What all Instructors Should Know

**Motivation is important for learning and is an essential part of effective teaching**¹

- Show that the subject is interesting, relevant, valuable to learn, worthwhile, fun, ... Remember that most students do not have the benefit of your experience and perspective.
- Convey that subject is challenging but all students can master it with effort, and why it is worth the effort.
- Convey that you care about all students’ successfully learning the material.
- Avoid: scare tactics, such as saying subject is really difficult; many students will fail, etc. These turn out to be demotivating to many students.²

**Think of yourself as a ”coach of thinking” rather than an as a "dispenser of information"**

"Learning" requires intense mental activity with resulting changes in the brain of learner.³

**Feedback that is timely and specific is critical for learning**

- Timely, frequent, detailed feedback that shows how to improve (“formative assessment”) should be provided for all students.
- Give marks for what you value (homework, reading, in class participation, quizzes, pre-tests, ...). For most students, marks define the expectations and what is important in a course.²

**Teach students how to learn**

- Explicitly model expert thinking, being careful not to skip steps that are now automatic for you. Convey how to best learn the material and skills, teach students how to study effectively and what is required for conceptual mastery and retention.³,⁴ These are fairly readily acquired skills that are seldom if ever taught.
- Know & teach using the best (proven) practices for achieving learning.¹, ⁵

**Dos and Don’ts for the first week**

- Explain why you are teaching the way you are teaching, why course is worthwhile, what are your goals and expectations. The first classes set the tone for the rest of the term.
- Explicitly work to establish a desired class culture.
- Don’t threaten or apologize for what or how you will teach.

**Find out what all your students are thinking; recognize they think differently than do you**

- Connect to and build on their prior knowledge, explicitly examine student preconceptions.¹, ³
- Probe understanding and adjust teaching as appropriate when find many are not getting it.

**Lay out framework, goals, & context for the knowledge & skills you want students to learn**

- Teach the organization and application of the knowledge, rather than just the facts. This is the vital element of mastery that students have the most difficulty perceiving and mastering.⁶

**Approach teaching as a challenging subject that can be mastered**¹,³,⁴,⁵

- The ability to teach effectively is not innate – it can be learned much like a scholarly discipline.
- Understand how people learn and what processes facilitate learning-- these are understood.
- Don't be afraid to copy what works. Use teaching practices that have been proven to be effective; they are readily replicated.

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² CWSEI and CU-SEI student interviews and focus groups, as well as other studies.


⁴ CWSEI guidance for students (www.cwsei.ubc.ca/resources/student_guidance.htm)


⁶ refs. 1, 2, 3, and 5, and many other studies.
Specific strategies for instructional activities

This document gives strategies to achieve the essential elements of effective learning, motivation, practicing to master expertise, feedback etc. You should apply these strategies to all the course components. Most of this material is summarized from the excellent book, *How Learning Works: Seven Research-Based Principles for Smart Teaching*.\(^1\) It is recommended that you buy that book, as it provides more detailed discussion.

- Motivation
- Developing mastery
- Practice & feedback
- Creating self-directed learners
- Creating productive views of intelligence and learning
- Memory and retention

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Motivation

Student motivation is a key ingredient in a successful course. Two major components of motivation, as identified by Ambrose et al., are

I. The expectations that students bring to the classroom, and
II. The value that students place on the course material and tasks.

Ways to address students’ expectations:

1. **Set attainable goals.** Students are best motivated when they feel optimally challenged – when the course and assignments are challenging, but students feel that they can be successful with some effort.

2. **Let students know your expectations.** Communicate your course goals, and how students can achieve those goals. Align instruction and assessment with those course goals – so that students can practice, and see whether they are achieving those goals. This helps to establish realistic expectations. The use of grading rubrics can help make your expectations of student performance on a task very explicit.

3. **Give students feedback.** Without feedback on their performance, students may lose sight of their progress towards a goal. Feedback is most effective when it is timely (i.e., without a long time delay), targeted (i.e., focused on a specific student performance on a specific task), and constructive (i.e., focusing on strengths and future action as well as weaknesses).

4. **Give students a sense of control and self-efficacy.** Self-efficacy is a very important ingredient to student motivation. Provide students with opportunities to feel successful early in the course. Be sure that your grading standards are seen as fair across students and over time. Provide students some flexibility and choice (for example, on assignment topics). Giving feedback on student progress towards well-articulated course and assignment goals can also enhance students’ sense of efficacy and control. Also, help students focus on things that they can control (such as study habits), rather than personal characteristics (such as intelligence). Avoid threats and framing your course as competition among students, as these are typically demotivating.

Ways to address students’ value of the material:

1. **Highlight the relevance of material and tasks.** Students are motivated to engage with material that relates to their personal interests, everyday lives, and academic or professional paths. Show students how these skills and ideas will relate to future courses and careers. Create assignments that are authentic and relevant; ensure that homework problems can pass the “Why should anyone care about the answer to this problem?” test.

2. **Get students to reflect on what they have learned.** e.g., ask students to write a short paragraph on what they learned from a class or an assignment, and how it applies to an interesting or important problem.

3. **Be enthusiastic.** Your own passion and enthusiasm can be a powerful motivator for students.

For more information about how to effectively use motivation in your teaching strategies, see Chapter 3 of How Learning Works (Ambrose et al.), and CWSEI 2-pager: Motivating Learning at www.cwsei.ubc.ca/resources/instructor_guidance.htm.
Developing Mastery

According to Ambrose et al., in order to develop mastery, students must acquire component skills, practice integrating them, and know when to apply what they have learned.

Ways to help students learn key skills

1. Get broad perspectives on necessary student skills. Decompose tasks by asking, "What would students need to know / know how to do in order to achieve this task?" Use your graduate student assistants in this endeavor, as they more recently struggled with this material. Your colleagues are also good sources of information about necessary student skills, as are professionals outside your discipline.

