why clickers work. In particular, see the two page "Tips for successful clicker use" at http://www.cwsei.ubc.ca/resources/files/Tips_for_Successful_Clicker_Use_Duncan.pdf.

A lesson should use clickers in various ways. Some purposes include

- Causing students to think with new knowledge.
- Having students individually commit to a decision before discussing with peers or instructor.
- Committing then discussing (or convincing) peers.
- To learn about the range of opinions that exist in a classroom.
- "Wrap" a video or demonstration with before and after clicker questions (more on this below).

In eosc114 we try to include at least one clicker question every 10 minutes or so. Pointers include:

- Do NOT simply test recollection of what was said or seen in the previous few minutes.
- Clicker questions could be used to assess some prior knowledge.
- Or consider having students apply current concepts in alternative situations.
- Perhaps you could check to determine if assumptions underlying a concept are understood.

VIDEOS: important advice for using videos is given in **Appendix III: Some Lecture Guidelines**.

If you have never used clickers, it is important to discuss their use with the lead instructor, other colleagues who are using clickers, and with any other support people around. Clickers make a big difference to how well students learn (see references on the website above) but they must be implemented properly.

Generating clicker questions:

Clicker questions are intimately coupled to your lecture. Ideas can come from previous instructors or notes you have used in the past. However it is not wise to use exam questions or "self test" questions from the text etc. You might find inspiration from these sources but don't use them directly because they will be highly "de-coupled" from the flow of the lesson.

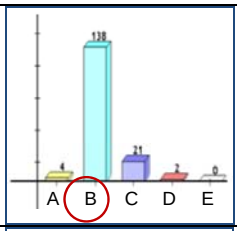
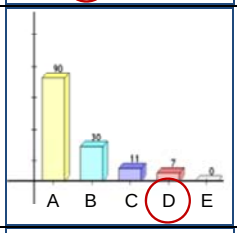
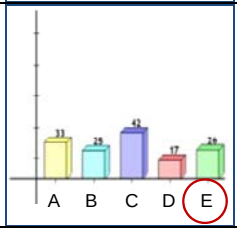
Note that the response patterns of any question should be checked before reusing, whether the question was one you used or one from a previous instructor's set of notes. The team meetings mentioned in "General Guidelines" will involve looking at and discussing clicker question and homework results. Ask if you need help.

Reviewing and improving clicker questions:

Improving your clicker questions will only happen if you review response patterns while you can remember what was going on in class when the question was posed. Build review files with questions plus answer statistics and graphics as outlined in the clicker guidelines. As an example of what can be produced (easily and quickly once you learn how) you should find files that are named like "*clicker results lec1-EQ-Spring09.doc*" in the package received from last term's work.

Clicker response patterns

How should you react in class when students respond? Assuming you are asking "normal" multiple choice questions in which there is a preferred answer, these four generic response patterns can be expected. The correct answer is circled in red. Suggested tactics are given in the table, BUT you should study the clicker resource guide and talk to experienced clicker users to build up some skills. This is not a trivial game for instructors, but well worth getting good at.

TYPE	EXAMPLE	POSSIBLE TACTICS
1. Mainly right		• Start by NOT revealing correct answer. • Ask "*Why do you think someone might have chosen C?*" • Get 2-3 explanations from students, then move on. • Avoid doing all the explaining. • OR … simply say "*Seems that was too easy – lets move on …*", THEN re-evaluate what this question was for next time you use it.
2. Mainly wrong		• Do not necessarily reveal the answer right away. • Ask "*Why do you think someone might have chosen A?*" Then again for "B". When misconceptions are discovered, use them as a positive source of inspiration for discussion or explanation. • OR … You could carry out a mini lecture or demonstration & then have students vote again.
3. Bimodal		• Focus on BOTH preferred answers to reveal source of misconception without revealing answer – yet. • Otherwise, consider similar tactics to type 2.
4. Random		• Ask "*Can we eliminate any of these choices?*" • OR … "*Lets see how you are making decisions …?*" • Same tactics as type 2.

NOTE the possible tactics may not be appropriate for *survey* or *opinion* type questions, or for questions where there is more than one correct response, or all responses are intentionally wrong. If you use either of these types of questions (more than one right, or all wrong), do it regularly (even if rarely). Don't do it only once – students will see that as "playing tricks". They don't like that.

