FLC E^{2}T: A Faculty Learning Community on Effective (and Efficient) Teaching

(Work in Progress)

Introduction

The paper is the result of a Faculty Learning Community (FLC) [1] within the college of engineering at the University of Delaware. The FLC was initiated, with the help of a $4k grant from the University's Center for Teaching and Learning, to create a series of short guides on effective teaching practices that distill the literature on various topics into actionable steps any faculty member (particularly new faculty) can implement. The FLC consisted of members from all departments within the college of engineering and a single colleague from the college of education with expertise in professional development (7 members total). All engineering FLC members were non-tenure track faculty with workloads that consisted primarily of teaching. Experience level ranged from a 2nd-year Assistant Professor of Instruction through mid-career faculty. Although service is also part of the workload of each member, participation in this group was voluntary, and each member was compensated $500 from the grant for their efforts.

The Guides

An initial list of guides was proposed at the beginning of the project (Figure 1) that grew into 12 total: Inclusive Teaching, Active Learning, Motivation & Engagement, Mindset, Rubrics, Learning Objectives, Syllabus Creation, Assessment, Inductive Teaching, Damage Control, Retrieval Practice, and Teams.

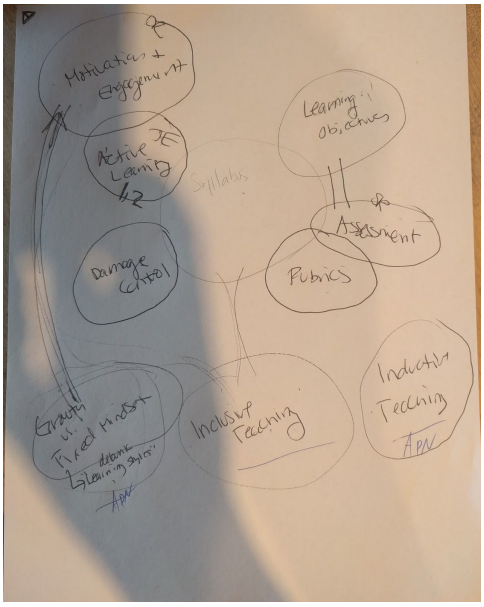

Figure 1: Guide topic brainstorming

This work is directly informed by both the scholarship of teaching and learning and discipline-based education research in the engineering and computer science disciplines and seeks to propagate this work across the faculty for the ultimate benefit of students. From the self-determination theory of motivation to review articles demonstrating the effectiveness of active learning in STEM disciplines, many evidence-based, effective teaching practices and frameworks are distilled in these guides. References and resources are provided in each guide that serve to both indicate the sources of the information in the guides and point to further reading and resources for professional development for interested faculty. Links to the guides as view-only google documents are provided here. Actual URLs and the full-text guides in their current state are included as an Appendix.

Guide 1: Inclusive Teaching
Guide 2: Active Learning
Guide 3: Motivation & Engagement
Guide 4: Mindset

Guide 5: Rubrics
Guide 6: Learning Objectives
Guide 7: Syllabus Creation
Guide 8: Assessment
Guide 9: Inductive Teaching
Guide 10: Damage Control
Guide 11: Retrieval Practice
Guide 12: Teams

The Process
The FLC met every 2-4 weeks for most of the 2017-2018 academic year. Once the guide topics were established, each engineering FLC member led the development of 1-3 of these guides and was responsible for moving them through 5 phases (with feedback incorporated between each phase):

1) first draft
2) reviewed with another engineering FLC member
3) reviewed with education FLC member
4) reviewed with a faculty member outside the FLC group
5) final draft

Challenges & Suggestions
This paper is marked as a work in progress because it turned out that phase 4 was a bottleneck in the process, and the guides range from about 20-60% complete. There are a few reasons for this: 1) we spent quite a bit of time between phases 1-3 iterating as a group, leaving little time for external feedback, 2) some members found scheduling time with faculty outside the group to review a teaching guide to be logistically difficult, and 3) two of the members (including the facilitator) accepted jobs at other institutions during this time, which made scheduling face to face meetings in the second half of the year more difficult than in the first half. As a result, none of the guides made it to the final draft stage.

Despite these shortcomings, the members of the FLC agree that other goals of convening an FLC [1] were fulfilled. We certainly created a stronger sense of community among interdisciplinary faculty members, and all advanced our knowledge of the scholarship of teaching and learning in the process. Additionally, several other project ideas and collaborations grew out of this FLC that include subsets of members as well as other faculty, so the positive results of this effort are not limited in duration to the initial FLC.

Our suggestions for others attempting to define a similar FLC include clarifying the goals of the FLC early in the process, incorporating the 10 qualities necessary for community in FLCs, and incorporating most or all of the components of an FLC [1]. Additionally, building in time to evaluate and assess the FLC [2] would be ideal.

In our case, we went into the process with this set of guides as our defined deliverables, anticipating they could be printed and handed out at faculty meetings and/or shared through

links. But this may not be the best format to use for sharing effective teaching practices. We talked about websites, wikis, and presentations as other potential means of dissemination. These ideas need to be developed in parallel with discussions with colleagues on how they would best prefer to consume material like this. It is also likely that 12 guides is too many. If we truly aim to create an easy on-ramp for new engineering educators to introduce effective teaching practices, it is likely better to combine some guides and condense the total number down to single digits.

Although this FLC had ended, each of the authors is moving forward with different elements of the guides in different ways. It is likely that a full paper will be submitted to next year's conference on progress on the guides including any revisions on format and results of sharing them.

Acknowledgments
The authors would like to thank Dr. Kevin Guidry and Dr. Kathy Pusecker from the Teaching Center at the University of Delaware for their support.

References
[1] M. D. Cox, "Introduction to faculty learning communities," *New Directions for Teaching and Learning*, vol. 2004, no. 97, pp. 5–23, 2004.
[2] H. Hubball, A. Clarke, and A. L. Beach, "Assessing faculty learning communities," *New Directions for Teaching and Learning*, vol. 2004, no. 97, pp. 87–100, 2004.

Appendix
For each guide, a hyperlink and URL are provided. Full-text guides in their current state follow.

Guide 1: Inclusive Teaching
https://docs.google.com/document/d/1MhLInvb5uM4Dy-WK_Nvt9tXEQfsaMIkk0YaTwYMfoGk/edit

Guide 2: Active Learning
https://docs.google.com/document/d/1bemPY9hEf3dq_dEN8jAzAB5TMUaovH-dnP5pdO39Hdc/edit

Guide 3: Motivation & Engagement
https://docs.google.com/document/d/1v09bGEE4qdmg3bYZ7aZ9SzPJDbJMsb7oPCYW_bn9zUM/edit

Guide 4: Mindset
https://docs.google.com/document/d/1Ark52OBRFbL8O0hBGI6MCJPcInVfCiYS3wVBT0EidZk/edit

Guide 5: Rubrics
https://docs.google.com/document/d/1fj6whqkEe17H9CJLKjPoiMXclQpiqEhc2JSKGdW9aHA/edit

Guide 6: Learning Objectives
https://docs.google.com/document/d/1a0oiVQ7H0e6D6MlG8RK-NOCOXRe-bqigg_MGexOHwk8/edit