2. Identify weak/missing skills and help students practice them. Early assessments (e.g., a diagnostic test of expected prior knowledge), as well as thoughtful analysis of student performance on assignments, can help you identify missing skills. Depending on the number of students exhibiting this lack of mastery, you can either devote class time and resources to the issue, or provide other resources. Create opportunities for students to work on their mastery of those skills. To address inaccurate prior knowledge (e.g., misconceptions), have students make and test predictions, and explicitly address any inconsistencies.

Ways to help students become more proficient

1. Give students opportunities to practice. As with other teaching practices, communicate your intent about the practice opportunities, and make your expectations about students' achievement level explicit.

2. Use productive constraints to reduce cognitive load. While practicing a skill, it can be helpful to reduce cognitive load by (a) calling students' attention to the key goals and features of a task (so they are not distracted by extraneous features) and (b) simplify tasks to hone in on key skills. Once they become more proficient, the complexity and scope of the task can be increased.

3. Assess students on their proficiency. Test students on how well they have integrated the components of complex tasks. This provides alignment between your goals, instruction, and assessment, and gives students feedback on their progress.

Ways to help students learn when to apply their knowledge

There are a wide variety of strategies for helping students learn to transfer ideas to new contexts, which are described in more detail in Ambrose et al. For example:

- Discuss the contexts and conditions in which a skill or approach is applicable, and give students practice in doing this. For example, ask them "Which statistical technique would be used to solve this problem?" or "What questions could this research method be used to investigate?"
- Ensure that students practice skills and understanding in many different contexts.
- Encourage students to generalize ideas from a specific context to a broader principle.
- Make use of structured comparisons to help students identify critical features. For example, you might give two problems that appear different, but use the same underlying principle.
- Give prompts to help students make connections between their knowledge and a new problem. For example, "Think back to the bridge we discussed last week."

For more information about how to help students develop mastery, see Chapters 1, 2, and 4 of How Learning Works (Ambrose et al.).
Practice and Feedback

Practice aimed at achieving specific goals and feedback on progress are critical for learning.

Ways to give students goal-directed practice

1. **Explicitly identify and communicate goals for students.** Make your expectations clear—both for student performance in the course overall, and on a given task. These goals can help guide their practice, especially when these goals are stated in terms of what students should be able to do at the end of an assignment or a course. Then, use rubrics to more specifically define performance criteria for a particular assignment.

2. **Support students in productive practice.** Give students multiple opportunities for practice (readings, quizzes, in-class activities, homework, etc.) so that they can develop skills and receive feedback. During these assignments, scaffold students’ development by giving students more support early in learning (e.g., by breaking a task into parts for them), and later remove these supports. Create realistic expectations about the amount of practice required by giving guidelines for the amount and type of practice that will be needed. Instead of guessing how long it will take students to do a task, gather data by asking students how long it took them (e.g., the last item on a homework set could be: How long did it take you to do this homework?).

3. **Give students positive and negative examples of performance.** What would ideal performance look like? What types of work would not meet your goals?

4. **Modify your criteria as your students become more proficient.** Early in the course, determine an appropriate level of challenge by conducting an assessment of student knowledge. As students progress through the course, refine your goals to meet their changing proficiency.

Ways to give students targeted feedback

There are a wide variety of strategies for giving students feedback, which are described in more detail in Ambrose et al. For example:

- **Provide feedback to the class** as a whole about common errors (you can look for common errors in homework or tests, listen in on student discussions during in-class activities and problem solving sessions, etc.).

- **Focus your feedback** on key elements of the task, so that students are not overwhelmed.

- **Communicate about strengths as well as weaknesses.** If students have made progress, point that out to them—people are often unaware of the progress they are making.

- **Give frequent feedback,** made possible through use of frequent, smaller tasks.

- **Give real-time feedback.** Collecting group responses through colored cards or clickers lets you give feedback to the whole group.

- **Use student-to-student feedback.** Explicit guidelines can make student comments on each others’ work even more valuable.

- **Have students reflect** on the feedback. Require students to incorporate feedback into later work or have them explain what they did wrong. Example from Carl Wieman’s teaching: each homework set starts with “Q1. Select a problem from the last HW set that you did incorrectly and explain what you did wrong and what should be done differently to obtain correct answer.”

For more information about how to give students opportunities for practice and targeted feedback, see Chapter 5 and Appendices D & H of How Learning Works (Ambrose et al.).
Becoming Self-Directed Learners

According to Ambrose et al, in order to become self-directed learners, students must learn to assess the demands of the task, evaluate their own knowledge and skills, plan their approach, monitor their progress, and adjust their strategies as needed.

How to help students learn to assess the task

1. Communicate the nature of the task and check understanding. Express the goals more explicitly than you might think is necessary, and what students will need to do in order to successfully complete the task. Check students' understanding of the task, and give them feedback on their understanding – for example, you might have them express the goal of the assignment in their own words. Be sure to tell students what it is that you do not want as well, by showing common student errors in the past.

2. Give students criteria for success. Share the criteria that will be used in student evaluation – for example, with a checklist or performance rubric. This helps students generate realistic understanding of the task, as well as learn to monitor their progress towards success.

How to help students evaluate their knowledge

1. Assess early and often. Periodic, timely assessments give students opportunity to get practice and feedback so that they can determine where their strengths and weaknesses lie – in time to make corrections before the exam.

2. Have students assess themselves. Reduce your grading burden by giving students tasks and have them check their own work using answer keys.

How to help students plan their approach

1. Provide a plan. Scaffold students' self-planning approach by providing them your own model for effective planning. This helps them see how a complex assignment might be broken down into pieces or plotted out over time.

2. Have students create plans; provide feedback on students' plans. Students might submit their plan as the first part of a complex assignment. This forces them to externalize their thinking, and gives you the opportunity to give them feedback on that plan.

