Contingent Teaching, Related Methodologies and Research Findings

Academically Adrift: Limited Learning on College Campuses (2011), Arum and Roksa

Using the Collegiate Learning Assessment (CLA) in a pre-test, post-test design, the team found only modest improvement in important learning areas such as critical thinking, reasoning, and writing for over half of a cohort group of students both during the first two years as well as over the entire period of completing a baccalaureate degree.

The authors concluded a general lack of rigor in study and inadequate time spent on academic endeavors reported by students.

In Aspiring Adults Adrift: Tentative Transitions of College Graduates, Arum and Roksa share that students in the cohort are failing to make key transitions after college in:

- citizenship (newspaper readership online or print and political involvement)
- critical thinking needed for job skills (quantitative reasoning and problem solving).

Arum and Roksa still lay the blame at the feet of the academy, arguing that we simply need to ask more of students while they are with us, and more of ourselves. In a Chronicle of Higher Educational article this month, the authors assert that we need to place more institutional responsibility for our own performance in helping students learn what is relevant for their success after graduation. They state that, "As educators, our only chance of avoiding being accountable to external parties is to take greater institutional responsibility for our own performance. Taking seriously the task of improving learning in higher education is not only a responsibility to our students and communities, but is in our own self-interest as professionals."

---

http://www.scientificamerican.com/article/scientists-bring-new-rigor-to-education-research/
Scientific American Volume 311, Issue 2

Scientists Bring New Rigor to Education Research

Fredrik Broden

The new research is challenging widely held beliefs, such as that teachers should be judged primarily on the basis of their academic credentials, that classroom size is paramount, and that students need detailed instructions to learn.

> "… students may actually be more engaged if they struggle to complete a classroom assignment."

Researchers found fairly consistent results:

> Students who practiced first performed 25 percent better than students who listened to a lecture first. "The idea here is that if you have a lecture first and you haven't explored the problem by yourself a little bit, you don't even know what questions the lecturing is answering,"

---

http://www.zdnet.com/blog/igeneration/what-technologies-will-shape-the-future-of-higher-ed/15272

Findings

Academically Adrift: Limited Learning on College Campuses (2011), Arum and Roksa

Using the Collegiate Learning Assessment (CLA) in a pre-test, post-test design, the team found only modest improvement in important learning areas such as critical thinking, reasoning, and writing for over half of a cohort group of students both during the first two years as well as over the entire period of completing a baccalaureate degree.

The authors concluded a general lack of rigor in study and inadequate time spent on academic endeavors reported by students.

In Aspiring Adults Adrift: Tentative Transitions of College Graduates, Arum and Roksa share that students in the cohort are failing to make key transitions after college in:

• citizenship (newspaper readership online or print and political involvement)

• critical thinking needed for job skills (quantitative reasoning and problem solving).

Arum and Roksa still lay the blame at the feet of the academy, arguing that we simply need to ask more of students while they are with us, and more of ourselves. In a Chronicle of Higher Educational article this month, the authors assert that we need to place more institutional responsibility for our own performance in helping students learn what is relevant for their success after graduation. They state that, "As educators, our only chance of avoiding being accountable to external parties is to take greater institutional responsibility for our own performance. Taking seriously the task of improving learning in higher education is not only a responsibility to our students and communities, but is in our own self-interest as professionals."

http://www.scientificamerican.com/article/scientists-bring-new-rigor-to-education-research/ Scientific American Volume 311, Issue 2

Scientists Bring New Rigor to Education Research Fredrik Broden

The new research is challenging widely held beliefs, such as that teachers should be judged primarily on the basis of their academic credentials, that classroom size is paramount, and that students need detailed instructions to learn.

“... students may actually be more engaged if they struggle to complete a classroom assignment.” Researchers found fairly consistent results:

Students who practiced first performed 25 percent better than students who listened to a lecture first. “The idea here is that if you have a lecture first and you haven't explored the problem by yourself a little bit, you don't even know what questions the lecturing is answering,” http://www.zdnet.com/blog/igeneration/what-technologies-will-shape-the-future-of-higher-ed/15272

1

Classroom emphasis is now often placed on challenges and 'active' learning models.
Learning methods can either be focused on one of two things: the teacher or the student. TTT: 'Teacher talking time' is known as passive learning, where a student's attention, in an ideal world, will be focused on the educator -- who may be explaining a task or conducting a lecture.