6. EOSC114 Homework

Students know the benefits of practicing use of new knowledge and skills. This is evident from feedback they provide in midterm and end-of-term surveying. Therefore students are required to answer some online questions to be answered based upon assigned readings. Principle guidelines are:

1. Weekly homework should be set with Monday morning cut-off dates, except for the first and last weeks, and weeks with midterm exams.
2. Reading assignments must be clearly defined. The course administrator must be given pages and sections well in advance so the course's online reading schedule can be used by students to manage their work loads.
3. Consider providing an explicit opportunity for students to ask a question as part of homework. BUT this requires coordination with the course administrator. A TA might be assigned to forward to instructors a sampling of these questions.
4. Ideally a TA should check validity of automatically marked work, and provide timely summaries of apparent difficulties to the instructors.

5. It is highly recommended that some reference to the homework be made during the week following its delivery. If your section ends midweek then provide some hints for followup to the next instructor.

Just as for clicker questions, the response patterns of all question should be assessed before reusing, whether the question was one you built or one from a previous instructor. This too will be a topic in instructor-team meetings, but you can ask the administrator for homework answering statistics. They are easy to provide from the Vista system. Such followup is a standard part of evidence-based practice; something we should all be striving for in order to constantly improve the course and our own skills.

Aspects you can observe include (for each multiple choice question) % of all students getting it correct, % of the top 25 students and bottom 25 students who answered correctly, a "discrimination" value indicating how well the question distinguished between top and bottom students (larger numbers are "better", negative numbers indicate more bottom students answered correctly than top students – bad!), and statistics on how often each option was selected (questions with several rarely selected options should probably be reviewed).

Where to find questions for homework?

The text (regardless of which is used) will have some instructors resources, either online, or on CD-ROM, or both. These will include question sets for quizzes. Also, the introductions, "objectives", summaries, review questions, etc at the end (and beginning) of each chapter may be helpful. They can a) provide questions that are directly coupled to text content, b) help inspire homework, clicker and test questions, and c) help improve consistency of delivery from one module to the next. (Note that text book instructor resources will also include animations and images from the text, as well as other resources such as simulations, project-like exercises, and so on.)

Alternatives to multiple choice questions are good, so try to be creative. Roland's "select the correct order of actions" question (homework for Fragile System) was implemented as a "jumbled sentence".

However, in the end it is good practice for students to work on MC questions because that is ultimately how they are graded in midterms and finals. Please learn what you can about how to make good MC questions. An excellent set of resources and recommendations can be found at http://teambasedlearning.apsc.ubc.ca/?page_id=163 . See also Appendix IV.

7. Midterms and final exams

Preparing exam questions is a requirement of all instructors. The same issues and recommendations given under homework and clickers (above) hold, but some points specific to examples are:

1. Each exam involves a vetting process, in which TAs gather to review each question. Some "bad questions" still get through, and results may be adjusted in the end to remove effects of questions that were poorly designed.
2. There is a debate between "all new questions every time" versus some degree of recycling. Without taking sides, here are some relevant points:
   a) It is true that excellent MC questions take significant time and practice to build. Therefore it is unreasonable to ask instructors to carry out this task each and every time.
   b) Exam questions will get out eventually, permitting some students to practice on questions that may appear on exams. However, there are hundreds of questions that have been used in the past. Therefore, striving for a balance of old and new questions should make it virtually impossible for a student to memorize all questions that will appear on an exam.
   c) Perhaps practicing on questions that may appear on the exam is an advantage that either no-one or everyone should have.
   d) Exam questions that get re-used **must** be checked for "reasonable" use patterns. Question answering metrics is a large topic with many experts (for example design and analysis of SAT and other American entrance or

qualifying exams) is a big, sophisticated business. For eosc114, midterms and finals for 4 terms (12 exams) were compiled in summer 2009 and results will be analyzed with help from a psychometrics expert as part of CWSEI research. Guidelines based on these will be made available when ready.

3. When midterms are given in class, we usually generate at two versions for each section of the course. DO NOT DO THIS by randomizing the questions because it can be challenging to re-align results for analysis. Generate new versions of exams by shifting all questions down, say 15-20 questions, and putting the last questions onto the front of the exam.
4. Most questions are posed as completely independent, without reference to previous or future questions. This is easier than generating coupled sets of questions. However there are arguments for building coupled questions in which the first asks about some concept, and the second asks about how the decision was made. These are not easy to build but have great value for finding out whether the first question was answered correctly for the right reason.
5. Use of figures is highly recommended. Class time relies heavily on visuals, and to do all the high-stakes evaluation with words only fails to measure all aspects of the learning.