Guide 7: Syllabus Creation
https://docs.google.com/document/d/1vdaYdlzRdGuIqDIhc4uwKEEGYUB9cqFw6JQ79khYgh0/edit#heading=h.rm6dva9qzxuv

Guide 8: Assessment
https://docs.google.com/document/d/1AFefTsUQaO1Hq9FtwqIa0p5RkzciiyswKCcLi12i9c4/edit

Guide 9: Inductive Teaching
https://docs.google.com/document/d/17WD1GQQkvRo2nyJni_oIOdFpRRX1VLagcXaxQaFoe0M/edit

Guide 10: Damage Control
https://docs.google.com/document/d/1lY3WNQuO8SueBWaGDqZmsS1O3bs7ZmqZup6tRT1ypAY/edit

Guide 11: Retrieval Practice
https://docs.google.com/document/d/19fYAKJtkOaJZIkRQxoJOincIOf2KFjWk2_OP099CUAE/edit

Guide 12: Teams
https://docs.google.com/document/d/17co75u15MxRo_mYo86WjExWHUb518n1CU4rpnVP7I2Y/edit

Inclusive Teaching

What does inclusive teaching mean, and why does it matter? How can I avoid stereotypes and biased language in my course? Who is most at risk of exclusion?

"Diversity is being invited to the party. Inclusion is being asked to dance." - Verña Myers

Inclusive teaching strategies refer to any number of teaching approaches that address the needs of students of various backgrounds, learning styles, and abilities [1]. In 2014, for the first time, the majority of the K-12 population of the US was minority [2]. Based on a recent assessment conducted within the UD College of Engineering [3], we could be doing better in this area - particularly with women and underrepresented groups (URGs - defined as non-white, non-asian). Women, URGs, first-generation, disabled, and low-income students tend to be more at risk for exclusion in traditional teaching environments. We all have implicit biases[1] and there may be subtle ways that you are activating *stereotype threat*[2] or disadvantaging some students without even realizing it. It can happen anywhere - in your syllabus, your homework problems, your exams, or in your lectures. Here are some things to look out for.

How do I practice inclusive teaching?

- **Include women.** Although explicit discrimination is thankfully becoming a rare occurrence (and is another topic altogether), the classroom is often still a chilly climate [3] for women students. Luckily there are some easy ways to warm things up. Instead of using gendered language (commonly masculine) to refer to mixed gendered groups, try these suggestions instead for **pronouns**:

Table 1: Using inclusive language (adapted from NETI workshop material and glaad.org resources)

	Instead of	**Use**
Recast into plural	Give each student his paper as soon as he is finished	Give students their papers as soon as they are finished
Reword to eliminate pronoun	The average student is worried about his grades	The average student is worried about grades
Replace masculine pronoun with one (3rd person) or you (2nd person)	If a student is unhappy with his grade, he should talk to the instructor	If you are unhappy with your grade, you should talk to the instructor
Alternate male and female expressions	Let each student participate. Has he had a chance to talk? Could he feel left out?	Let each student participate. Has she had a chance to talk? Could he feel left out?

[1] Don't believe this? Take a test: https://implicit.harvard.edu/implicit/takeatest.html

[2] *Stereotype threat*: the risk of confirming negative stereotypes about an individual's racial, ethnic, gender, or cultural group (e.g. girls are bad at math, black students are less intelligent).

Use a plural indefinite pronoun	Anyone who wants to go on the trip should bring his money	All those who want to go on the trip should bring their money
Use double pronouns (he or she, he/she, him or her, him/her)	Everyone has a right to his opinion	Everyone has the right to his or her opinion

Similarly, you can easily **avoid words with masculine stems**:

Instead of	**Use**
Common man	Average person, ordinary people
Chairman, Chairwoman	Chair or Chairperson
To man (verb)	to staff, to run, to operate
Man-hours	Work hours, hours worked, staff hours, person hours, hours
Mankind	Humanity, human race, human beings, people
Manmade	Artificial, synthetic, manufactured, crafted, machine made
Manpower	Work force, labor force, personnel, workers
Guys	Everyone, people, folks

- **Plan ahead.** Include statements about inclusion and diverse learning needs in your syllabus.
- **Embrace diversity in content and practices**
  - Assume students are diverse in ways you can't see. Race, national origin, socioeconomic status, ethnicity, physical and mental disabilities, sexual orientation, religion, political beliefs, color-blindness, and many other possibilities aren't always visible.
  - If you do group work or assignments, switch it up: sometimes require students to work with others they may not know, and other times make sure the minority students are not isolated.[3]
  - Include textbooks, guest speakers, examples, and other resources from diverse scholars. Give appropriate acknowledgement to the individual's identity.
  - Use diverse examples, imagery, and other course content
    - Example: If the Statics book you are using shows only men as the figures next to construction equipment examples, choose examples with no figure at all (especially on exams) or practice your photoshop skills to alternate gender cues in the figures.

[3] For assistance in formation of groups, CATME (www.catme.org) can randomly create groups while adhering to certain constraints (not isolating based on race or gender, for example).

Sources
NETI material

Other Resources

Women in Engineering Proactive Network (WEPAN)
Women in STEM Knowledge Center (WSKC – powered by WEPAN)

- Engineering Inclusive Teaching: Faculty Professional Development webinar series

Transforming Engineering Culture to Advance Inclusion and Diversity (TECAID)
ASEE Safe Zone Training

References

[1] "Diversity and Inclusive Teaching | Center for Teaching and Assessment of Learning." [Online]. Available: http://ctal.udel.edu/enhancing-teaching/inclusive-teaching/. [Accessed: 01-Aug-2017].
[2] https://www.washingtonpost.com/news/grade-point/wp/2016/09/26/an-ivy-league-professor-on-why-colleges-dont-hire-more-faculty-of-color-we-dont-want-them/?utm_term=.1ee6a408a7cc [Accessed: 25-Oct-2017]
[3] T. Barnes and X. Zhang, "Assessment of Student Culture for Women and Underrepresented Groups in the University of Delaware's College of Engineering." Delaware Education Research & Development, July 2017.
[4] B. R. Sandler, L. Silverberg, and R. Hall, *The Chilly Classroom Climate: A Guide To Improve the Education of Women*. Washington, D.C.: National Association of Women in Education, 1996.

Active Learning

How do I motivate students to attend and participate in class? How do I maintain the attention of as many students as possible? How can I get students to engage with content more frequently?

What is it? Anything students are called on to do other than watching a lecture and taking notes is active learning.

(insert graph of retention of info during a lecture versus time - with and without active learning; need to grab reference from NETI docs)

How can I implement it? Active learning events can be run for anywhere from 30 seconds through an entire course meeting. Some of these activities require virtually no change to your lesson plans at all. Here are a few options that require no advanced preparation time and only a few minutes of implementation during class:

Activity	Class Time Needed	Description
Comparing Notes	1-2 min	Take a short break and invite students compare their notes with a neighbor, filling in any gaps. Afterward, optionally follow up this activity with a short Q&A session based on any confusing points.
Minute Paper / Muddiest Point	1-2 min	End class 2 minutes early and ask students to write down (anonymously or not) the main point of today's class, and/or the most pressing question or confusing point from today's class. Begin the next class by addressing any common questions.
Participation Preparation	2-5 min	Prior to asking a question of the class that you were already going to ask, tell students you are about to ask them that question and give them 1-2 minutes to reflect on the question, writing down their answer in their notes. Then follow up by call on a few students at random.
Think-Pair-Share	3-5 min	Ask a question and give students a minute to write down some thoughts ("think"), then another minute or two to discuss their thoughts with a neighbor ("pair"), then follow up by calling on pairs at random to discuss with the whole class ("share").