3. Compare and contrast strategies. Problems or tasks can be approached in multiple ways; use of different strategies can help students understand the relative merits, particularly if they are given the task of explicitly determining advantages and disadvantages of different approaches.

How to help students learn to monitor their progress

1. Model metacognition. Walk students through your own approach to a problem or assignment, identifying different steps and questions that you would ask yourself to check your progress (e.g., "Am I making reasonable assumptions?").

2. Provide strategies for self-correction and reflection. Students can ask themselves, "Is that a reasonable answer?" "What assumptions am I making?" or "Is this task taking me too long?" Students can also benefit from reviewing classmates' work, especially when given a rubric.

For more information about how to help students become self-directed learners, see Chapter 7 and Appendices A & C of How Learning Works (Ambrose et al.).
Beliefs about Intelligence & Learning

According to Ambrose et al, these beliefs have a major impact on student motivation, choice of learning strategies and methods, and the achievement of effective monitoring and self-regulation of learning.

1. Discuss the nature of learning. Tell students about the various types of knowledge, from factual recall, to conceptual understanding, to applying those concepts. This can help move them away from an overly rigid view of learning ("you know it or you don't.") Address common misconceptions about learning, to move students away from unproductive ideas (e.g., "I'm not a math person.") Discuss the features of learning discussed in this document, such as the impact of practice on performance. Studies by Dweck and others have shown that a student’s view of intelligence has a substantial impact on their motivation, approaches to learning, and their academic success. Those who have a view that intelligence is fixed ("There are right-brained people good at math and science and left-brained people who are not") are less successful than those who have a growth mindset ("Learning and mastery is achieved through hard work rather than innate talent."). These studies have also shown that such beliefs are quite malleable if explicitly addressed.

2. Encourage students to persevere. If students have unrealistic expectations about how quickly they will learn something, they may not push themselves when they hit difficulties. Discuss how you or others you know had to work to become expert in a field. Focus students on aspects of their learning over which they have control, such as their study habits, rather than external factors – such as their level of intelligence or aspects of the course. This helps to increase self-efficacy and a tendency to work through challenges.

3. Show them the research. Present research on learning showing how particular types of learner activities and practice are necessary for achieving expertise, and how teaching practices that involve greater student cognitive activity demonstrate greater learning. Show benefits of mentally demanding study strategies (e.g., “test yourself on retrieval and application of ideas”, and fully engaged effort to solve hard problems) compared to less effective strategies (e.g., reread and review and practice of easy problems, or split-attention study activities).

For more information about how to address students' beliefs about intelligence and learning, see Chapter 7 of How Learning Works (Ambrose et al.).
Memory and Retention

Introduction – Research on memory
Memory can be divided into two types; the long-term memory which has a large information capacity and can remember information for many years, and the “working memory” which handles memory and processing of new information over periods of seconds and minutes and has a very limited capacity. Information enters (and leaves) the working memory quickly and easily. It is much harder to get information into long-term memory, and accessing it is also challenging due to interference among the different items in memory during the retrieval process. Repeated retrieval and application of the information, spaced out over time, is the most important element for achieving long-term memory. The working memory plays a major role in the mental processing that takes place in the classroom, and other similar time-constrained situations, and its limitations have a correspondingly large impact on learning that takes place in that setting. The human working memory has a remarkably small capacity, typically 4-7 new (e.g. not already in long-term memory) items. The working memory does not just store information, it also carries out basic processing, and so as it is called upon to remember more new items, its ability to process is correspondingly reduced, analogous to a computer with very limited RAM. The very limited capacity of the working memory has profound implications for the design of suitable classroom activities. It means that anything that puts additional demands (“cognitive load”) on the working memory of the student has a cost in what the learner can process and learn. For example, every unfamiliar technical term introduced during a lecture has a significant impact on the capacity of the audience to follow arguments and process the ideas, even if it that term is clearly explained and/or unimportant. Similarly, studies have shown that anything that involves unnecessary input of information or processing during a learning activity has a detrimental effect. Mayer and colleagues have done a series of studies showing how the addition of “seductive details” commonly used by many teachers and textbooks, such as adding amusing anecdotes, attractive pictures, or background graphics that are only peripherally related to the topic, reduce learning.

Strategies to reduce unnecessary demands on the working memory in the classroom

1. Explicitly show how different topics or ideas are linked together, and explicitly show the organization of the class presentation/activities, emphasizing how the parts are connected. This helps the different topics to be consolidated (“chunked”) in the working memory of the students rather than remain distinct, thereby taking up less capacity. Novices often do not recognize these connections that are obvious to experts.

2. Use analogies—this maps complex relationships onto existing relationships already in long term memory, so the working memory needs only remember the link to relevant part of long term memory.

3. Use pictures, even simple sketches, to illustrate spatial relationships, rather than relying on verbal descriptions that must be translated into images.

4. Provide worked examples for initial problem solving. Worked examples show the organizational structure and focus the learner’s attention on key elements, reducing cognitive load.

5. Use pre-class reading assignments and quizzes to have students review definitions and basic examples before class. See Preclass-Reading Assignments; Why they may be the most important homework for your students (www.cwsei.ubc.ca/resources/files/Pre-reading_guide_CWSEI.pdf).

6. Keep the use of unfamiliar jargon to an absolute minimum; remembering each new term has a cost.


**Strategies for Achieving Long Term Retention and Useful Access of Learning**

1. Provide opportunities and encouragement to students to repeatedly test themselves on retrieving and applying material. The more active the cognitive processing involved in this, the better.

2. Make homework and exams cumulative so that students are reusing and thinking about the ideas multiple times in the presence of new material. Explain why this supports learning.

3. Provide multiple associations (“hooks”) between material to be learned and material already in the students’ long term memory.