STT: 'Student talking time', however, is active learning. A student may be involved in a team project, working on a presentation, or performing an independent task. Traditional learning leaned heavily in the midst of TTT, whereas modern methods, at least in certain subjects, attempt to promote STT in order to engage students and encourage student self-learning, where they collaborate and teach each other. Student-centered approaches and 'minimalist' teaching have taken root more in modern times -- this is how I was trained -- and the use of technology such as tablets and smartphones can further promote how a student wishes to engage with a topic independently.

Work is increasingly collaborative, driving changes in how student projects are structured.
As collaboration is more widely expected within a working environment, in order to prepare students, academia has to follow suit in its learning methods. In a world of digital information and continual information exchange, projects are now not only marked based on content, but group dynamics and teamwork.

To facilitate this concept in education, tools including Google Docs, Skype, social networks and wikis are expected to be implemented more widely in the next few years. Are there any other tools or trends you believe the report a overlooked -- such as free online resources?

David Gooblar

They Haven't Done the Reading. Again.

If you believe the research, on any given day, **something like 70 percent of our students come to class having not done the assigned reading.** That phenomenon is immensely annoying to most faculty members. Who among us has not faced a classroom full of blank stares, with seemingly no one prepared to answer the well-thought-out question we've asked about the reading?

By asking questions that point to the use you'll make of the reading, you'll underline the fact that the reading is indeed integral to the course. You'll also provide yourself with useful information to guide your lecture or class discussion.

Classroom emphasis is now often placed on challenges and 'active' learning models.

Learning methods can either be focused on one of two things: the teacher or the student. TTT: 'Teacher talking time' is known as passive learning, where a student's attention, in an ideal world, will be focused on the educator -- who may be explaining a task or conducting a lecture.

STT: 'Student talking time', however, is active learning. A student may be involved in a team project, working on a presentation, or performing an independent task. Traditional learning leaned heavily in the midst of TTT, whereas modern methods, at least in certain subjects, attempt to promote STT in order to engage students and encourage student self-learning, where they collaborate and teach each other. Student-centered approaches and 'minimalist' teaching have taken root more in modern times -- this is how I was trained -- and the use of technology such as tablets and smartphones can further promote how a student wishes to engage with a topic independently.

Work is increasingly collaborative, driving changes in how student projects are structured. As collaboration is more widely expected within a working environment, in order to prepare students, academia has to follow suit in its learning methods. In a world of digital information and continual information exchange, projects are now not only marked based on content, but group dynamics and teamwork.

To facilitate this concept in education, tools including Google Docs, Skype, social networks and wikis are expected to be implemented more widely in the next few years. Are there any other tools or trends you believe the report a overlooked -- such as free online resources?

David Gooblar

They Haven't Done the Reading. Again.

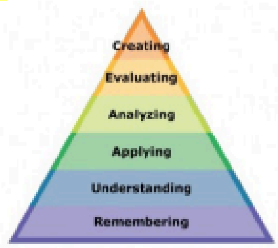
If you believe the research, on any given day, something like 70 percent of our students come to class having not done the assigned reading. That phenomenon is immensely annoying to most faculty members. Who among us has not faced a classroom full of blank stares, with seemingly no one prepared to answer the well- thought-out question we've asked about the reading?

By asking questions that point to the use you'll make of the reading, you'll underline the fact that the reading is indeed integral to the course. You'll also provide yourself with useful information to guide your lecture or class discussion.

Flipping the Classroom

http://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom/

In essence, "flipping the classroom" means that students gain first exposure to new material outside of class, usually via reading or lecture videos, and then use class time to do the harder work of assimilating that knowledge, perhaps through problem-solving, discussion, or debates.



In terms of Bloom's revised taxonomy (2001), this means that students are doing the lower levels of cognitive work (gaining knowledge and comprehension) outside of class, and focusing on the higher forms of cognitive work (application, analysis, synthesis, and/or evaluation) in class, where they have the support of their peers and instructor. This model contrasts from the traditional model in which "first exposure" occurs via lecture in class, with students assimilating knowledge through homework; thus the term "flipped classroom."

Barbara Walvoord and Virginia Johnson Anderson promoted the use of this approach in their book *Effective Grading* (1998). They propose a model in which students gain *first-exposure learning* prior to class and focus on the *processing* part of learning (synthesizing, analyzing, problem-solving, etc.) in class.