What are the common pitfalls to avoid?

Do not run these activities for too long. Ideally you want to end the activity before the room has quieted down (explaining to students that this is your intention; you want to just bring their small-group work to the entire class before losing their momentum).

Make sure to call on some students at random after most activities. If you always begin by asking for volunteers, students will realize they can get away with being off-task during this time. By calling at random first, everyone needs to be prepared to be held accountable. (You can always ask for volunteers next.)

Avoid trivial prompts or questions. You want to pose a prompt that merits taking a moment or two of class time or group work to accomplish. The worst kind of prompts are those that only require the recall of one specific answer.

Resources

Inductive Teaching and Learning Methods
https://pdfs.semanticscholar.org/3117/cb748126490efab28e727afd2f68b1db3335.pdf

We Never Said It Would Be Easy
http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Columns/Noteasy.html

Does Active Learning Work? A Review of the Research
www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Prince_AL.pdf

Advanced Options

Many other course activities are possible, requiring some advance preparation before using them in the classroom.

Activity	Class Time Needed	Description	Tips
Intentional Mistake(s)	2-10 minutes	Present students with inaccurate work (on a slide or handout) and have them take a few notes on what is wrong, then follow up by calling on students	Potential sources of material include your own personal notes where you made a mistake, or a homework/exam solution that introduces mistakes worth pointing out Make clear something is wrong on your handout, to avoid confusing students who arrive late or aren't fully paying attention
Sequence Reconstruction	5-15 minutes	Take a list/sequence and jumble it, then have students put it back in order, then discuss the responses as a whole class	Examples: steps in a chemical or biological mechanism, priorities of design heuristics, lines of a computer algorithm Potential sources: anything that appears in tables/lists in the textbook that are worth thinking about this way
Peer Instruction / ConcepTests	3-10 minutes	Give students a clicker-question and collect results. If <25% correct, further lecture/example may be needed, if >80% correct, move on to next topic; if in between, have students form groups and defend their answer, then poll again.	Links to known conceptests - for example the AIChE Concept Warehouse

Category Building	5-15 minutes	Give students a list of items/properties/features and categories and have the students sort them.	Example: statements that describe interpolation or regression or both or neither
Predictions	3-5 minutes per predictio n	Have students watch a video/simulation up to a point where they should predict what happens next. Have them write down their predictions, finish the video/simulation, then answer short questions related to why they made the prediction they did. Helps to confront misconceptions.	Need to cite work from Vigeant and Prince It's important to have students write predictions down upfront to force them to make a decision (and also to "own" it). It's also important to follow up with a couple of questions to enforce thought and reflection.
In-class Groups (variation on Think-Pair-Sha re)	1-5 minutes	Have class form groups of 2-4 and quickly select a recorder. Then give 1-3 minutes to address a question: recall prior material, generate a question, start a problem solution, work out the next step in a derivation, brainstorm a list, summarize a lecture. Then randomly call on groups to share some or all of their work.	This requires a small bit of preparation because the activity needs to be significant enough to merit the time to work in groups.
Guided Questions	3-15 minutes	Have class form groups of 3-4, and provide them with a series of "question stems."Have each student within the group individually prepare 1-2 questions using the stems, then have small groups discuss these questions.	Example stems: How does ___ relate to what I've learned before? What conclusions can I draw about ___? What are the strengths or weaknesses of ___? What is the main idea of __? What is an example of ___? What is the best __ and why? What if ___? Explain why ___? How are __ and __ similar? Why is ___ important? How could I use __ to __? How does __ affect __?

Pair Programming	5-60 minutes	Two students collaborate at a single computer, one as "pilot" (who has the keyboard) and the other as "navigator" (who talks the pilot through the work), switching roles regularly throughout.	Best suited for computer labs. Planning needed to decide on a “deliverable” to hold students accountable.

Additional Resources

Chapter 5 of Teaching What You Don’t Know by Theresa Huston (here, active learning is pitched as “thinking in class” - put provides more detail on many of the strategies listed above)
https://www.amazon.com/gp/product/0674066170/

Small Teaching by Jim Lang

Retrieval Practice: http://www.retrievalpractice.org/

Refer to two folders:
Active Learning Peer-Reviewed Articles - contains peer-reviewed literature on efficacy of active learning strategies (including one document that summarizes findings from many different studies)
Active Learning PDFs - contains documents of different active learning strategies and tips (not studies)

Motivation & Engagement

What motivates students to learn? How can I motivate my students to learn? Do you feel like you have to continue prodding your students to participate or complete their work?

Motivation

Motivation is a spectrum (see Figure 1). Engineering students tend to be extrinsically motivated (will this be on the test?) as opposed to intrinsically motivated (it's important to me that I learn this) [1]. Most of us would like to move our students farther to the right on this spectrum towards intrinsic motivation. But how?

Behaviour	Nonself-determined					Self-determined
Type of Motivation	Amotivation	Extrinsic Motivation				Intrinsic Motivation
Type of Regulation	Non-regulation	External Regulation	Introjected Regulation	Identified Regulation	Integrated Regulation	Intrinsic Regulation
Locus of Causality	Impersonal	External	Somewhat External	Somewhat Internal	Internal	Internal

Figure 1: The spectrum of motivation (figure from [2])

Enter self-determination theory. Self-determination theory says there are 3 antecedents of motivation:

1) **Autonomy**: Involves self-initiation and self-regulation of one's own behavior
2) **Competence** (i.e. mastery in [6]): Ability to interact proficiently or effectively with the environment
3) **Relatedness** (i.e. purpose in [6]): Feelings of closeness and belonging to a social group

So, to increase motivation, support the development of one or more of its antecedents. How? We have collected examples from various sources and grouped them into these three buckets.

1) **Autonomy support**: Allow for choices whenever possible, or at least the perception of choice. This can happen on the syllabus (if you're happy with your grade after exam 3, you can choose whether or not to take the final), in lectures (would you like to hear an example of static equilibrium using an airplane or a roller coaster?), or in projects (allow students to choose their own roles within teams). Give some choice over learning tasks (e.g. homeworks or exams with more questions than students need to answer, and let them choose which to answer).
2) **Competence/mastery support**: Relate the material to the prerequisite courses. Make homeworks and assessments developmentally appropriate (good learning objectives make this easier). Use formative assessments to give relevant feedback. Allow re-submission of exam/assignment to make up 50% of points lost. Emphasize growth (vs. fixed) mindset and learning as a process.