8. Using Teaching assistants

Currently most TAs spend time staffing the Earth Course Assistance Center (ECAC) room. TAs also help with proofreading of exams, and invigilating. They could be involved in observations in class, or for helping with homework that is not automatically marked by the Vista system.

TAs are managed by the eosc114 course administrator and the head TA. These two people should have experience and some history with the course. Some points of note include:

- Use of ECAC is encouraged, but so far (August 2009) it has only been used as a drop in centre. Experience and literature show that drop in centres are not used to support learning unless there are specific tasks that require the one-on-one support that these centres can provide.
- Emails to ECAC are monitored, but the they need to be handled from Day 1 of the term by a dedicated person.
- There is a separate ECAC guidelines document.

Appendix I: Ways to support improvement at thinking / acting like an "expert".

The following are guidelines for students to help them improve their abilities to work with scientific information. Instructors can foster their use, or demonstrate them, during lectures or class activities.

Remember that this will be the only science course taken by the majority of students. Therefore we can have only limited expectations for students becoming more expert-like in their thinking. However, it is probably worth while highlighting when students are "automatically" using such thinking styles. This shows them they can, and do, think appropriately when given suitable opportunities.

1. Experts are good at using a **framework or structure** for their knowledge. Try to fit all your learning into a framework identified by instructors, or your own. For example, think: "Are we talking about observations or explanations? Are we speculating? Must we decide based on likelihood or certainty? And so on.

2. Ideally the learning goals should be based on some explicit framework, and using that framework should be articulated as part of the learning goals.

3. Behaviors that help when working with scientific information
    a. Be willing to try things that might fail, because you can advance your learning by analyzing why/how you failed. Progress was never made by getting it "right" all the time!
    b. Information makes more sense if you place it within a broader context.
    c. "Brainstorming" with colleagues is a powerful tool for refining ideas and understanding.
    d. Aspects of dealing with problems / issues:
    1) identify the issue, or state the problem; 2) list what you need to know; 3) find commonalities.
    e. Look for meaningful patterns of information.

4. Numbers and values
    a. Use common metrics.
    b. In physical sciences, the metric "value" always includes numbers and units.
    c. Dimensions (units) give information about relationships.

5. Common "standard practices":
    a. Some phenomena must satisfy budgets (such as a heat budget). Budgets can help you anticipate the constraints on a system.
    b. Equations are just a shorthand notation for concepts we can describe in words. They are like the sheet-music of science.
    c. The limits, boundaries, or edges of a concept help define and constrain it ... and help you understand it.
    d. Organize your knowledge to aid deep understanding.

6. All instructors should feel free to point out additional in-class experiences (for example while working on clicker questions) during which students are given opportunities to use "expert thinking". Highlight these with the "Insights" icon (light bulb), but it is probably better to avoid the term "expert thinking".

Appendix II: Some pedagogic principles (Ask an STLF for references.)

1. The brain cannot be simply "filled" – learning happens as result of **working** the brain.
2. Cognitive overload will prevent learning. One new concept every 10-15 minutes is plenty.
3. Motivation is key. No motivation = no learning, regardless of all other aspects.
4. Keep in mind both intrinsic vs. extrinsic (eg. self vs. grades oriented) motivation.
5. Prior learning is crucial, sometimes called foundational knowledge. No person has "no prior knowledge". AND, misconceptions must be found, otherwise further errors in understanding will result.
6. Provide frameworks to help with construction of knowledge.
7. Active effort is crucial. Passive behavior produced very limited results.
8. Students must apply effort related to the concept – simply hearing about 4-5 new complex concepts during 50 minutes of passive sitting does not support learning.
9. Feedback is crucial. Students cannot try harder or differently without help with identifying what's working and when they are off track. They will get better as their education progresses – but it doesn't come instantly!
10. Good study habits must be learned and can be taught. Many students in eosc114 are only 18 years old and have no idea what is needed to succeed at university.
11. Learning is essentially a social activity. However, supporting "groups" or "teams" in classes is non-trivial.
12. Developing "transfer skills" (ability to apply in new contexts) is challenging.
13. Target all levels (consider Bloom's taxonomy) and domains of learning (cognitive, skills, attitude - consider "heads, hands, hearts").
14. http://www.cwsei.ubc.ca/resources/index.html has many evidence-based pointers about teaching and learning.
15. No pedagogic strategies are trivial nor the answer to all problems. It is possible to do more harm than good if a "great idea" is tried without doing it right. Ask for wisdom from colleagues or teach/learn support staff.