To ensure that students do the preparation necessary for productive class time, Walvoord and Anderson propose an assignment-based model in which students produce work (writing, problems, etc.) prior to class. The students receive productive feedback through the processing activities that occur during class, reducing the need for the instructor to provide extensive written feedback on the students' work.

- **CATs** (http://www.celt.iastate.edu/teaching-resources/classroom-practice/teaching-techniques-strategies/check-student-learning/)
    - Classroom assessment techniques **(CATs)** are simple, **non-graded**, usually **anonymous**, **in-class activities** designed to give you and your students useful **feedback** on the teaching-learning process **as it is happening**.

- **Contingent Teaching**

Flipping the Classroom

http://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom/

In essence, "flipping the classroom" means that students gain first exposure to new material outside of class, usually via reading or lecture videos, and then use class time to do the harder work of assimilating that knowledge, perhaps through problem- solving, discussion, or debates.

In terms of Bloom's revised taxonomy (2001), this means that students are doing the lower levels of cognitive work (gaining knowledge and comprehension) outside of class, and focusing on the higher forms of cognitive work (application, analysis, synthesis, and/or evaluation) in class, where they have the support of their peers and instructor. This model contrasts from the traditional model in which "first exposure" occurs via lecture in class, with students assimilating knowledge through homework; thus the term "flipped classroom."

Barbara Walvoord and Virginia Johnson Anderson promoted the use of this approach in their book Effective Grading (1998). They propose a model in which students gain first-exposure learning prior to class and focus on the processing part of learning (synthesizing, analyzing, problem-solving, etc.) in class.

To ensure that students do the preparation necessary for productive class time, Walvoord and Anderson propose an assignment-based model in which students produce work (writing, problems, etc.) prior to class. The students receive productive feedback through the processing activities that occur during class, reducing the need for the instructor to provide extensive written feedback on the students' work.

• CATs (http://www.celt.iastate.edu/teaching-resources/classroom-practice/teaching-techniques-strategies/check-student-learning/)

o Classroom assessment techniques (CATs) are simple, non-graded, usually

anonymous, in-class activities designed to give you and your students useful feedback on the teaching-learning process as it is happening.

• Contingent Teaching

- Contingent Teaching: Since it can occasionally be challenging to determine what students understand and what they do not understand, clickers can be used to gauge that in real-time during class and modify one's lesson plan accordingly. If the clicker data show that students understand a given topic, then the instructor can move on to the next one. If not, then more time can be spent on the topic, perhaps involving more lecture, class discussion, or another clicker question. This approach has been called "agile teaching" by Beatty et al. (2006), who write, "This contrasts with the common practice of teaching according to a 'ballistic' lesson plan: designing a plan for an entire class meeting, 'launching' the plan, hoping that it hits reasonably close to its target, and waiting for the next exam to know for certain." Certainly there are other ways to determine if students are understanding course material as one progresses through a course, but clickers can provide a convenient way of doing so. See also Draper & Brown (2004) for more on this approach.

- **Concept Tests**

  What is a ConcepTest? http://frc.sbcc.edu/pdfs/MazurandAbbot4steps.pdf
  A concept test is a short multiple-choice question designed to test students' conceptual understanding on the topic being discussed. Students choose from the available answers.

  ConcepTests *(from Carleton College....)*
  - Focus on a single concept
  - Can't be solved using equations
  - Have good multiple-choice answers
  - Are clearly worded
  - Are of intermediate difficulty

  ConcepTests (conceptual multiple choice questions interspersed in a lecture): "ConcepTest" refers to questions that assess students' understanding of concepts presented in a lecture.

  During lecture students are presented with a ConcepTest question and "are given one to two minutes to think about the question and formulate their own answers; they then spend two to three minutes discussing their answers in groups of three to four, attempting to reach consensus on the correct answer. This process forces the students to think through the arguments being developed, and enables them (as well as the instructor) to assess their understanding of the concepts even before they leave the classroom." (Mazur Group, 2009)

http://www.physics.oregonstate.edu/portfolioswiki/doku.php?id=strategy:clicker:start

---

o Contingent Teaching: Since it can occasionally be challenging to determine what

students understand and what they do not understand, clickers can be used to gauge that in real-time during class and modify one's lesson plan accordingly. If the clicker data show that students understand a given topic, then the instructor can move on to the next one. If not, then more time can be spent on the topic, perhaps involving more lecture, class discussion, or another clicker question. This approach has been called "agile teaching" by Beatty et al. (2006), who write, "This contrasts with the common practice of teaching according to a 'ballistic' lesson plan: designing a plan for an entire class meeting, 'launching' the plan, hoping that it hits reasonably close to its target, and waiting for the next exam to know for certain." Certainly there are other ways to determine if students are understanding course material as one progresses through a course, but clickers can provide a convenient way of doing so. See also Draper & Brown (2004) for more on this approach.