3) **Relatedness/purpose support**: Frame examples in terms of industry or research problems (especially from personal experience). Invite representatives from student organizations (ASME, AiChe, BMES, etc.) to class to recruit new students, and consider incentivizing participation. Bring in guest speakers or judges/reviewers when possible. Encourage students to attend relevant extracurricular activities. Encourage teamwork, group projects, etc. Highlight relevant news or current events relevant to the course. Relate course material to familiar phenomenon and problems that students may be called upon to solve in their intended careers.
    - Get to class early and post something on the screen (the NASA picture of the day or equivalent, quote, physical object on document camera, etc.) and ask students: what do you notice? What do you wonder? Spend the first few minutes of class talking about it. -- from Chapter 7 in [5]
    - Resources:
        i) Everyday Engineering Examples - blog from a UK professor
        ii) ENGAGE: Everyday Examples in Engineering - NSF funded resource

Motivation is necessary but not sufficient for **engagement** [3]. Engagement, or a student's active involvement in a task or activity, is important because (among other things) it is linked to retention and graduation rates [4]. Luckily for us, of the 11 engagement indicators used by the NSSE study [4], many of them can be addressed but supporting the 3 antecedents of motivation above. Others, including effective teaching practices (e.g. clearly explaining learning objectives, using examples to explain difficult points) are addressed in other guides in this series.

Cited References

[1] R. M. Ryan and E. L. Deci, "Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions," *Contemporary Educational Psychology*, vol. 25, no. 1, pp. 54–67, Jan. 2000.

[2] E. L. Deci and R. M. Ryan, "The 'What' and 'Why' of Goal Pursuits: Human Needs and the Self-Determination of Behavior," *Psychological Inquiry*, vol. 11, no. 4, pp. 227–268, Oct. 2000.

[3] J. J. Appleton, S. L. Christenson, D. Kim, and A. L. Reschly, "Measuring cognitive and psychological engagement: Validation of the Student Engagement Instrument," *Journal of School Psychology*, vol. 44, no. 5, pp. 427–445, Oct. 2006.

[4] "Engagement insights: Survey findings on the quality of undergraduate education," National Survey of Student Engagement (NSSE), Annual Results, 2016.

[5] J. M. Lang, *Small Teaching: Everyday Lessons from the Science of Learning*, 1 edition. San Francisco, CA: Jossey-Bass, 2016.

[6] D. H. Pink, *Drive: The Surprising Truth About What Motivates Us*. New York: Riverhead Books, 2011.

Notes

Check out L. D. Fink, *Creating Significant Learning Experiences: An Integrated Approach to Designing College Courses*, 2 edition. San Francisco: Jossey-Bass, 2013.

Mindset

Questions?

Growth (vs. Fixed) Mindset

People can think about intelligence as something that is stable (a fixed mindset) or as something than can be grown (a growth mindset). Dozens of studies show that students with a growth mindset embrace challenges and perform better over time. Research also shows that students' mindsets can change through targeted interventions and interactions with adults. Want to know more? Read: Mindset by Carol Dweck, the website based off her work, use this assessment to see where you or your students fall on the growth mindset scale, or if you want the short version, watch Carol Dweck's TED talk.

Fixed	Growth
Feels threatened by the success of others	Finds lessons and inspiration in the success of others
Pitying and negative	Looks at bigger picture and seeks solutions
Ignores useful feedback	Learns from criticism
Sees effort as fruitless or worthless	Sees effort as the path to mastery
Gives up easily	Persists in the face of setbacks
Avoids challenge	Embraces challenge
Desire to look smart	Desire to learn
Ignores situation/ looks for a distraction	Takes responsibility for learning

How do I encourage students to have a growth mindset?

Concept	***Say/Do This***	***Not This***	***Here's Why***
Celebrate productive struggle	Mistakes are how we grow just keep at it.	You should have done XYZ.	Research shows that conceptual mistakes are an important part of learning. Having to work through a difficult problem and try different strategies is the best way to get better at a subject.

Praise the process, not the person	Praise students when they work hard to accomplish a difficult task. Imply that you value hard work and that hard work is the cause of success.	You're very smart/talented!	When students later encounter a setback they conclude: "If my past success made me smart, my current struggle makes me dumb."
Give growth mindset encouragement	Remind students that challenges are the best way to grow their brains.	Previous students have done well at this.	Help them picture their brains getting stronger as they work through a difficult problem.
Sometimes give "open" tasks	Give tasks where they can set their own level of excellence.	Always assigning the textbook questions.	This encourages students to own the content like a professional. (See motivation guide)

Celebrate mistakes and productive struggle
Many students fear making mistakes. They think mistakes mean they are not smart. But research shows that conceptual mistakes are an important part of learning. Having to work through a difficult problem and try different strategies is the best way to get better at a subject. Tell students that you like mistakes and show them how to learn from them.

Praise the process, not the person
Our intuition is often to praise students for being smart. This sends the wrong message. When students later encounter a setback they conclude: *"If my past success made me smart, my current struggle makes me dumb."* Instead, praise students when they work hard to accomplish a difficult task. This implies that you value hard work and that hard work is the cause of success.

Give growth mindset encouragement
When students are struggling, remind them that challenges are the best way to grow their brains. Help them picture their brains getting stronger as they work through a difficult problem.

Give "open" tasks
Give tasks with multiple steps and multiple right answers. This encourages students to learn concepts instead of memorize lists of facts or rules.

Assess learning, not just performance

Are students engaged in the learning process? For example, in group work: Are students leaning in? Is everyone participating? Are students asking each other questions?

What should you avoid?

Do not just tell students to have a growth mindset

Students can have a negative reaction to being told how to think. Instead of telling students to "have a growth mindset," explain to them the science behind how intelligence works — that the brain can get stronger and smarter with new learning.

Do not exhort students to "just try harder"

Most students have heard "just try harder," but a growth mindset isn't just about trying harder. Students need to understand why they should put in effort and how to deploy that effort. Sometimes a better strategy is more useful than sheer effort.

Cited References

[1] R. M. Ryan and E. L. Deci, “Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions,” *Contemporary Educational Psychology*, vol. 25, no. 1, pp. 54–67, Jan. 2000.

[2] E. L. Deci and R. M. Ryan, “The ‘What’ and ‘Why’ of Goal Pursuits: Human Needs and the Self-Determination of Behavior,” *Psychological Inquiry*, vol. 11, no. 4, pp. 227–268, Oct. 2000.

[3] J. J. Appleton, S. L. Christenson, D. Kim, and A. L. Reschly, “Measuring cognitive and psychological engagement: Validation of the Student Engagement Instrument,” *Journal of School Psychology*, vol. 44, no. 5, pp. 427–445, Oct. 2006.

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[6] D. H. Pink, *Drive: The Surprising Truth About What Motivates Us*. New York: Riverhead Books, 2011.