Appendix III: Some Lecture Guidelines

These are neither comprehensive nor complete. They are a starting point. Please make use of EOS-SEI teaching and learning fellows to test-run lecture sequences, clicker questions, homework, exam and other questioning issues.

1. **Appendix IV** contains some "best practices" for using PowerPoint.

2. Provide reminders of goals / structure / framework frequently. HOWEVER, don't waste lots of time summarizing in detail at the end of each lecture period – students "tune out" if you dwell on these.

3. Remember "cognitive overload". Give students opportunities to USE new ideas frequently (eg clicker questions) but make sure you include some form of feedback so students aren't "using" ideas blindly.

4. Where ever possible, try to relate current topics with content & activities in other modules. That means you have to know what is being discussed in the other modules! So please communicate with all other members of this course's teaching team.

5. As much as possible, try to avoid seeming distant and removed from students.
    a. Most students sit in back half of a large lecture theater.
    b. Use the microphone and instructor's clicker so you can wander around the lecture theater as you talk.
    c. If you ask open questions, count slowly to 10 before refining the question. But do not just answer the question. No one will ever choose to respond again because they know you will answer for them.
    d. Ask occasional quick "show of hands" types of questions – something quicker than a clicker question. One format that works is *"If I asked an exam question about xyz, how many would not be confident about …"*. This is easier for students to answer honestly than "Does everyone understand?", which nearly always results in blank stares.
    e. Consider starting the class period with "Any pressing questions?"
    f. Watch for unsolicited questions (hands up) and respect them.

6. A good questioning paradigm is to ask "what do you **perceive** about ... this video/image/graph?" some options for using clickers with such a question are: "How many *xyz* do you perceive?" or "How often do you see *xyz* happen?" or "What happened when *xyz* ?"; all with multiple choice options.

7. Do not ask "trick" questions which distract the attention from the main point.

8. Use lots of video
    a. Search and use Youtube.
    b. Include several per lecture.
    c. Include some no-stress questions.
    d. IMPORTANT: students need to have a stake in what's shown. Make them predict, take sides, whatever.
    e. For a useful form of followup question, see "A good questioning paradigm is …." above.

9. **More on videos:** Having students commit to a judgment **prior** to seeing a video or demonstration helps motivate them, and directs attention towards the key concept in the video or demo. Therefore consider using a pre-post question pair to get students to commit individually to a decision or choice before the video or demonstration. Show the responses to the initial question but DO NOT discuss yet. Show the video. After it's over, ask the question again (or something similar or related). Discuss results or have peers discuss. This pattern is based on research about what makes demonstrations beneficial. Simply showing a demonstration or video is usually only useful as entertainment. It's all about motivation, commitment, well-directed thinking, and assessment that helps make learning happen.

10. As noted above, ask an STLF for input or feedback. Having someone visit a class and provide observational feedback on how the lesson went, how the clicker questions worked, or other aspects of the class is always very useful regardless of your experience and confidence (or lack thereof!)

11. **What about providing "extra material"?** If it is important, learning goals must say so. Then, the concepts must be assessed, otherwise students will not treat it as important. THEREFORE, do not include extra content with the necessary material. You could include pointers and references, but you should put material that is *supplemental and therefore not assessed* into a separate place.

Appendix IV: Some "best practices" for using PowerPoint.