4. Avoid covering material in a separated sequential fashion, where each topic is covered and tested only once and not revisited. While conducive to a well-organized syllabus, this is not conducive to useful learning. Students need to build broader associations and to practice sorting out interference between topics when accessing ideas in long-term memory. The additional cognitive processing required to sort out and suppress erroneous interference when studying interleaved topics acts to suppress such interference when accessing information in the future. Too often students will learn and retain that some concept or solution method is associated with Chapter 4, covered in week 6, but they will not develop the useful expert-like associations of the material with a suitable range of contexts, concepts, and problem types that will facilitate the desired access from long term memory.

5. Provide practice activities that explicitly build specific “expert” associations—those commonly recognized and used by experts. Have an assignment that asks students to explain all the ways a new solution method or principle might be used to solve problems associated with topics encountered earlier in the term. Have the students generate general criteria for deciding when this material might be useful.

References on memory and retention:


Recommendations for implementing specific instructional practices

The rest of this transformation guide provides guidance on a variety of instructional practices, both in and out of the classroom:

- Creating and using effective learning goals
- First day of class
- Better ways to review material in class
- Basic instructor habits to keep students engaged
- Pre-class reading assignments
- Tips for successful "clicker" use
- Student group work in educational settings
- Creating and implementing in-class activities; principles and practical tips
- What not to do
- Assessments that support student learning
- Promoting course alignment: Developing a systematic approach to question development
Check-list for creating learning goals:

☐ Does the learning goal identify what students will be able to do after the topic is covered?
☐ Is it clear how you would test achievement of the learning goal?
☐ Do chosen verbs have a clear meaning?
☐ Is the verb aligned with the level of cognitive understanding expected of students? Could you expect a higher level of understanding?
☐ Is the terminology familiar/common? If not, is knowing the terminology a goal?
☐ Is it possible to write the goal so it is relevant and useful to students (e.g. connected to their everyday life, or does it represent a useful application of the ideas)?

We also aligned the verbs with the cognitive level expected of students. The table below shows levels of learning and examples of verbs that match each level, based on Bloom’s taxonomy of the cognitive domain.

<table>
<thead>
<tr>
<th>Levels of cognitive understanding and corresponding verbs</th>
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<tbody>
<tr>
<td><strong>Level</strong></td>
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<tr>
<td>Factual Knowledge</td>
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<td>Application</td>
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<td>Analysis</td>
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<td>Synthesis</td>
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<td>Evaluation</td>
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Benefits

Writing learning goals requires effort and time, but carries multiple benefits. Faculty use learning goals as they plan class time, develop homework, and create exams. All aspects of the course become better aligned, and focus on what faculty most want the students to achieve. Faculty using learning goals report that writing good exam questions becomes easier. At CU and UBC, we have seen that the cognitive level of exams often increases as faculty align the questions with the higher cognitive level of the learning goals.

Sharing the learning goals with students improves faculty-student communication. Learning goals are often posted online and each lecture begins with the relevant learning goals for the day. Surveys reveal that students are overwhelmingly positive about having access to learning goals. The greatest reported benefit is that learning goals let students “know what I need to know,” which helps students focus on important ideas and study more effectively.

For departments, writing learning goals has informed, shaped, and aligned the departmental curriculum. By considering the learning goals from multiple courses, departments have discovered that some concepts were taught in an identical manner in multiple courses and other critical concepts were omitted entirely. As a result faculty members who teach different courses have begun to work together so that their goals complement each other and encompass what every student should be able to do by graduation. For instance, some fundamental evolution concepts were added to the CU biology curriculum after this process revealed their absence.

Resources:

www.cwsei.ubc.ca/resources/learn_goals.htm – compilation of learning goals and other resources from the CU and UBC SEIs

“At the end of my course, students should be able to ...”: The benefits of creating and using effective learning goals, Michelle Smith and Katherine Perkins, Microbiology Australia, pp. 35-37, (March 2010).


First Day of Class – Recommendations for Instructors  
CWSEI, 2014

Set the Environment
The first day of class can have a large influence on students’ perception of the entire course. By the end of the first class, you want students to have a good sense of why the course is interesting and worthwhile, what kind of classroom environment you want, how the course will be conducted, why the particular teaching methods are being used, and what the students need to do (generally) to learn material and succeed in the course. It is also important to give the students the sense that you respect them and would like all of them to succeed.

1. Establish Motivation
   a. Provide an entry-level preview of the course material and explain why the course material is important & interesting. Avoid jargon as much possible. Where applicable, make connections to:
      - Real world/everyday life
      - What students know
      - What students will need to be successful in future studies or career
      - What students are interested in, current events, ...

2. Personalize the learning experience
   a. Welcome students to your class – make it clear that you are looking forward to working with them.
   b. Introduce yourself, including describing your background and interests in connection to the subject, e.g.:
      - Why you find it interesting and exciting for them to learn
      - How it applies to other things you do (research, ...)
      [Students—especially those majoring in the subject—say it is inspiring to hear about the instructor’s background and research, and how it is relevant to the course.]
   c. Introduce teaching team
      - If applicable: TA’s and anyone else involved that students will be interacting with (could show pictures or have them come to class)
   d. Make an effort to find out who the students are and their expectations, motivations, and interests, e.g.:
      - Ask them a series of questions about major, goals, background, ... (perhaps use clickers or a survey)
      - If appropriate, ask them to introduce themselves to other students they will be working with. [note: use with caution; some students say it makes them uncomfortable if used as a general “icebreaker”, but it is appropriate to introduce themselves to group members with whom they will be working]

3. Establish Expectations (best if also handed out and/or online, not just spoken)
   a. Describe overarching (course-level) learning goals—big picture view
   b. Emphasize that you want them to learn and your role is to support their learning
   c. Explain how course will be conducted, what will happen in class, expectations for out of class work, overview of schedule, and marking scheme
d. Explain why you’re teaching the way you are teaching, how the different components support
their learning (especially important if you are teaching differently than most other courses are
taught);† e.g.:
- Teaching methods based on what is known about how people learn
- Students need to play an active part and be intensively engaged in the learning process, ...

e. Describe (generally) how to succeed in your course
- Learning and improvement take practice and effort; as well as good feedback.