• Concept Tests

What is a ConcepTest? http://frc.sbcc.edu/pdfs/MazurandAbbot4steps.pdf A concept test is a short multiple-choice question designed to test students' conceptual understanding on the topic being discussed. Students choose from the available answers.

ConcepTests (from Carleton College....)

•

Focus on a single concept

•

Can't be solved using equations

•

Have good multiple-choice answers

•

Are clearly worded

• Are of intermediate difficulty ConcepTests (conceptual multiple choice questions interspersed in a lecture): "ConcepTest" refers to questions that assess students' understanding of concepts presented in a lecture.

During lecture students are presented with a ConcepTest question and "are given one to two minutes to think about the question and formulate their own answers; they then spend two to three minutes discussing their answers in groups of three to four, attempting to reach consensus on the correct answer. This process forces the students to think through the arguments being developed, and enables them (as well as the instructor) to assess their understanding of the concepts even before they leave the classroom." (Mazur Group, 2009)

http://www.physics.oregonstate.edu/portfolioswiki/doku.php?id=strategy:clicker:start

4

ConcepTests (aka Peer Instruction, "Clicker" Questions), invented Eric Mazur, (*Peer Instruction, A User's Manual*, Prentice Hall, 1997) are multiple choice questions that are used during class. Typically the question and the multiple choice answers are posted on a computer projector. All students in the class respond via some kind of a technological "clicker" or by holding up coded pieces of paper. The results of this voting are shown to the class by the instructor. In cases where the class does not hone in on a single answer, students are instructed to "turn to your neighbor" and discuss the problem, then to vote again. The instructor then discusses the results with the class.

There are now many authors of Concept Tests from many institutions and many disciplines. The best concept tests include typical incorrect student answers "distractors" among the multiple choices and require students to understand the concepts being discussed, rather than the ability to do rote calculations. Many are based on Physics Education Research and address prevalent and persistent student problems. Careful preparation of these questions vastly improves their usefulness in the classroom.

Concept Tests were invented to allow for active engagement a large-enrollment environment. If you are blessed with small classes, you might want to try our "Small White Board Questions" which allow for open-ended rather than multiple-choice answers and can be implemented spontaneously.

- **Punctuated Lecture:**

  "I lecture only when I am convinced it will do more good than harm." - Wilbert McKeachie, author of *Teaching Tips:Strategies, Research, and Theory for College and University Teachers*

  A punctuated lecture assessment activity consists of students answering questions about what they are doing while they are present in class. The instructor uses this technique to help **make students aware of their attention strategies, their meaning-making strategies, and/or their note-taking strategies.** Typically, an instructor would lecture on a particular topic and then stop the lecture to administer a punctuated lecture assessment. This provides immediate reflective information for individual students and useful data to instructors on what students do and don't know about classroom learning strategies. This assessment tool also helps remind instructors to cue students from time to time about what students should be doing—especially in first-year and sophomore level courses. (https://collab.ist.psu.edu/learning/?q=node/72

  Because lecturing as an instructional technique can easily become non-learner-centered, it needs to be dealt with carefully. Lecturing can offer an effective way to facilitate learning. However, as a general rule lecturing seems to work most effectively in "punctuated blocks" lasting no more than fifteen minutes. Research supports this approach [Stuart & Rutherford, 1978 and Penner, 1984, as reported in Johnson, D.W., Johnson, R.T., & Smith, K.A. (1998). Active Learning: Cooperation in the College Classroom. Edina, MN: Interaction Book Company.], including this surprising finding: **students recorded items in their notes concerning 41% of**

ConcepTests (aka Peer Instruction, "Clicker" Questions), invented Eric Mazur, (Peer

Instruction, A User's Manual, Prentice Hall, 1997) are multiple choice questions that are used during class. Typically the question and the multiple choice answers are posted on a computer projector. All students in the class respond via some kind of a technoligical “clicker” or by holding up coded pieces of paper. The results of this voting are shown to the class by the instructor. In cases where the class does not hone in on a single answer, students are instructed to “turn to your neighbor” and discuss the problem, then to vote again. The instructor then discusses the results with the class.