Modified from http://www.turpincommunication.com/articles/pptbestpractices.htm

Tips on **developing** PowerPoint presentations

- **How many slides?** 1 per minute is too fast. Therefore: for a 50 min. lecture, 4 mins for setup/close out + ~4 for video + 4 clicker questions x avg 3 minutes each = ~15 slides. Or, consider ~30 as the absolute maximum if you include an opening slide, goals or topics lists, and if your slides are very sparse. (Note that 3 mins for each clicker question should be **average**. "Easy" clickers are faster (but less useful); more involved ones with peer discussion and pre-post, etc., will be slower.)
- **How much on each slide?** No more than one thought, unless they are content lists. Sparse is good. Very sparse means more slides – just remember you should only be spending less than 30 minutes actually referring to slides. The rest of the time students should be actively involved in some way.
- It is not bad to include slides with introduction, closing remarks, and intermediate reminders of goals or outlines. HOWEVER don't dwell on these – students tune out when they show up. But seeing them helps communicate a sense of structure to the material.
- Treat the heading of each slide as valuable real estate. Make your headings specific and meaningful.
- The smallest letters on any slide should be at least 24 points.
- Slides always look better on your computer than they do on when projected. Some pointers are: i) Avoid subtle colors. ii) Always increase brightness of photographs. iii) Do not rely on color to make a point. iv) Recall that 7-10% of males are red/green color blind (http://en.wikipedia.org/wiki/Color_blind).
- Avoid graphics that are NOT related to the message. This includes textured backgrounds.
- Try to ensure that print versions are equally readable.
- Less is more. Use single words or phrases rather than sentences or paragraphs. Your bullet points are there to remind you what to talk about, not tell the whole story.
- As you mercilessly edit your slides, cutting away every word that is not absolutely necessary, say to yourself, "My slides are not a *script*. I will not read my slides. My slides are not a script."

Tips on **delivering** PowerPoint presentations

- Take the time to set up each slide. Your explanation of a slide should begin with an overview. Tell people what they are looking at—even if you think it's obvious, even if it's a list of bullet points. BUT don't just read them.
- Pause before moving to a next slide. You might feel awkward, but you will sound great.
- Look at the slide when you want your listeners to look at it. Look at your listeners when you want to draw their attention away from the slide.
- Use the whole room – walk around, use a remote slide advancer and pointer if you can. Try to reduce the "barrier" between you and the students.
- As you deliver your presentation, especially when you're deep into the body, assume that your listeners are thinking, "What does this have to do with me?" or "Why should I care?" This will remind you to keep your explanations short and relevant.
- Visual aids in your presentation are meant to back you up as you engage your audience in a structured conversation.

Appendix V: Regarding new terms and scientific jargon

Adapted from C. Wieman, February 26, 2008:

"I spent a couple of days trying to find answers to questions about learning technical jargon a couple of years ago. **The quick answer is that I could not find anything**! I am convinced that this is a major unexplored area for science education research. From research of my own group and others, I am convinced that the technical language is a major impediment to the learning of science {ed- especially when the "technical jargon" involves normal words that have been given new meanings by the experts. All disciplines have this problem.}

Finding no research on the subject, I asked **John Bransford (of How People Learn)** what he could tell me. He did some early work on language. He sent me a long reply, but brief summary was he did not know of research on learning technical jargon, but **some basic things about learning languages likely apply. Namely, to learn jargon, students have to practice using it in authentic discourse repeatedly and regularly, just as they would learn a foreign language**. It also would likely help them learn if they had to explicitly explain what the terms meant in their own words, perhaps to a younger sibling for example.

Also, I am confident that **cognitive load issues** are highly relevant to use of jargon. In other words, every new jargon term that is introduced in a class period will demand a heavy price in terms of thinking and "brain space". **For each new term, there will be roughly 14% less working memory available for student to use to learn anything else in that class.** So you can be pretty confident that instructors should avoid introducing any jargon in lecture that is not ABSOLUTELY necessary. The cognitive load demands mean that any course that is introducing a lot of technical terminology effectively becomes a terminology course, whether you like it or not. There is just not enough brain left to learn anything else. This is why I advocate that any time you are establishing learning goals for a course, the **technical terms you want students to know are listed as explicit goals**. That helps one focus on what terms are essential and have to be covered, and implicitly also identifies which are not essential, and hence should not be used. You can also be pretty confident that **any jargon that is introduced to students, but they will not be called upon to use regularly after the course is over, they will very quickly forget**. So there is a very real waste of time and energy in using a nonessential jargon term. Students will not retain it, and it will reduce what they learn.

So in a course like eosc114 where the students will not be using terminology from that course in a subsequent course, I would advocate actually not introducing ANY jargon. In a class where there is jargon that you want students to learn, I suggest having them review and have to answer some questions about the terms before coming to class. I have not done any research proving this works, but it seems likely that it will reduce the cognitive load when the term is used in lecture.

