

An Introduction to Flipped Classrooms

This section provides an introduction to flipped classrooms. While each flipped classroom guide is mostly similar, each may offer different activities for the module-specific content.

In putting together this guide, we've chosen to use Coursera's definition of flipped classroom, where they define the flipped classroom as "...a form of blended learning, a term that refers to any form of education that combines face to face instruction with computer mediated activities."¹ We also encourage thinking about flipped classrooms and your role as an instructor in the way that King did in "From Sage on the Stage to Guide on the Side"² and as Leicht *et al.* do in their paper "Employing the Classroom Flip to Move "Lecture" Out of the Classroom," where they state that³

In the classroom flip method, the role of the instructor shifts. No longer is the instructor the "sage on the stage" (King, 1993) in which the primary role is to transmit information during class time. Rather he or she uses class time to guide students through a variety of active learning exercises and allows for more student collaboration, without feeling pressure to 'cover' necessary material. (p. 19)

According to Coursera's *Flipped Classroom Field Guide*,¹ successful flipped classrooms share these characteristics:

1. The in-class activities involve a significant amount of quizzing, problem solving and other active learning activities, forcing students to retrieve, apply, and/or extend the material learned outside of class. These activities should explicitly use, but not merely repeat, the material in the out-of- class work.
2. Students are provided with real-time feedback.
3. Completion of work outside class and participation in the in-class activities are worth a small but significant amount of student grades. There are clear expectations for students to complete out-of-class work and attend in-person meetings.
4. The in-class learning environments are highly structured and well-planned.

If you are new to flipped classrooms, do not underestimate the time it may take you to best integrate a flipped classroom into your regular class.^{1,4,5} It is imperative that before assigning the module as a homework or in-class exercise, that you structure the way in which you plan to use the module, the activities you plan to supplement the module with, and the types of assessments (and the assessments themselves) that you will use with the module.^{1,5} Also, communicate your expectations of module completion to your students when assigning a module as an out-of-class activity and the learning objectives you are planning on achieving by using the module.⁴⁻⁷

Please note that the content of topical modules is predicated on completion of the Introductory modules. This means your students will have been exposed to content covering an introduction to ethics, methods of ethics spotting, and a discussion of the ethical dimensions of scientific research. As such, this is also ripe ground for developing a new learning objective for your course. A sample learning objective to cover this material might be what we list as the last learning objective in the modules, “Ethics-spot (research integrity, broader impacts, and embedded ethics) in cases related to myths and research around SUBJECT.” We provide this example here merely for demonstration and encourage you to create a learning objective that best suits the needs of your course while also justifying the use of the module in class.

From Vanderbilt’s Flipping the Classroom guide students may need to be incentivized to prepare for class.^{6,8} In Vanderbilt’s Flipping the Classroom guide, Broome suggests assigning points to outside of class assignments and that “in many cases, grading for completion rather than effort can be sufficient, particularly if class activities will provide students with the kind of feedback that grading or accuracy usually provides.”⁸ Additionally, the Penn State “7 Things You Need to Know About Flipping the Classroom” guide indicates that “providing a means for accountability of students to come prepared to discuss course materials in class can change the dynamic of a classroom, as well as the teaching.”⁹

We offer assessments in the module, but these should not be used as your own assessment. Rather, these are offered as self-checks for students to check their own comprehension throughout the module. This is why each answer is unpacked so that students can see why each selection is correct or incorrect.

Due to the asynchronous nature of students completing the flipped classroom activities, you should have a method for students to contact you with any potential issues with the materials or any questions. Either email or a discussion board can work for these purposes, but make sure to indicate your response policy to the students so that they are clear on how long a response may take. Additionally, as researchers at Penn State discovered, in receiving feedback from students on a flipped classroom pilot, students suggested that instructors should “[provide] a means for students to ask questions, such as a message forum.”³ The authors of this guide have found that using online discussion forums (such as Yammer) in the classroom and requiring students to post their thoughts about out-of-class readings provide a way to structure in-class discussion.

Before considering using a flipped classroom for any of the modules, make sure it is pedagogically appropriate and technologically feasible for your students/your course. We have distilled questions from several flipped classroom guides down to a few questions to consider (note: this is a non-exhaustive list)^{1,6} :

1. Do your students have access to the materials outside of the classroom?
2. Are your students technologically literate enough to complete the module?
3. Is the level of the materials suitable for the level of your class?