There are now many authors of Concept Tests from many institutions and many disciplines. The best concept tests include typical incorrect student answers “distractors” among the multiple choices and require students to understand the concepts being discussed, rather than the ability to do rote calculations. Many are based on Physics Education Research and address prevalent and persistent student problems. Careful preparation of these questions vastly improves their usefulness in the classroom.

Concept Tests were invented to allow for active engagement a large-enrollment environment. If you are blessed with small classes, you might want to try our ”Small White Board Questions” which allow for open-ended rather than multiple-choice answers and can be implemented spontaneously.

• Punctuated Lecture:

“I lecture only when I am convinced it will do more good than harm.” - Wilbert McKeachie, author of Teaching Tips:Strategies, Research, and Theory for College and University Teachers

A punctuated lecture assessment activity consists of students answering questions about what they are doing while they are present in class. The instructor uses this technique to help make students aware of their attention strategies, their meaning-making strategies, and/or their note-taking strategies. Typically, an instructor would lecture on a particular topic and then stop the lecture to administer a punctuated lecture assessment. This provides immediate reflective information for individual students and useful data to instructors on what students do and don’t know about classroom learning strategies. This assessment tool also helps remind instructors to cue students from time to time about what students should be doing—especially in first-year and sophomore level courses. (https://collab.ist.psu.edu/learning/?q=node/72

Because lecturing as an instructional technique can easily become non-learner-centered, it needs to be dealt with carefully. Lecturing can offer an effective way to facilitate learning. However, as a general rule lecturing seems to work most effectively in “punctuated blocks” lasting no more than fifteen minutes. Research supports this approach [Stuart & Rutherford, 1978 and Penner, 1984, as reported in Johnson, D.W., Johnson, R.T., & Smith, K.A. (1998). Active Learning: Cooperation in the College

Classroom. Edina, MN: Interaction Book Company.], including this surprising finding: students recorded items in their notes concerning 41% of

material given in a 15-minute lecture, 25% of material given in a 30-minute lecture, and only 20% of material in a 45-minute lecture. Because **active learning produces better results than passive learning**, we recommend you **give lectures that last fifteen minutes** or less, then move to a learning activity in which **students discover/construct their own knowledge and meaning.**

- **The Interrupted Case Method** (http://jmbe.asm.org/index.php/jmbe/article/view/96/html_3)
  - The **Interrupted Case Method** has proved successful. The way that we have used it is simple: an instructor selects a topic, such as the HIV virus replication cycle. In class, the instructor takes students through a series of carefully developed scenarios drawn from students' texts and recent literature. At each stage, students are given information and asked **to predict what might happen (DRTA*)** if such and such were done.

    Students are asked at what point scientists might attempt to interrupt the viral reproduction cycle. Students are shown a series of options and asked to vote using their clickers, with their choices displayed as a histogram on a PowerPoint slide to the whole class. They are told of one early attempt to control the disease using the drug AZT. Students are asked to predict what would happen if AZT were administered to a patient if the treatment worked, and shown a series of graphs following the number of virus particles in the blood over time. Before voting, they can consult with their neighbors. The instructor, using a microphone, asks a few students their thoughts. After students vote, the real results are shown. Then another experimental scenario is presented, which continues the story line in our understanding of HIV.

    It is important to emphasize that this **case method integrates lecture material, case scenario material, student discussion with their neighbors, clicker questions, clarification of the answers, more lecture, and data.** And the cycle is repeated. The data we have collected indicate that attendance jumps dramatically (90%) and students write that they greatly value this approach over the traditional lecture. Performance on critical-thinking questions also improves and class grades rise. Using clicker cases promises to offset many of the criticisms that have been leveled at science teaching, especially in large enrollment science courses, as **it engages students in real-world problems and challenges them to think every step of the way.**

Peer Instruction

---

material given in a 15-minute lecture, 25% of material given in a 30-minute lecture,

and only 20% of material in a 45-minute lecture. Because active learning produces better results than passive learning, we recommend you give lectures that last fifteen minutes or less, then move to a learning activity in which students discover/construct their own knowledge and meaning.