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NSEE survey with interventions https://survey.perts.net/share/toi

A rubric is a “scoring tool that lays out the specific expectations for an assignment” (Stevens and Levi, 2011, p.1)

A rubric can be
· Holistic
· Analytic

Why use rubrics?
· Help students understand the criteria used to evaluate their work (Bolton 2006; Reddy and Andrade 2010)
· Increase consistency in grading (Jonsson and Svingby, 2007).
Help provide feedback more efficiently (Stevens and Levi, 2011)

Example rubrics
AAHLE http://course1.winona.edu/shatfield/air/rubrics.htm

Resources

· University of Toronto’s Development of Analytic Rubrics for Competency Assessment (DARCA) project (aligns with ABET student outcomes)
  - https://sites.google.com/site/uoftlearningoutcomesproject/
    - http://ctal.udel.edu/assessment/resources/rubrics/ - Kathy knows a ton about rubrics and inter-rater reliability, etc.
    - AACU Value Rubrics (these are mentioned on the CTAL site, and Kathy Pusecker worked on some of these-- there’s been a lot of validation work on these rubrics)
    - Introduction to Rubrics by Stevens and Levi https://www.amazon.com/Introduction-Rubrics-Assessment-Effective-Feedback/dp/1579225888/
    -

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Learning Objectives

*Do your students complain that your course is unfair? Do students tell you they study the material and do the problems, but still cannot pass your exams? Do you have a clear vision of what your students should be able to **DO** after passing your course?*

"A key to making courses coherent and tests fair is to write **learning objectives** - explicit statements of what students should be able to do if they have learned what the instructor wants them to learn - and to use the objectives as the basis for designing lessons, assignments, and exams." [1]

Why do I need to use them?

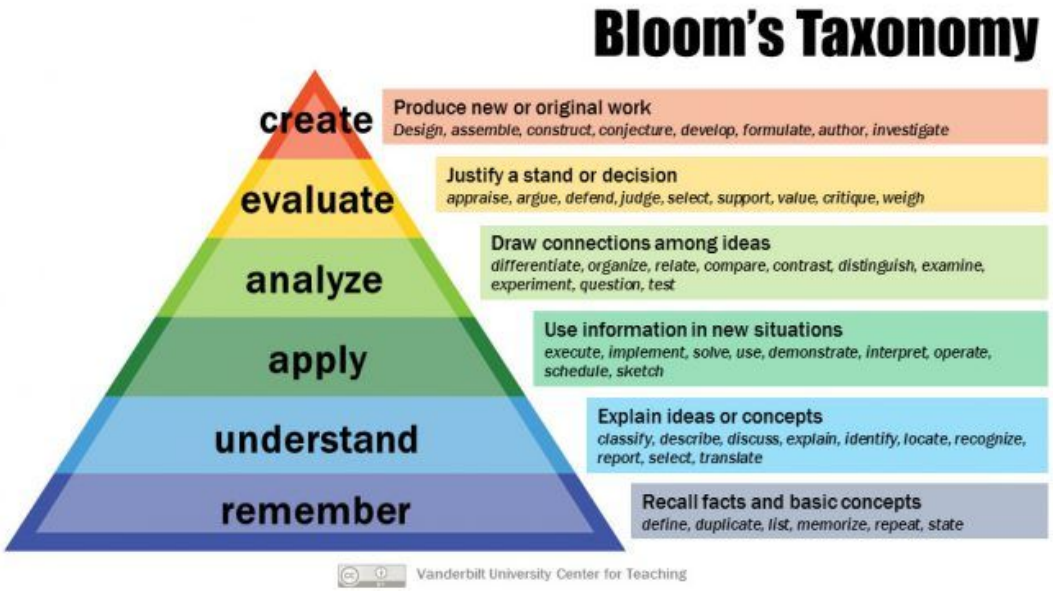
Students generally lack the big picture vision needed to understand what is and what is not important. Learning objectives address this deficiency by providing clarity and focus to the students' efforts. Additionally, learning objectives facilitate instruction by identifying course content and specifying the *cognitive level* of the desired learning outcomes.

Learning objectives tell us not only ***what*** a student should know
but also ***how*** they should be able to ***use*** that knowledge.

How do I use them?

Objectives are developed in close coordination with the six *levels of cognitive learning* described originally by Bloom's taxonomy [2] and more recently revised by Anderson and Krathwohl [3].

- Objectives should specify *observable* actions (see examples used in figure below)
- **Avoid** vague and unobservable terms (e.g. know, learn, understand, appreciate)



Learning objectives may be written for a lesson, a quiz, an exam, the entire course, or a whole program. For example, ABET student outcomes function as program-level learning outcomes. Only 3-6 objectives are typically recommended at the course level.

Level of learning objective	Example(s)
Course	● APPLY the principles of mechanics to calculate stresses in a given mechanism or structure. ● Incorporate the fundamentals of thermodynamics and material properties to DESIGN a heat exchanger.
Exam	● DESIGN the top member of a truss with a given geometric layout and a specified loading. ● Given two alternative designs for a pressure relief valve, COMPARE the alternatives and SELECT the preferred design.
Class/Quiz/Homework	● Given an axially loaded steel bar, CALCULATE the maximum normal stress. ● Using both words and sketches, DEFINE convection and EXPLAIN the process of convection.

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[3] Anderson, L.W. and Krathwohl, D.R., A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives, Addison Wesley Longman, Inc., 2001.

Resources

L. Dee Fink, Creating Significant Learning Experiences, 2nd Ed
- Proposes a taxonomy for “significant learning” (think Bloom’s, plus things like caring and understanding the human dimension)

Barkley, E.F. and Major, C.H., *Learning Assessment Techniques*, John Wiley & Sons, 2016.
- This book uses Fink’s taxonomy of significant learning experiences as a framework

Revised Bloom’s Taxonomy Resources (verbs, images)
- http://www.teachthought.com/category/critical-thinking/blooms-taxonomy/

UD Resources

General Education Objectives: http://sites.udel.edu/gened/
CTAL: Writing a Learning Outcome

Syllabus Design

What should I include in the syllabus? How do I get students to read the syllabus? How do I get students to not ask questions that are covered on the syllabus?

Purpose

A syllabus has multiple functions that should be considered while creating the document.

(1) Plan the course (for example, lay out the schedule and the assessments)
(2) Communicate the objectives of the course (for elective courses, help students decide whether they truly want to take the course or not)
(3) Serve as a "contract" or at least a "reference guide" for course policies (how to contact the instructor/s, coursework policies, etc)

Content

At a minimum, your syllabus should include the following information. Beneath each "main item" on this list are questions to consider as you decide what to include and how.

- Course number, title, semester, section(s), meeting time(s) and location(s).
- Name and contract information for instructor. Consider the following…
  - How can students reach you on campus? How/when do you prefer to be reached? (Office location and hours, phone number, website…)
  - Who are the other instructors, TAs, peer mentors, etc., and how can they be reached?
  - What else do you want your students to know about you?
- Course description, objectives, and prerequisites.
  - Consider whether the official course catalog description is suitable or not for this document. You may want to present your interpretation of it instead.
  - Present the "big-picture" learning objectives for the course. If this is a required engineering course, you may want to consider the ABET a-k outcomes.
- Textbooks, materials, resources
  - At a minimum, which books are used and whether they are required or optional/references.
  - You may also consider indicating what other tools are needed (calculators, safety equipment, etc)
- Assessments and grading scheme
  - Give students an idea of how grades are determined at the end of the course.
  - If you already have them planned, a schedule of due dates for assignments and the dates of any exams.
- Course policies
  - What is the attendance policy?

- What is your policy on canceled classes (due to weather, etc)? How is work made up, homework collected, exam rescheduled?
- How does the academic integrity policy apply?