Carl.

P.S. I should have added that, although I never gathered quantitative data on it, when we started using clicker questions where students had to discuss with each other, their facility with the language of physics dramatically improved. In retrospect, it should have been obvious that this would happen.

Appendix VI: R. Stull's instructions for writing exam Questions

- Each question must be numbered.
- There should be only 1 correct (best) answer for each question.
- Answer choices should be labeled with upper-case letters A) thru E), because the Scantron form uses upper-case.
- Always have 5 reasonable answers (A-E). Avoid True/False, or other questions that have only 2 or 3 reasonable answer options.
- Do not create answer choices that are obviously wrong, such as
- "The discoverer of plate tectonics was:
  A) Santa Clause B) the tooth fairy C) …"
- Avoid answer options such as: … D) all of the above E) only A & B.
- For number or size answers, put the answer choices in ascending or descending order. A good example is:
- "A decade is ___ years long. A) 1 B) 2 C) 5 D) 10 E) 100."
- Don't write a question where grammar gives away the answer. A badly worded question is:
- "The main cause of death at Galveston Texas in 1900 was from a:
  A) tornadoes B) lightning bolts C) traffic jams
  D) storm surge E) hurricane parties".

  This problem is easily fixed by including the pronoun with the answer:

  "The main cause of death at Galveston Texas in 1900 was from:
  A) tornadoes B) lightning bolts C) traffic jams
  D) a storm surge E) hurricane parties".
- If the right answer must be fairly long, then make at least one wrong answer longer.
- Try to make a lot of the correct answers be D) or E) or A). Namely, be sure that the correct answers are evenly distributed among A thru E.
- Don't create a question that gives away the answer for some other question.
- Never write questions that are vague.
- Each question should be worth 1 mark. Don't give different weights to different questions for the multiple-choice part of the exam.
- Make some questions that are easy for almost everyone to answer, and others that only a few of the brightest students will likely answer. Put a few of the easy questions first as a confidence builder.
- You can write questions that require the student to analyze a graph or diagram, or plot data, before they can select the correct answer.
- For a 50 minute exam period, the test should have 50 questions. For a 2.5-hour final exam, plan for 100 questions. For a course with 2 midterms plus a final exam, this works out to about 4 to 5 questions per day of lecture, plus 3 to 8 questions per chapter of reading. ALL exam questions should be based on the learning goals from the lecture. If you find you want to ask questions that are not related to the learning goals, then be sure to change the learning goals for future lectures.
- Always write very clear instructions at the beginning of the exam (see example below). Also, for the first Scantron test of the term, make a transparency of the scantron sheet and show it to the class at an earlier class

meeting, and tell them: what parts of the Scantron form to fill out when they take the test; about the need to fill in the blocks carefully with no stray marks; the need to use pencil so the student can erase mistakes cleanly.

- Always have one other person (or even better, a group of people) besides the question author review each question carefully. The reason is that authors of questions often have an answer in mind when they create a question, and are often unable to recognize that either the question is too vague to lead to the right answer, or that more than one answer selection might correct.
- After creating the semi-final draft of the test, check to see that each question is numbered consecutively, and that there are no questions that accidently have two or more answers labeled with the same letter.
- If you need to create multiple versions of an exam, so that students can't copy from their neighbor, then do it by first creating one master test, and then create the other versions by shuffling a block of questions from the beginning to the middle or end. This ensures that every student has a test of exactly the same difficulty.
- Be sure to clearly label each different version of the test as Version A, Version B, etc.
- Be sure that the student indicates the test version on the Scantron answer sheet.

  For the 200-question form, there is a separate region of the form called "TEST FORM". You can find it just left of questions 1 - 7.
- When you have finished creating all the test versions, then answer them yourself and fill out scantron forms as answer keys, using a separate scantron form for each test version. These answer keys should be scanned along with the students' scantron forms.
- To help ScanScore identify which scantron sheet is an Answer Key, write "ANSWER A" (or B or C etc) in the name field, and fill in the appropriate blocks in that name field.

Exam Instructions: Closed book. No calculator. Don't cheat. Indicate all your answers on the Scantron sheet. Only the Scantron sheet will be marked, but turn in both the Scantron (answer) sheet and this question packet. Put your name and student number (I.D. Number) on both the Scantron sheet and question packet. There is only one best answer for each question. Don't leave any questions unanswered. It pays to guess if you don't know the right answer. Good luck.