  A good activity is to tell students: “1. Think of something you are really good at. Write it down
  (you don’t have to share it with anyone). 2. Now, in one or two words, describe how you got
  to be good at that thing. 3. On the count of 3, shout out how you got to be good.” The
  overwhelming word shouted will be “PRACTICE”. Then talk to them about what kind of
  practice is the most effective for mastering the material in this course.
- Give general description of how assessments are used for both feedback and marks, leaving
details to be read on course website
- Give advice on how to study

f. Express that you feel they can succeed if they put in the effort

4. Details (syllabus, detailed schedule, detailed learning goals, academic conduct, deadlines, rules ...)
   a. Don’t go into details during first class; give links to more details on course
   - Could give an assignment involving reading these.

5. Other Tips

<table>
<thead>
<tr>
<th>Good practices</th>
<th>Avoid</th>
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<tbody>
<tr>
<td>Check out classroom before first class (avoid technical problems)</td>
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<tr>
<td>Start class on time (sends message that you expect them to be on time)</td>
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<tr>
<td>Telling students you think they can all succeed if they put in the effort</td>
<td>Telling students threatening things such as: you expect</td>
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<td>(fine to say the course is challenging, as long as also express that it is</td>
<td>some to fail; or lots of students don’t like the course</td>
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<td>interesting/worthwhile and do-able)</td>
<td>and/or have found it very difficult</td>
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<td>Address academic conduct in context throughout course (e.g. talk about</td>
<td>Emphasizing rules and penalties first day (sends message</td>
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<td>plagiarism when you are giving a writing assignment)</td>
<td>of distrust, and they’re not listening anyway)</td>
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<td>Provide students with some experiences that give a sense of what future</td>
<td>Talking the entire class time</td>
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<td>classes will be like</td>
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<td>End class on time with slide containing pertinent info (your name, office</td>
<td>Ending class early</td>
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<td>hours, contact info website, homework, ...)</td>
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In future classes: reinforce these messages periodically in the appropriate context.

† For examples, see Framing the Interactive Engagement Classroom: www.colorado.edu/sei/fac-resources/framing.html
Better Ways to Review Material in Class

by Carl Wieman, 2014

A substantial amount of class time is spent reviewing material from previous courses or the previous class meeting. It is very common for instructors to give such review lectures that can occupy one or more classes at the beginning of a term, and/or 5-10 minutes at the start of each class. When we had trained observers at UBC watching the attention of students during classes, it revealed that this form of review was less than useless. Rather than helping students improve their memory and understanding of the material, it primarily diverted their attention to thinking about things other than the class they were in, and this made it harder to get them reengaged when new material was being covered. In retrospect, it is easy to understand why this method of review fails. There is a very well established result from cognitive psychology that familiarity with a topic makes people erroneously believe they understand it. When a person is being lectured on something they believe they already know, they will become quickly bored and start thinking about other things (or checking email, etc.). This means that students who have previously heard about the topic being reviewed will probably not pay attention, and those students who are not familiar with it will probably quickly get lost in the rapid review.

The better way I found to do review is to replace ALL review lecturing with problems that the students solve in class that cover the material I want to review. This is particularly easy to do if they have clickers. Doing a problem gets them actively thinking about the relevant material and testing their understanding. If they get the problem wrong, and often even if they don't, they are then primed to ask questions and listen to responses and explanations to learn why. Also, if there are things that everyone in the class already knows, I can see that immediately from their problem solutions or clicker responses, and can quickly move on and avoid wasting class time talking about that topic. That leaves more time to spend on the topics where many struggle with the relevant review problem.

A final benefit is that I end up with a good idea of what topics individual students, and the class as a whole, have and have not mastered. As I move on to the subsequent material, I have a vastly better sense of their state of mastery than I previously got from review lectures, and can tailor instruction more effectively.

Another review method: two-stage review

An alternative review format to use at the start of a course is a two-stage review. This has similar and possibly greater benefits. Give the students a quiz in class that has the review problems on it, have them do it individually and turn it in, and then have them do a group quiz in groups of 3-4 and turn in 1 answer sheet per group. The resulting discussion will provide nearly all the students with the primed and targeted review that they need. The instructor will then only have to worry about dealing with those students whose individual tests indicated they have seriously deficient backgrounds, and dealing with those topics where there are widespread deficiencies. During the group test portion, the instructor should listen in on the various group conversations. That is likely to reveal any widespread difficulties that can then be immediately addressed after the completion of the group test. There would also be a variety of more subtle benefits to this exercise having to do with classroom dynamics, and, as mentioned above, the instructor will know much more about their students' prior knowledge as they move on to subsequent material.

There is a fear that starting the first day with a difficult test will set the wrong tone for the course, so it is best to introduce the two-stage review with a statement like: “This is a carefully designed set of practice problems for your review and discussion, to help you prepare for the upcoming material. This will have no influence on your course grade, except in that they may help you to be better-prepared to do well in the course.”

A two-stage review was implemented in a UBC science course in the spring of 2014. The 3rd year course built on topics covered in the 2nd year pre-requisite course, but the instructor knew that the students had a variety of backgrounds in that material. Overall, the experience was very positive for the students and instructor, and the instructor learned of some misconceptions that many of the student had.

1 The two-stage review is patterned after the successful two-stage exams now used in a variety of science courses at UBC. See: Examinations That Support Collaborative Learning: The Students’ Perspective, G. Rieger & C. Heiner, Journal of College Science Teaching, Vol. 43, No. 4, pp. 41-47 (2014) and references therein (www.cwsei.ubc.ca/SEI_research/).
We usually think of homework as a task, such as a problem set, in which students apply what they have learned in class. But homework can prepare students to learn in future classes. Here we discuss the benefits of pre-reading assignments, report on what students think about pre-reading, and give tips on how best to implement pre-reading assignments to make them effective.