Additional items to consider for your syllabus include the following:

- Course schedule and structure
  - When will certain topics be addressed?
  - When should certain readings be done?
  - When will homework be assigned? When will it be due?
  - When are projects due?
  - When are exams held?
- "Caveat statement" that schedules/policies are subject to change.
- Inclusive teaching practices
  - How does Disability Services apply?
  - What resources do you want to make students aware of?
  - How do you intend to create an environment for students to learn?

Activities to get students to engage with the syllabus

Take time in the first day of class to give students 5 minutes to read the syllabus, then do a group competition/quiz to have them answer questions about it https://www.facultyfocus.com/articles/teaching-professor-blog/five-things-to-do-on-the-first-day-of-class/

"Syllabus speed dating" – take 10 minutes the first day of class to have students pair off and read the syllabus and ask each other questions, challenging one another to find specific information. Incorporate other questions as icebreakers https://www.facultyfocus.com/articles/teaching-professor-blog/first-day-of-class-activities-that-create-a-climate-for-learning/

Syllabus quiz – give an "open-book" quiz on the syllabus, asking questions that force students to especially read/know the parts you often get questions about. Even better, implement this online in Canvas to have it automatically graded, and consider "adaptive release" so that students must complete the quiz before they can access some or all of the Canvas site.

Sample statements

Academic Integrity

Please familiarize yourself with UD policies regarding academic dishonesty. To falsify the results of one's research, to steal the words or ideas of another, to cheat on an assignment, to re-submit the same assignment for different classes, or to allow or assist another to commit these acts corrupts the educational process. Students are expected to do their own work and neither give nor receive unauthorized assistance.

http://www1.udel.edu/studentconduct/policyref.html Office of Student Conduct, 218 Hullihen Hall, (302) 831-2117. E-mail: student-conduct@udel.edu .

Harassment

It is unacceptable and a violation of university policy to harass, discriminate against or abuse any person because of a person's race, color, national origin, gender, sexual orientation, disability, religion, age or any other characteristic protected by applicable law. Such behavior threatens to destroy the environment of tolerance and mutual respect that must prevail for this university to fulfill its educational mission. Contact the Office of Equity and Inclusion http://sites.udel.edu/sexualmisconduct/how-to-report/ if you believe a violation has occurred.

Faculty Statement on Disclosures of Instances of Sexual Misconduct

If, at any time during this course, I happen to be made aware that a student may have been the victim of sexual misconduct (including sexual harassment, sexual violence, domestic/dating violence, or stalking), I am obligated by federal law to inform the university's Title IX Coordinator. The university needs to know information about such incidents to, not only offer resources, but to ensure a safe campus environment. The Title IX Coordinator will decide if the incident should be examined further. If such a situation is disclosed to me in class, in a paper assignment, or in office hours, I promise to protect your privacy--I will not disclose the incident to anyone but the Title IX Coordinator.

In the event that you, or someone you know, has experienced sexual misconduct that you would like to discuss with a trained individual in a confidential setting, please go to the website of the University's Office of Equity and Inclusion. Here, you will find resources to help you. You are not alone, and this is not your fault. There are members of the University community that you can speak to confidentially, including licensed counselors and members of the clergy. These individuals can be found at the Center for Counseling & Student Development, as well as certain licensed counselors in Student Wellness & Promotion and within pastoral care. UD provides 24-hour crisis assistance and victim advocacy and counseling. Contact 302-831-2226, Student Health Services, to get in touch with a sexual offense support advocate.

For information on various places you can turn for help, click here. For more information on Sexual Misconduct policies, where to get help, and reporting information please refer to www.udel.edu/sexualmisconduct.

Inclusion of Diverse Learning Needs
This course is open to all students who meet the academic requirements for participation. Any student who has documented a need for accommodation should contact Disability Support Services and the instructor privately to discuss the specific situation as soon as possible. Disability Support Services can be reached at 302-831-4643, or dssoffice@udel.edu . DSS staff will coordinate accommodations for students.

Please note: The University of Delaware is committed to all students' learning and welcomes students with disabilities. If you have a documented disability and need for an accommodation in this course, please contact the Office of Disability Support Services located at dssoffice@udel.edu or call 302-831-4643 to coordinate accommodations.

Non-Discrimination Statement, July 2017
The University of Delaware does not discriminate against any person on the basis of race, color, national origin, sex, gender identity or expression, sexual orientation, genetic information, marital status, disability, religion, age, veteran status or any other characteristic protected by applicable law in its employment, educational programs and activities, admissions policies, and scholarship and loan programs as required by Title IX of the Educational Amendments of 1972, the Americans with Disabilities Act of 1990, Section 504 of the Rehabilitation Act of 1973, Title VII of the Civil Rights Act of 1964, and other applicable statutes and University policies. The University of Delaware also prohibits unlawful harassment including sexual harassment and sexual violence.
For inquiries or complaints related to non-discrimination policies, please contact:
Director, Institutional Equity & Title IX Coordinator- Susan L. Groff, Ed.D. groff@udel.edu
305 Hullihen Hall Newark, DE 19716 (302) 831-8063
For complaints related to Section 504 of the Rehabilitation Act of 1973 and/or the Americans with Disabilities Act, please contact: Director, Office of Disability Support Services, Anne L. Jannarone, M.Ed., Ed.S. - ajannaro@udel.edu
Alison Hall, Suite 130, Newark, DE 19716 (302) 831-4643

OR contact the U.S. Department of Education - Office for Civil Rights
(https://wdcrobcolp01.ed.gov/CFAPPS/OCR/contactus.cfm)

Other Resources

UD Syllabus Template:
https://docs.google.com/document/d/1L06gQJFCN7FFktLO0a80yrSrzAnfFJoPBd8M_3iL7Bg/edit#heading=h.w4jpfvl5mhiv
(hyperlink located on CTAL page here: http://ctal.udel.edu/enhancing-teaching/course-design/)

How do I decide which assignments, projects, or exams to give?

Where are areas that I can improve in my teaching, course design, or curriculum?

Assessment

Collecting, reviewing, and using data to measure outcomes and evaluate a student's understanding, a lesson, course, or program in order to improve

Course Grades ≠ Assessment

Assessment provides feedback to students on achievement of learning outcomes. A single letter grade or number does not provide ample feedback on strengths or weaknesses, and sometimes course grades include categories that do not assess the outcomes (e.g., participation points).

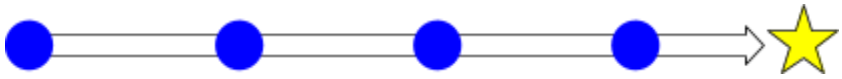
All assessments should provide feedback; however, not all assessments need to be graded.

How do I know if my students understood today's lesson, if they attained the course goals, or if graduates of our program attained the outcomes?

How do I know if my students are "getting it?"

Assessments can be direct or indirect, objective or subjective, quantitative or qualitative.