• The Interrupted Case Method (http://jmbe.asm.org/index.php/jmbe/article/view/96/html_3) o The Interrupted Case Method has proved successful. The way that we have

used it is simple: an instructor selects a topic, such as the HIV virus replication cycle. In class, the instructor takes students through a series of carefully developed scenarios drawn from students' texts and recent literature. At each stage, students are given information and asked to predict what might happen (DRTA*) if such and such were done.

Students are asked at what point scientists might attempt to interrupt the viral reproduction cycle. Students are shown a series of options and asked to vote using their clickers, with their choices displayed as a histogram on a PowerPoint slide to the whole class. They are told of one early attempt to control the disease using the drug AZT. Students are asked to predict what would happen if AZT were administered to a patient if the treatment worked, and shown a series of graphs following the number of virus particles in the blood over time. Before voting, they can consult with their neighbors. The instructor, using a microphone, asks a few students their thoughts. After students vote, the real results are shown. Then another experimental scenario is presented, which continues the story line in our understanding of HIV.

It is important to emphasize that this case method integrates lecture material, case scenario material, student discussion with their neighbors, clicker questions, clarification of the answers, more lecture, and data. And the cycle is repeated. The data we have collected indicate that attendance jumps dramatically (90%) and students write that they greatly value this approach over the traditional lecture. Performance on critical-thinking questions also improves and class grades rise. Using clicker cases promises to offset many of the criticisms that have been leveled at science teaching, especially in large enrollment science courses, as it engages students in real-world problems and challenges them to think every step of the way.

Peer Instruction

Peer Instruction: The teacher poses a question to his or her students. The students ponder the question silently and transmit their individual answers using the clickers. The teacher checks the histogram of student responses. If significant numbers of students choose the wrong answer, the teacher instructs the students to discuss the question with their neighbor. After a few minutes of discussion, the students submit their answers again. This technique often (but not always!) results in more students choosing the correct answer as a result of the peer instruction phase of the activity. This is a fairly simple way to use clickers to engage a large number of students in discussions about course material. This approach can also set the stage for a class-wide discussion that more fully engages all students. See Mazur (1997) for more on this approach.

Eric Mazur and Catherine Crouch describe a modified form of the flipped classroom that they term peer instruction (2001). Like the approaches described by Walvoord and Anderson and Lage, Platt, and Treglia, the peer instruction (PI) model requires that students gain first exposure prior to class, and uses assignments (in this case, quizzes) to help ensure that students come to class prepared. **Class time is structured around alternating mini-lectures and conceptual questions.** Importantly, the conceptual questions are not posed informally and answered by student volunteers as in traditional lectures; instead, all students must answer the conceptual question, often via "clickers", or handheld personal response systems, that allow students to answer anonymously and that allow the instructor to see (and display) the class data immediately. If a large fraction of the class (usually between 30 and 65%) answers incorrectly, then students reconsider the question in small groups while instructors circulate to promote productive discussions. After discussion, students answer the conceptual question again. The instructor provides feedback, explaining the correct answer and following up with related questions if appropriate. The cycle is then repeated with another topic, with each cycle typically taking 13-15 minutes.

How People Learn, the seminal work from John Bransford, Ann Brown, and Rodney Cocking, reports three key findings about the science of learning, two of which help explain the success of the flipped classroom. Bransford and colleagues assert that

"To develop competence in an area of inquiry, students must:
- **a) have a deep foundation of factual knowledge,**
- **b) understand facts and ideas in the context of a conceptual framework, and**
- **c) organize knowledge in ways that facilitate retrieval and application" (p. 16).**

http://mazur.harvard.edu/research/detailspage.php?rowid=8

Peer Instruction: The teacher poses a question to his or her students. The students

ponder the question silently and transmit their individual answers using the clickers. The teacher checks the histogram of student responses. If significant numbers of students choose the wrong answer, the teacher instructs the students to discuss the question with their neighbor. After a few minutes of discussion, the students submit their answers again. This technique often (but not always!) results in more students choosing the correct answer as a result of the peer instruction phase of the activity. This is a fairly simple way to use clickers to engage a large number of students in discussions about course material. This approach can also set the stage for a class- wide discussion that more fully engages all students. See Mazur (1997) for more on this approach.