What are pre-reading assignments and what are their benefits?
Traditionally, students are first introduced to a topic in lecture; however, students can read the textbook before coming to class and complete a short quiz on the reading. This is a pre-reading assignment. The first benefit of such assignments is that students will get more out of class if they already know the basic definitions and vocabulary, as well as having already had the chance to work through simple examples and think about concepts at their own pace. This helps control for the variability in background knowledge of the students, and students regularly mention in surveys that pre-reading helps them follow what is covered in class. Also, Louis Deslauriers has monitored the student questions in lectures and noted that student questions are on a cognitively higher level in weeks with pre-reading assignments compared to those in weeks without. Second, by looking at the average responses to pre-reading quiz questions or by directly asking your students what was difficult in the pre-reading assignment, you can gain insight as to which topics your students find difficult. Third, you don’t have to spend (much) time on definitions or low-level examples, so you have more class time to focus on the more challenging material.

What students think about pre-reading assignments
Assigning reading is not new. However, in science classes students often do not read the assigned text on a regular basis. So what is different with our pre-reading approach? The assigned readings directly target material used, but not repeated, in upcoming classes and are coupled with targeted quiz questions. This leads students to recognize the textbook as being helpful to their learning. Typically 85% of students report that they read the assigned text every week or nearly every week when the pre-reading assignments are implemented as described here. This has been true across numerous courses spanning several science disciplines. Slightly higher numbers report completing the online quiz (for which self-reports match closely to the computer record). When asked what motivated them to do the pre-readings, the most frequent single answer was the contribution to their grade, but more than half the students said it was because they found the pre-readings ‘helpful for understanding the material’, and ‘to know what to expect in lectures’.

Examples of student comments:
Student A: “I know that if I complete the pre-reading I will better understand what is going on in the lecture as well as I can figure out where I need to pay the most attention and potentially ask questions.”
Student B: “I think this forced me to think and was very beneficial to start off the week as I would come into class knowing what to expect and what was expected of me.”
Student C: “To be honest, I did so because it was for marks. After a while, I didn’t mind reading it; and the questions on the pre-reading quizzes help me understand some of the concepts.”

How to implement pre-reading assignments
The pre-reading approach is a variant on “Just-In-Time-Teaching” (JITT†), in which every class is preceded by a pre-reading assignment and a quiz with open-ended questions about the difficulties encountered. The instructor reacts to these postings by adjusting the lecture to discuss the difficulties “just in time” for the next class. The full JITT approach requires a strict timetable for the students and the instructor, which is

challenging to implement in many courses, particularly ones with large enrollments, and/or multiple sections.

Here we offer a ‘softer’ approach to JITT that provides many of the same benefits. The students get a weekly pre-reading assignment to complete over the weekend, preparing them for the next week of classes. There is a quiz on the reading due before class. There are three key components for the successful implementation of pre-reading assignments: (1) the reading is very specific, (2) the quiz questions explicitly refer to the textbook, and (3) the instructor does not begin class by repeating much of the material in the assigned reading.

**Best practices**

1. The assignment should focus on what you plan to discuss in class. This creates a clear connection between the reading and the expectations of the students for class.

2. Omit everything that is not necessary. The shorter the assignment is, the more likely the students will actually read it and focus on the key material. Some instructors believe in longer, less focused, readings from which the students are expected to extract the relevant material. This is an unrealistic expectation for a first exposure to the material.

3. The reading should be guided with explicit prompts for the students of what to look for while reading.

4. Give a reading quiz for marks. By assigning marks, you are telling your students that this assignment is important, even if the actual numerical value is small. We have seen that weightings of between 2% and 5% of the course grade achieve similar ~85% reading completion rates, while assignments without associated marks have much lower completion rates.

5. The questions on the quiz should force the students to read the sections you want them to read and concentrate on the figures that are rich with information. By referring to specific figure numbers, (or equations, etc.) in the textbook, students must at least open the textbook to be able to answer the question.

6. Refer in class to things from the pre-reading—*but do not* re-teach them. The point of pre-reading is that the students are expected to come to class prepared with some knowledge. If you re-teach it all, the students will quickly realize that pre-reading is a waste of time and stop doing it. Explain the purpose of pre-reading in your first class and stick with the approach.

7. While there are various quiz options, we have found that a multiple-choice online quiz is better than a paper or clicker-based in-class quiz. In addition to saving precious class time, having the students do the assignment at home with their textbooks open lets them review – before class – their mistakes (and at their own pace). A reading quiz is not a pop quiz -- the idea is to prepare students and not to surprise them. Pre-reading assignments should take less than an hour, with the quiz portion, typically around 5 questions, taking no more than 10-15 minutes of that time. Use mostly questions that all students could answer with the book, but add in a few that require a little more “reading between the lines”. Don’t forget: your goal is to draw their attention to something in particular and to motivate, not to trick or overly burden them during their first exposure to the material.

8. It is important that the students understand why and how the pre-reading will be beneficial to them. Explicitly explain your rational and expectations. On the one hand, you expect the students to read the text and try hard to answer the quiz correctly. On the other hand, you do not expect them to “teach themselves” the material nor understand it all completely from the textbook alone. This first exposure gets them started and helps reveal the trouble spots to both the students and the instructor. It is worth repeating the benefits of pre-reading to your students a couple of times during the term.
Student group work in educational settings

CWSEI and CU-SEI, 2008

Although group work is sometimes hailed as an educational panacea, the realities are considerably more complex. Many studies of group work have been done, and they show a wide variety of results. These range from dramatic improvements in student learning and satisfaction to negative impacts on both. The potential benefits of social interaction on learning are readily apparent. Who has not understood a topic better through explaining it to a colleague and/or having that person raise questions about an explanation? Also, in many situations, peers can provide an effective low cost substitute to individualized instruction by the teacher. However, achieving these and other benefits, such as learning teamwork skills, do not come automatically, and there are clear potential downsides to group work, including the time for organizing groups and dealing with intra-group problems, potential student resentment, more complex grading policies, and difficulties in scheduling and room layout. To achieve the maximum benefit from group work, an instructor must carefully consider the desired educational goals and the benefits, tradeoffs, and pitfalls of introducing different types of collaborative work, and then choose the most suitable type.