- **Formative:** *checkpoints* for feedback on areas to improve before the end (of lesson, course, program)
- **Summative:** *final evaluation* to identify/document achievement at the end (of lesson, course, program)



Assessment process for continuous improvement:

1. Define the learning or program outcomes **(refer to… learning outcomes)**
2. Design or select assessment methods and corresponding rubrics **(refer to… rubrics)**
3. Create learning activities that lead to successful achievement of outcomes **(refer to… active learning)**
4. Administer assessment methods and evaluate using rubrics from step 2
5. Close the Loop: Provide feedback and use assessment results to improve teaching and learning

Direct assessment method examples (*For details and other examples, refer to...Learning Assessment Techniques reference below)*

- Essay
- Problem set
- Presentation
- Project
- Portfolio
- Standardized exam (e.g., FE exam)
- Peer Instruction
- Locally developed (you created) exam
- Interview/oral exam (e.g., defense)
- Simulation
- Case study
- Concept map*
- Muddiest point/minute paper*
- Clicker questions*
- Peer review (fill in a rubric evaluating another person's work)*

*Great for in-class, formative assessment

When possible, use **authentic assessments**, which simulate real-world experiences.
Example: A requirements review presentation to a group of stakeholders in the design process.

Frequent, low-stakes assessment enhances student learning because it creates dialogue, builds confidence, and increases motivation. **(refer to… retrieval practice)**

Instructors can use assessment to improve their teaching.

1. Administer a mid-semester course evaluation to the students (anonymous helps encourage honest feedback).
2. Reflect upon the feedback.
3. Address it in class.

Your formal, end-of-semester course evaluations may improve if you take the time to listen to your students and address the weaknesses of the course.

> *Ways you may consider addressing student feedback: provide additional resources, change your pace, prioritize (what's really important/urgent to learn now), re-visit previous lessons, show students their progress, explain the big picture and how concepts fit into it, make explicit connections, drop or modify assignments or allow revisions, etc.*

CTAL also provides resources for continuous improvement in course instruction.

References:

Barkley, E.F. & Major, C.H. (2016). *Learning Assessment Techniques: A Handbook for College Faculty.* San Francisco, CA: Jossey-Bass.

Biggs, J. & Tang, C. (2011). *Teaching for Quality Learning at University 4th ed.* New York, NY: Open University Press McGraw-Hill.

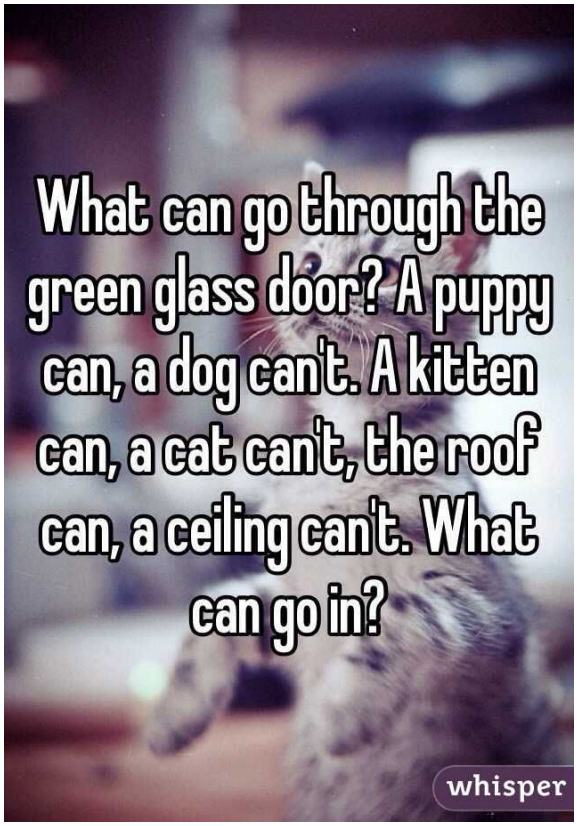
Resources:

https://ctal.udel.edu/assessment/
http://www.abet.org/
https://resources.depaul.edu/teaching-commons/teaching-guides/feedback-grading/Pages/low-stakes-assignments.aspx
http://ctl.yale.edu/Formative-Summative-Assessments
https://www.cmu.edu/teaching/assessment/basics/formative-summative.html
https://ww2.kqed.org/mindshift/2014/01/06/the-importance-of-low-stakes-student-feedback/

Inductive Teaching

Are your students disinterested? Do they ask "why do I need to know this"? Are abstract details failing to stick?

This simple adjustment can quickly energize your students, provide context for theory, and improve the efficacy of your lectures.



"Start with the end in mind"
Inductive: Examples -> Rules
Deductive: Rules-> Examples
Many names: Inquiry, Problem-based, Project-based, Discovery Learning, Just-in-time

Layout the meaningful picture of where this is heading in order to inspire the technical minutiae between here and there.

Giving a context for the abstract makes the material more relatable

If you find yourself saying "trust me you'll need this later" you're not doing inductive teaching. If your students say "will I ever need this" you're not doing inductive teaching.

'Hand it round first, and cut it afterwards.'

Greenfield #2:

Start with why, start with a grand objective, start with the end result you want

Then the students can imagine the steps from here to there and as you give examples and details they will have the framework for placing that information.

Your starting goal gives them a skeletal framework on which to build.

Easy to implement just motivate the abstract by the inspirational.

Cheating
Advising
Attendance - clickers for large classes, dropping a certain number to avoid complaints about missing
Interventions
Proactive vs reactive
Complaints about policies
“Grumpy campers”
During class -- Active learning conflicts (within teams, within small group discussion, inappropriate share-outs)

Retrieval Practice

If we want to be able get information out of our memory, we need to practice retrieving it.

Common wrong assumption: When information comes to mind easily, we've learned successfully.

Reality: When information come to mind easily, it's easy to forget. Just because we learn something quickly does not guarantee we'll remember it.

- The goal is to require *thinking* rather than mindless, passive acquisition of information.
- The key is to "throw away the box." Practice retrieving information without cheating by looking at notes.
- Both short answer and multiple choice are effective, but the more thinking, the more learning.
- Provide feedback, but this doesn't have to be in the form of more grading. For example, discuss answers and provide explanations to a clicker question in class.

Retrieval practice is easy to implement!

Instead of… Rehearsal (putting information *in*)	**Try...Retrieval (getting information *out*)**
Example: Re-reading notes	Example: Quizzing yourself without notes
Easy, but tricks you into thinking you know more than you do; works for short-term but not long-term learning	Challenging because it requires mental effort; the more difficult the retrieval practice the better it is for long-term learning
Lectures	Clickers questions, Response cards
Videos/Readings	Reading checks
Notes	Closing questions (written preferred over oral)
Review sheets	Frequent, low-stakes quizzing
Overview of last class	Opening questions ("Can anyone remind me what we talked about last class? What about last week?")

Example- Minute Paper: Ask students to put away notes and spend 1 minute writing their answer to a question on the lesson's content. This activity provides retrieval practice for the students, and the instructor can also use this feedback to gauge whether the students took away the content they intended. *Example questions: What are the three most significant things you learned during this lesson? How does concept A relate to concept B? Provide an example of...*

The benefits of retrieval practice are well studied and documented for long-term learning/retention.

Don’t get discouraged! You might be surprised by how difficult these seemingly “easy” exercises are for the students. Students may also get frustrated by the challenge. But they’ll get better at it if you persist, and you’ll notice improvements in their learning. Students will be happier with their higher exam grades.