Eric Mazur and Catherine Crouch describe a modified form of the flipped classroom that they term peer instruction (2001). Like the approaches described by Walvoord and Anderson and Lage, Platt, and Treglia, the peer instruction (PI) model requires that students gain first exposure prior to class, and uses assignments (in this case, quizzes) to help ensure that students come to class prepared. Class time is structured around alternating mini-lectures and conceptual questions. Importantly, the conceptual questions are not posed informally and answered by student volunteers as in traditional lectures; instead, all students must answer the conceptual question, often via "clickers", or handheld personal response systems, that allow students to answer anonymously and that allow the instructor to see (and display) the class data immediately. If a large fraction of the class (usually between 30 and 65%) answers incorrectly, then students reconsider the question in small groups while instructors circulate to promote productive discussions. After discussion, students answer the conceptual question again. The instructor provides feedback, explaining the correct answer and following up with related questions if appropriate. The cycle is then repeated with another topic, with each cycle typically taking 13-15 minutes.

How People Learn, the seminal work from John Bransford, Ann Brown, and Rodney Cocking, reports three key findings about the science of learning, two of which help explain the success of the flipped classroom. Bransford and colleagues assert that "To develop competence in an area of inquiry, students must:

a) have a deep foundation of factual knowledge, b) understand facts and ideas in the context of a conceptual framework, and c) organize knowledge in ways that facilitate retrieval and application" (p. 16).

http://mazur.harvard.edu/research/detailspage.php?rowid=8

One problem with conventional teaching lies in the presentation of the material. Frequently, it comes straight out of textbooks and/or lecture notes, giving students little incentive to attend class. That the traditional presentation is nearly always delivered as a monologue in front of a passive audience compounds the problem. Only exceptional lecturers are capable of holding students' attention for an entire lecture period. It is even more difficult to provide adequate opportunity for students to critically think through the arguments being developed. Consequently, lectures simply reinforce students' feelings that the most important step in mastering the material is memorizing a zoo of apparently unrelated examples.

In order to address these misconceptions about learning, we developed a method, Peer Instruction, which involves students in their own learning during lecture and focuses their attention on underlying concepts. Lectures are interspersed with conceptual questions, called *ConcepTests*, designed to expose common difficulties in understanding the material. The students are given **one to two minutes to think about the question and formulate their own answers; they then spend two to three minutes discussing their answers in groups of three to four, attempting to reach consensus on the correct answer.** This process forces the students to think through the arguments being developed, and enables them (as well as the instructor) to assess their understanding of the concepts even before they leave the classroom.

We have taught two different levels of introductory physics at Harvard using this strategy and have found that students make significant gains in conceptual understanding (as measured by standardized tests) as well as gaining problem solving skills comparable to those acquired in traditionally taught classes. Dozens of instructors at other institutions have implemented Peer Instruction with their own students and found similar results.

Peer Instruction is easy to implement in almost any subject and class. It doesn't require retooling of entire courses or curricula, or significant expenditures of time or money. **All that is required is a collection of ConcepTests (available on Project Galileo) and a willingness to spend some of class time on student discussion.**

http://www.personal.psu.edu/asg102/blogs/portfolio/2011/02/educause-learning-initiative-k.html
Mazur's Peer process involves the following:

- Brief Presentation
- Concept Test
- Clicker Poll 1
- If the % correct is over 70%, he discusses the answer and moves on to repeat the process
- If the % correct is 30-70%, he has the students talk with their peers and discuss their answers and try to convince them that their answer is correct - after which, he has found that most students figure out the correct answer

One problem with conventional teaching lies in the presentation of the material.

Frequently, it comes straight out of textbooks and/or lecture notes, giving students little incentive to attend class. That the traditional presentation is nearly always delivered as a monologue in front of a passive audience compounds the problem. Only exceptional lecturers are capable of holding students' attention for an entire lecture period. It is even more difficult to provide adequate opportunity for students to critically think through the arguments being developed. Consequently, lectures simply reinforce students' feelings that the most important step in mastering the material is memorizing a zoo of apparently unrelated examples.

In order to address these misconceptions about learning, we developed a method, Peer Instruction, which involves students in their own learning during lecture and focuses their attention on underlying concepts. Lectures are interspersed with conceptual questions, called ConcepTests, designed to expose common difficulties in understanding the material. The students are given one to two minutes to think about the question and formulate their own answers; they then spend two to three minutes discussing their answers in groups of three to four, attempting to reach consensus on the correct answer. This process forces the students to think through the arguments being developed, and enables them (as well as the instructor) to assess their understanding of the concepts even before they leave the classroom.