Here we briefly review different levels of group work and list the potential benefits and negatives, and what requirements research has shown are needed to ensure a high probability of success.

Levels of collaborative activity – Benefits, Requirements for success, and Negatives

1. Multiple, brief small group discussions in class
   (in response to challenging instructor questions or in-class assignments)
   A. Benefits: Learn through explanations to others, learn metacognitive skills through analyzing other’s reasoning, learn jargon through use in discourse, learn to carry out scientific discourse. Peers provide low level help and feedback, such as catching arithmetic mistakes and avoiding “getting stuck”. The stress of speaking in class is reduced, particularly if student is asked what their group thought.
   B. Requirements: Incorporating this in class is relatively easy – just provide some reason for students to discuss the material with each other. Implementation needs to include some minor reward system or class expectation to promote the group discussion, because otherwise it will not happen spontaneously for many students. Group size should be small (2-4). Two low-effort options for group formation that enhance interaction over just “talk to your neighbour” are: 1) instructor randomly assigns, or 2) students self-organize and register their group online. Such formal groups particularly enhance interaction if students are occasionally required to provide group consensus answers. While it is preferable to have a range of backgrounds and levels in each group, the benefits in this setting are usually not considered large enough to be worth the effort. The benefits are primarily from avoiding groups composed solely of low motivation and low ability students. With mixed groups, the better prepared students can provide explanations to the weaker students, with benefit to both.
   C. Negatives: Minor. Time needed to form student groups. Potential disruption due to off-topic discussions in class (usually minor).
   D. Other: Opinions vary, but we recommend keeping group composition stable, except where problems.

2. Informal, out-of-class study groups
   A. Benefits: Like 1A, plus students can study more effectively by getting low to moderate level feedback from each other. This avoids wasting time from “getting stuck” or overlooking trivial mistakes. Students can succeed at more challenging and complex assignments. Students may find course work more satisfying and enjoyable, and learn teamwork skills.
   B. Requirements: Minor. Regularly encourage and discuss the benefits of study groups. Ensure that marking/grading scheme does not appear to penalize collaboration, as discussed below. Provide some form of both group and individual incentives. For example, collaborating can improve grades on assignments, but there are also exams that are closely aligned with assignments. Assignments must be challenging to draw students into meeting for study groups. Make it logistically easy and not socially challenging to form into groups. For large classes, this likely will involve scheduling a room and time for students to meet and/or website for connecting up. Having instructor or TA at these study sessions can draw more students, but it is important that the instructor/TA does not provide the answers.
   C. Negatives. Negligible. Time needed for elements of B.
3. **Formal in-class group activities** (such as tutorials, concept mapping, labs, …)

   A. Benefits: Same as #2, but involves all students. Plus students can develop more teamwork skills.

   B. Requirements: Best to have a challenging activity where students work with ideas that are typically difficult to learn and the activity requires them to think about and debate these ideas with each other. Need course structure and space conducive to group work (4/table works well). TAs with role of facilitating group discussion and Socratic teaching works well. Grading options include: only for participation, grading individual work, or grading collective work. Be explicit about why and how collaborative learning is beneficial. If grading collective work, need time and attention devoted to why and how to work in teams effectively, roles and responsibilities of team members, and evaluation of contributions as part of team. Often rotating roles are assigned, manager, recorder, sceptic, etc.

   C. Negatives. Time and personnel needed to organize facilities and groups.

4. **Formal in or out-of-class collaborative assignments- collective group work and shared marking**

   A. Benefits: Same as #3, plus reduces time for marking assignments.

   B. Requirements. Similar to #3, and a significant goal of the course should be to have students learn to work in teams. Assignments must encourage teamwork, such as being sufficiently difficult or complex that is easier to set up team and work together than to complete as an individual. Assignments that require judgement decisions are found to be most effective at encouraging diverse participation. Groups should be formed by the instructor in a manner that assures equal diversity and skills across groups and is perceived to be scrupulously fair. There must be timely feedback on the functioning of group and a process for dealing with intra-group squabbles.

   C. Negatives. 1) There will be some level of student resentment and intra-group disagreements over credit and level of effort. 2) Time required to create groups and deal with logistics. In many courses, groups will not spend the 40 hours of interaction that has been cited as needed to have a highly effective team. 3) Instructors who are not experienced in implementing this can find it difficult to obtain good results.

   D. Other. Group size 4-5 is considered optimal, with all visibly under-represented minority students in a group with at least one other minority student.

5. **Learning with fully developed teams**

   A. Benefits. Same as #4, plus students learn to work as part of team to solve problems and manage projects that would usually be impossible for an individual to complete.

   B. Requirements. Major part of course goals needs to be learning teamwork. All of #4B, plus requires more attention to group size, composition, task assignment, general group interaction, and reward system. Majority of course should be team based project(s). More time and attention devoted to why and how to work in teams effectively, roles and responsibilities of team members, and evaluation of contributions as part of team. Teams should have at least 5 and preferably 6 or 7 members, and the composition should be as diverse as possible.

   C. Negatives. Similar to #4, plus significant time required to create good team-based learning projects.

**Group work and marking/grading scheme**

If student marks depend on relative student ranking (“grading on curve”, “normed”, etc.) there is a clear disincentive for a student to collaborate with other students. The inherent contradiction between telling students that they must collaborate, while at the same time penalizing them for helping other students through the marking scheme, will always result in student discomfort and resentment.