References/Resources

1. Agarwal, P.K. (2017). *Retrieval Practice*. Retrieved from www.retrievalpractice.org (accessed Aug. 16, 2017)
2. Brown, PLC., Roediger, H.L., & McDaniel, M.A. (2014). *Make it stick: The science of successful learning.* Cambridge, MA: Harvard University Press.
3. Kornell, N., Jenson Hayes, M., & Bjork, R.A. (2009) Unsuccessful retrieval attempts enhance subsequent learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 35(4), 989-998.
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5. Miller, M. (2011). What college teachers should know about memory: A perspective from cognitive psychology. *College Teaching,* 59, 117-122.
6. Pyc, M.A., Agarwal, P.K., & Roediger III, H.L. (2014). Test-enhanced learning. In V.A. Benassi, C.E. Overson, & C.M. Hakala (Eds.), *Applying science of learning in education: Infusing psychological science into the curriculum.* American Psychological Association Society for the Teaching of Psychology. Retrieved from http://www.teachpsych.org/Resources/Documents/ebooks/asle2014.pdf
7. Roediger III, H.L., & Butler, A.C. (2007). Testing improves long-term retention in a simulated classroom setting. *European Journal of Cognitive Psychology,* 19, 514-527.
8. Roediger III, H.L., & Karpicke, J.D. (2006). The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science,* 1, 181-210.
9. Rogerson, B. (2003). Effectiveness of a daily class progress assessment technique in introductory chemistry. *Journal of Chemical Education,* 80(2), 160-164.

Figure from https://onsizzle.com/i/1-read-directions-on-box-2-throw-box-away-pull-1648756

Using Teams in Courses (Cooperative Learning)

How should I design group assignments/projects? How do I make sure all individuals are pulling their weight? How do I assign individual grades?

Aside from being a learning outcome for ABET (outcome 7, "an ability to function effectively as a member or leader of a team"), well designed team activities in courses has been shown to benefit student learning.

More formally, this team work is referred to as *cooperative learning* - an instructional method with *individual accountability* at its core that effectively promotes the development of both cognitive and interpersonal skills.[1,2]

Some thought needs to go into using teams in courses so that students benefit from the experience.

Do	Don't
Have a mechanism for creating teams, even if it's just random number generation. Canvas can create randomized teams ("group sets"). The TeamMaker function of the software CATME (catme.org) uses a combination of randomization and student input to create teams based on given parameters (GPA, attitudes toward teamwork, perceived comfort with a specific piece of software).	Always allow students to choose their own groups, especially if learning objectives related to teamwork are involved in your class.
Have some course component that is truly individual, such as an exam covering the full range of knowledge and skills required to complete the group project.	
Carefully consider group size - individual accountability is known to waver in groups large enough to promote "social loafing."	Exceed five members on a "team." In many cases, having six or more members leads to one or more members not contributing, or a fracturing of the team into subsets of three or four members each.
Devote some element of the course to training and explanation of effective teamwork, such as exploration of tools to promote positive interactions, social skills, and group processing. Examples include facilitation of an "icebreaker" event and requiring a "team contract" or "statement of norms" as a team assignment early in the semester. Other examples are summarized in Table 1 of this reference.	Assume students will learn teamwork skills merely because they're working on something in a group.
Explain the main assignment (team project) and the reason teamwork will be used to complete it.	
Help students process how well the group functioned. Collect peer feedback in a way to provide constructive guidance to the group. Again, CATME (catme.org) provides one way to collect information.	

[1] Felder and Brent, chapter in: www.ncsu.edu/felder-public/Papers/CLChapter.pdf
[2] Prince, "Does Active Learning Work?", 2004

There are five essential elements to cooperative learning.[3] These are essentially met with the considerations in the do's/don't's table above.

1) Positive Interdependence: A mutually desirable goal, understanding of "means" and boundaries (resources, roles, and tasks), and personal connection and communication.
2) Individual Accountability: A mechanism to assess the performance of each individual against a standard and a sense that one's contributions to the group matters.
3) Promotive Interaction: The encouragement and facilitation of one another's efforts to accomplish the group's goals.
4) Appropriate Social Skills: Training and support in getting group members to know and trust each other, to communicate accurately and unambiguously, to accept and support one another, and to resolve conflicts constructively.
5) Group Processing: A mechanism to reflect on what group member actions are helpful and unhelpful, and to make decisions about which actions to continue or change.

Resources
http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Oakley-paper(JSCL).pdf

[3] Johnson and Johnson, "An Educational Psychology Success Story: Social Interdependence Theory and Cooperative Learning." http://journals.sagepub.com/doi/pdf/10.3102/0013189X09339057

Team-Based Learning

Team-Based Learning (TBL) in its "purest" sense refers to a specific set of pedagogical practices, incorporated regularly throughout a course.

Definition

Team-Based Learning is an evidence based collaborative learning teaching strategy designed around units of instruction that are taught in a three-step cycle: preparation, in-class readiness assurance testing, and application-focused exercise.

Students prepare for each class by completing some task, such as a reading, video, or problem solution. Individually, they complete a Readiness Assurance Test (RAT), usually a set of 5-20 multiple choice questions related to the preparation work. The individual RAT (iRAT) may be completed before class meets (for example, through a Canvas quiz) or in the first part of that day's class. Then students complete the same RAT in their teams (tRAT), (for example, using IF-AT cards). The rest of the class period is devoted to teamwork on one or more application-focused exercises.

Principles

There are four main principles to TBL:

1. Groups should be properly formed and fixed for the duration of the course. "Properly formed" means creating as well-balanced teams as possible (based on intellectual background and measures of diversity).
2. All students are accountable for their individual pre-learning and for their work in teams.
3. Team assignments must promote both learning and team development.
4. Students must receive frequent and immediate feedback.

iRAT and tRAT Suggestions[4]

Appeals: Teams have the opportunity to do a written appeal of a multiple choice question (MCQ) they felt was poorly written, the answer was mistakenly coded, or their answer choice is better.
Instructor Feedback: The instructor may review material from the RAT that students still feel are problematic.
This test approach that counts for assessment is important, as it gives students a real incentive to learn materials beforehand, attend classes, and contribute to team discussions. The readiness assurance process holds students accountable for coming to class prepared and working together as a team.

Application Exercise Principles

Application exercises are meant to be large, authentic problems that address the "Four S's" --
Significant - the problem must be meaningful and complex enough to require the whole team to engage. For instance, a problem with incomplete or contradictory information where multiple perspectives are needed to make a decision.
Same - all teams in the class work on the same problem, so that follow-up class discussion/debriefing is meaningful.
Specific choice - teams must be able to express their solution by means of a choice that is easy to describe. The most common way to accomplish this is to provide a list of possible solutions upfront, as a multiple-choice question.

[4] (this is just copied from teambasedlearning.org)

Simultaneous report - all teams are required to report at the same time, usually via holding up a colored or lettered card (or other representation of the “choice” the team made), or with use of clickers.

After teams have reported in, whole-class discussion is used to have teams justify their work.

Resources

Many application exercises have been written by UD faculty in the PBL Clearinghouse:
http://www1.udel.edu/inst/

References

Team Based Learning Collaborative, http://www.teambasedlearning.org/
Team-based Learning: A Transformative Use of Small Groups in College Teaching
http://learntbl.ca/what-is-tbl/structured-problem-solving/