Appendix VII: Learning Goals matrix for eosc114

		A. For earthquakes, volcanoes, landslides, storms, waves, and						B. We will strive to:				
	Course level goals are horizontal ==> Department goals are below in this column. Some cells have examples in "comments".	1. Learn how they work.	2. Locate dangerous places where they often occur	3. Learn ways to observe and monitor them.	4. Find out why it's hard to forecast them.	5. Learn what you and your community can do to prepare for them.	6. NON-SPECIFIC FUNDAMENTALS	1. Empower you to be a survivor.	2. Enable you to approach new challenges insightfully.	3. Sharpen your observations of nature.	4. Stimulate your excitement in our planet.	NOT YET COVERED
Students taking a service course in EOS will learn about …												
A.	the spatial and temporal scales at which Earth's processes operate.		✔		✔							
B.	how Earth changes through time.	✔										
C.	Earth's materials and their properties.	✔										
D.	Earth's systems and complex interactions.	✔										
E.	how Earth and humans are inextricably linked.					✔		✔				
F.	the methods earth scientists use to collect and analyze evidence.			✔						✔		
G.	how to use evidence to evaluate earth science concepts and draw conclusions.								✔			
Students taking a service course in EOS will develop their abilities to …												
A.	read, visualize and interpret spatial representations of Earth science data.			✔					✔	✔		
B.	apply high school level math and science skills to real world settings.	✔							✔			
C.	distinguish among evidence (data), models, assumptions, hypotheses, theories, interpretations, and predictions / recommendations in non-specialist readings or other media.				✔							
D.	reason with incomplete information.								✔			
E.	reason with and/or evaluate multiple working hypotheses.	✔							✔			
Regarding habits and attitudes …												
A.	Service courses in EOS should actively help students to employ appropriate learning skills for the Earth, ocean or atmospheric sciences, including:											
	i. identifing and using learning goals for the course, module or lesson;	These are covered via the learning goals for each individual lecture										
	ii. applying good team member and leadership skills;											
	iii. consciously assessing progress and modifing study actions;											
	iv. using feedback from instructors, peers, and/or self-reflection.											
B.	Service courses in EOS should actively help students to consider science as an ongoing endeavor that embraces curiosity, creativity and societal needs, and is not just a set of facts.					✔		✔	✔	✔	✔	
C.	Service courses in EOS should actively help students recognize and experience two approaches used in the Earth system sciences, including:											
	i. historical, descriptive, systems-oriented approaches;		✔									
	ii. reductionist approaches such as use of controlled experiments.	✔										
D.	Service courses in EOS should actively help students to ask "How do we know?", "Why do we accept it?", and "What is the evidence for …?".								✔	✔		

Appendix VIII: Generating and reviewing i>clicker results

Like all effective science and teaching, outcomes will improve when work and results are reviewed and steps are taken to improve based on what's learned by that review. This summarizes how to process and deliver clicker question results using the *i>clicker* system in use at UBC. Two simultaneous objectives are (i) minimum steps for each of the "n" instructors in our team, (because "n" people will do it "n" different ways), and (ii) maximum efficiency of the consolidation step by administrator.

Summary:

- At the end of their module, instructors need to produce one "UploadFile.csv" file for each lecture section. Please do NOT combine data from two course sections (eg section 101 and 102). Each "UploadFile.csv" file should contain accumulated clicker results from all lectures in one module for one course section (eg all "volcanoes" clicker results for course section 101). Be sure to rename the "UploadFile.csv" to something useful like "*volc_cresults_s101_fall08.csv*" otherwise someone will have to waste time figuring out who's files are who's.
- The administrator will have to combine all these data anyway, and it is easier to connect student numbers and names to clicker serial numbers, handle students who have not registered their clickers properly, calculate percentage grades, etc. all at once. If instructors do any of these steps, then the administrator ends up with a range of different types of data in different formats – it's harder to sort out than to process "raw" data.

Before using *i>clicker* in class:

These are recommendations. Details about which values to use may be modified by the lead instructor.

1. At the start of an eosc114 term, set ***i>clicker*** preferences for:
   - Number of participation / attendance points per session = 1.
   - Participation requirement = "very Lenient".
   - Performance Points:
     - Number of performance points for each question = 0.
     - Additional points for each correct answer = 1.
     - Cap performance points = No.
2. When setting up ***i>clicker*** in class, DO NOT set ***i>clicker*** to "output format = Vista". It causes ***i>clicker*** to try connecting to vista every time you perform an export function.