**References & Resources**


Team-based Learning: A Transformative Use of Small Groups, ed. by Larry K. Michaelsen et al. (2002). A good reference on Team-Based Learning and also a good reference on group dynamics (chap. 4 by Birmingham & McCord is on research on group dynamics); also see: UBC Faculty of Applied Science website on Team-Based Learning cis.aps.c.ubc.ca/services/team-based-learning/
Creating and implementing in-class activities; principles and practical tips

CWSEI, 2013

1) Choose a goal or topic to focus the activity

   Look closely at your material and ask yourself some of the following questions:
   a. What is the most important content or learning goal and how might the activity support that?
   b. Are there existing materials (such as a lecture, assignment, or exam question) to base the activity on?
   c. Is there an important framework, model, or concept to reinforce?
   d. How will it be giving them practice thinking like an expert in the subject?
   e. What is most difficult? What gives students trouble? Are there exam questions students do poorly on?
   f. Is there a controversy in the material? Is there material that would make a good discussion?
   g. What could students work out on their own?

2) Decide how students will engage with the material

   The next step is to look at the material you’ve selected and decide how the students will interact with it. This is key for developing activities. Try to design it so all of the students engage deeply with the content, not just a few.
   a. Consider your context. How many students are in your class? How many may require some accommodation?
      Will you have help administering the activity? How will this work in your particular classroom setting? If the students will work in groups, how large will those be and how will they be formed?
   b. What type of activity will be used? If you have difficulty deciding, discuss it with a colleague. Here are a few options that work well with a variety of topics:
      i. Think/Pair/Share [typically 5-15 min] – This type of short activity is designed to let everyone engage with the material first individually and then in pairs. First the instructor poses a question, then students spend one minute thinking or writing silently about the idea on their own (you may have to enforce silence, some students will likely try to talk). Then students form groups of 2, each partner takes a minute or so describing their thoughts. Finally the instructor facilitates a discussion with the whole class. This activity will usually increase students’ responses to questions posed in class.
      ii. Worksheets [typically 15-50 min] – Write a few questions that lead students through the content in a structured way and photocopy enough for everyone (but see #5d below). Encourage them to work in groups or pairs. The difficulty level should be set so that it is very challenging for most students if working individually, but reasonably doable in groups. An approach that works well is to make the first part relatively easy, so that most groups know how to start, and make later parts more challenging. Adjust the difficulty after running it the first time.
      iii. Case Study [typically 15-50 min] – In a case study, students engage with the content in a real world context. Many people present cases or examples to students in lectures, however it is more effective to give the students material and handouts (e.g. graphs, maps, data, ...) that describe the conditions of the case and have them work in groups to make decisions about it. Choose a case that is compelling and requires the students to both analyze the situation and come to a decision or series of decisions and then justify their choices (examples: how to proceed with a project, what to recommend to clients, where to drill, what future changes to expect, how to reduce energy loss, which technique or instrument to use to achieve a goal, etc.).

3) How will the students be motivated to put in effort?

   a. Is it challenging, but doable in groups? Will students see that they are becoming more “expert” at something?
   b. Can you connect the activity to a good real world example or something they may do in their future careers?
   c. Does it convey why you and others see this topic as interesting and important?
   d. Does it involve them making decisions and justifying actions, not simply following set procedures?
   e. Does the activity relate to the types of tasks students will be asked to complete on a midterm or final exam?

4) What product will students generate?

   a. Consider more sophisticated tasks. For example, have students make and justify a decision (and perhaps identify the criteria used to make a decision), produce a prediction, produce a ranking, or make a judgment (e.g. best/worst/most efficient).
   b. Consider having students produce a novel representation, such as a specialized graph or sketch.
Key points and factors from the review paper “Conditions Under Which Assessment Supports Student Learning,” by G. Gibbs and C. Simpson

Key points
(Extensive references to data supporting all these points are listed in the original article)

From the students’ point of view:
• What is tested in a course dominates what students think is important and what they do.
• Effective feedback is the most powerful single element for achieving learning. Feedback that is not attached to marks can be highly effective.
• Students who focus on picking up cues as to what will be on exams and study accordingly do much better than those who do not. Students often realize this form of studying is not the same as studying to master (i.e. understand and apply) the course material.
• Students prefer courses with a significant marked assignment component, feeling that such courses provide them with more practice and feedback, and the assessment is fairer.

Marked assignments versus exams:
• Much assessment fails to engage students with appropriate types of learning.
• Exam scores correlate very weakly with post graduate performance. Scores on marked assignments are better predictors than exams of long term learning retention.
• When assignments are a significant fraction of the course mark, the failure rates are 1/3 what they are when course mark is based solely on exam scores. Students also study and learn in more naive ways when mark is based solely on exams. Although not in Ref. 1, there are techniques to minimize cheating on such marked assignments.

Factors that make assessments contribute to learning (And are frequently neglected)
1. Assigned and assessed tasks that:
   • are focused on the most important aspects of the course (tied to learning goals),
   • require extended time to complete,
   • are given frequently,
   • engage students in appropriate forms of study/effort.

2. Students need to have a clear concept of the assigned task and of learning in the discipline. The criteria for setting the mark on the assignment needs to be explicit and understood by the student.

3. The single most important element of assessment supporting learning is the frequency and type of the feedback provided with the assessment. Feedback that supports learning:
   • is frequent and sufficiently timely to the task so that it still matters to the student
   • focuses on student performance and learning, rather than student characteristics
   • is specific and detailed, addresses small chunks of material, and provides guidance for future efforts
   • matches the purpose of the assignment and encourages the student to improve
   • is supported by mechanisms that require the student to attend to and act upon the feedback

Implementing good assessment and feedback without spending excessive time marking
It is particularly challenging to have frequent assignments and timely feedback in large-enrollment classes. Below are a few examples of ways to do this.
• Online, computer graded homework. There are numerous systems for this. (Instructor needs to generate or find source of good multiple-choice questions, many systems provide these.)