We have taught two different levels of introductory physics at Harvard using this strategy and have found that students make significant gains in conceptual understanding (as measured by standardized tests) as well as gaining problem solving skills comparable to those acquired in traditionally taught classes. Dozens of instructors at other institutions have implemented Peer Instruction with their own students and found similar results.

Peer Instruction is easy to implement in almost any subject and class. It doesn't require retooling of entire courses or curricula, or significant expenditures of time or money. All that is required is a collection of ConcepTests (available on Project Galileo) and a willingness to spend some of class time on student discussion.

http://www.personal.psu.edu/asg102/blogs/portfolio/2011/02/educause-learning-initiative-k.html Mazur's Peer process involves the following:

• Brief Presentation

• Concept Test

• Clicker Poll 1

• If the % correct is over 70%, he discusses the answer and moves on to repeat the process

• If the % correct is 30-70%, he has the students talk with their peers and discuss their answers and try to convince them that their answer is correct - after which, he has found that most students figure out the correct answer

- If under 30%, then there is a lack of understanding, so he goes over the concept and gives an easier question

His proof for the impact on learning is interesting. He used to administer the Force Concept Inventory test before and after his introductory physics course with no change before trying the peer interaction model. After implementation, he noticed a marked increase in scores and has been able to repeat this many times over the last 20 years.

Question-Driven Instruction

This approach combines contingent teaching and peer instruction. Lesson plans consist entirely of clicker questions. Which questions are asked depends entirely on how students answer the questions. An instructor might come into class with a stack of clicker questions, with multiple questions on each topic. As students perform well on clicker questions, the instructor moves on to questions on new topics. As students perform poorly, the instructor asks further questions on the same topic. The instructor does not have a lesson plan in the traditional sense when using this approach. Instead, the course of the class is determined reactively to demonstrated student learning needs. See Beatty et al. (2006) for more on this approach.
http://www.northeastern.edu/edtech/projects/university_initiative/clicker_fall_2009_pilot_northeastern_university

---

DRTA– Directed Reading-Thinking Activity*

Overview:
Predicting, reading, proving; divergent thinking to convergent thinking.
Materials:
Fiction lending itself to prediction works well initially. After students are accustomed to DRTAs, selections from content textbooks or other nonfiction can also be used. The teacher should decide beforehand where students will stop to discuss and predict.
Procedure:

1. Students read selection title (and perhaps a bit of the selection) and make predictions about content.
2. Students read to first predetermined stop. They confirm, refine, or reject their initial hypotheses and justify their ideas with reference to the text. Students then make new hypotheses.
3. Students read the next section and follow procedures in step two. This cycle continues until text is read.
4. Follow-up activities may be completed after the text is read.

• If under 30%, then there is a lack of understanding, so he goes over the concept and

gives an easier question

His proof for the impact on learning is interesting. He used to administer the Force Concept Inventory test before and after his introductory physics course with no change before trying the peer interaction model. After implementation, he noticed a marked increase in scores and has been able to repeat this many times over the last 20 years.

Question-Driven Instruction

This approach combines contingent teaching and peer instruction. Lesson plans consist entirely of clicker questions. Which questions are asked depends entirely on how students answer the questions. An instructor might come into class with a stack of clicker questions, with multiple questions on each topic. As students perform well on clicker questions, the instructor moves on to questions on new topics. As students perform poorly, the instructor asks further questions on the same topic. The instructor does not have a lesson plan in the traditional sense when using this approach. Instead, the course of the class is determined reactively to demonstrated student learning needs. See Beatty et al. (2006) for more on this approach.
http://www.northeastern.edu/edtech/projects/university_initiative/clicker_fall_2009_pilot_northeastern_university

DRTA– Directed Reading-Thinking Activity*

Overview: Predicting, reading, proving; divergent thinking to convergent thinking. Materials: Fiction lending itself to prediction works well initially. After students are accustomed to DRTAs, selections from content textbooks or other nonfiction can also be used. The teacher should decide beforehand where students will stop to discuss and predict. Procedure:

1. Students read selection title (and perhaps a bit of the selection) and make

predictions about content. 2. Students read to first predetermined stop. They confirm, refine, or reject their

initial hypotheses and justify their ideas with reference to the text. Students then make new hypotheses. 3. Students read the next section and follow procedures in step two. This cycle

continues until text is read. 4. Follow-up activities may be completed after the text is read.