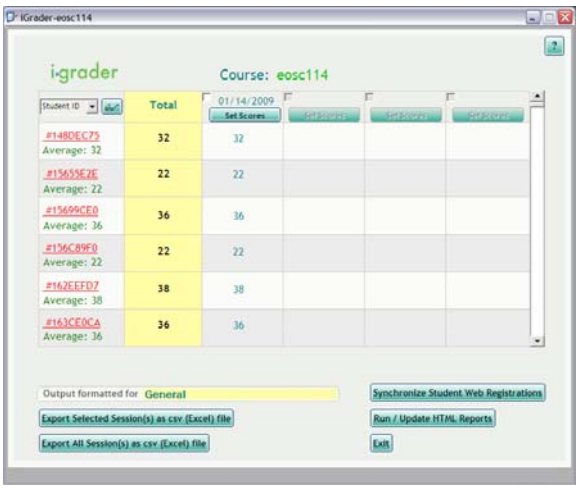
During lecture when using *i>clicker*:

Where possible, specify the correct answer during lecture by first displaying the histogram of responses using the "B" button, and then hitting the "E" button multiple times on your instructor's ***i>clicker*** to cycle to the correct answer before hitting the "B" button to close the histogram and save the answer. (But if you don't indicate the correct answer during lecture, or if more than 1 answer is correct, you can always change it later. So no worries.)

Instructor's workflow for producing Clicker results and delivering to course administrator.

Derived from procedures of Fall 2008, these do NOT explicitly take into account for multiple sections of a course.

1. Setup:
   a. Note that ***i>grader*** is very particular about how file names and folder names are used.
   b. The following steps assume that all your clicker data (ie results of clicker use in all lectures) were collected with the same computer and using the same installation of *i>clicker* software.
2. Run *iGrader.exe*. Then, for each lecture date (i.e. column) shown in the *i>grader* window (figure right):



a. Click on the "set scores" button. A new "set scores" window will appear. Focus on the third section (bottom half) of that window.
b. For each question in that session:
   i. Use the "**View Screenshot / Image**" button to display the image of the computer screen that was captured when the clicker question was run in the class. (NOTE this will only work if all data were kept where it was automatically put when clickers were used in class. If it does NOT work, it is probably because the images captured during the lesson can not be found in the correct "images" sub-folder.)
   ii. In the "Points" boxes under each of the A, B, C, D, E, options, enter the appropriate value.
   iii. If you assign 0 marks for wrong answer participation, and 1 marks for correct answer, make sure the two values under "Participation and Attendance Points" both equal 1.
   iv. If more than one answer is correct, such as for a survey Q, type in the appropriate points under **each** of the response ABCDE headings.
   v. Use the green **<Previous | Next >** links to repeat for the next screen shot, until finished with the lecture session.
   vi. IF THE QUESTION IS TO BE IGNORED click the "**Delete This Question?**" "**Yes**" button. This does not delete the question, it simply leaves the corresponding data out of final tallies.
c. Click the button: "Set and Close" to save your results
d. Click on the next column header to repeat the process until the grading schemes for all sessions (columns) have been checked.
e. NOTE if there are more than 4 sessions there will be a horizontal scroll bar under the columns.

3. Be sure to keep track of exactly how many points are possible for each data set. **For example**, if there were 3 clicker questions per day for a 4 day module there will be 12 questions and a total of 1x12+4=16 possible points. This example accounts for both participation and bonus points.
4. Proceed only after you have "set scores" for all sessions.
5. Click the checkboxes to select all those sessions that are part of this data set (above the "set scores buttons").
6. Now use the "**Export Selected Session(s) as csv (Excel) File**" button. Select "Student ID only", then click the "**Export**" button.
7. Find the resulting file called "*UploadFile.csv*" in the same folder as the *i>grader.exe* program. Rename it to identify where it comes from, and Email a copy of this file to the E114 administrator, ALONG WITH the max. number of points possible (item 3 above).

   NOTE: for eosc114, using the "*Synchronize Student Web Registrations*" button in ***i>grader*** is not necessary at this step. The administrator will do that as a last step so that it only has to be done once.