These materials are designed for first-year graduate students in science, technology, engineering, and mathematics (STEM) fields. We envision that these modules can also be adapted to upper-level undergraduate classrooms. Before doing so, make sure that the content of the module and the level of discourse contained in the modules are appropriate for your students. If your course is one that centers on this topic, you may think that you can have the students skip the introductory section of each module which presents the basic science of the topic. We would not recommend this, as that material can both serve as a refresher, and is specifically targeted to introduce students to the necessary information to complete the rest of the module.

Here is a (non-exhaustive) list of additional resources:

The Coursera *Flipped Classroom Field Guide* is an excellent resource for instructors who are interested in working with blended classrooms and can be found at:

<https://docs.google.com/document/d/1arP1QAkSyVcxKYXgTJWCrJf02NdephTVGQltsw-S1fQ/view#bookmark=id.a8f43zfmw8cs>

Several universities maintain repositories of resources or guides for flipping your classroom:

Stanford University's collection can be found at:

<https://teachingcommons.stanford.edu/gallery/flipped>

The University of Washington also offers a comprehensive collection of flipped classroom guides which can be found at:

<http://www.washington.edu/teaching/teaching-resources/engaging-students-in-learning/flipping-the-classroom/>

University College Dublin offers several guides for different aspects of flipped classrooms:

E-Learning: Blended Learning in Large Classes: <http://www.ucd.ie/t4cms/UCDTLE0063.pdf>

E-Learning: Guidelines for Good Practice in Designing a Blended Module in Blackboard:

<http://www.ucd.ie/t4cms/UCDTLE0061.pdf>

E-Learning: Planning Your Module Design for On-line or Blended Modules:

<http://www.ucd.ie/t4cms/UCDTLE0062.pdf>

Cornell University's Center for Teaching Excellence has the following flipped classroom guide:

<http://www.cte.cornell.edu/teaching-ideas/designing-your-course/flipping-the-classroom.html>

Vanderbilt University's Center for Teaching has the following flipped classroom guide:

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

New York University's Flipped Classes resources:

<http://www.nyu.edu/faculty/teaching-and-learning-resources/instructional-technology-support/instructional-design-assessment/flipped-classes.html>

University of Waterloo's Centre for Teaching Excellence features this collection:

<https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/lecturing-and-presenting/delivery/class-activities-and-assessment-flipped-classroom>

<https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/planning-courses-and-assignments/course-design/course-design-planning-flipped-class>

<https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/lecturing-and-presenting/delivery/online-activities-and-assessment-flipped-classroom>

Georgia Tech's Center for 21st Century Universities features this guide:

http://c21u.gatech.edu/sites/default/files/Flipped%20Classroom%20Guide_final.pdf

Using the Introduction Modules (Introduction to Moral Literacy & Introduction to Ethical Dimensions of STEM Research) in a Flipped Classroom

The best way to assign the two Introductory modules for a flipped classroom is as an out of class homework assignment. This module has been designed to approximate a week's worth (~three hours) of instructional time and students will need time to complete the introductory module(also ~three hours), so please take both this information and your own experience with completing the module into consideration when determining the length of time to give students to complete the assigned material. Use this experience as one to increase the amount of interacting you do with your students and make sure to poll them afterwards about what they thought did and didn't work.^{1,10}

New York University's "Steps to Flipping Your Class" suggests that the first ten minutes of your class be used to get "...students in the right frame of mind."¹⁰ They suggest review-style activities like an overview of the pre-class content, a Q&A session about the pre-class content, or a quick quiz to see where the students are with respect to the material.¹⁰ We suggest that the latter could inspire a clicker-based (or low-tech, hands-raised) activity for real-time results on where students may be struggling.

Here, we've listed and adapted activities inspired by personal communications¹¹ and found in several flipped classroom guides^{1,6,8,12} to the Introductory modules (note: these activities conform to what Coursera calls an *instructor-led flipped classroom*¹) for use during the rest of class time:

- 12-Steps Analysis
 - When we use the 12-steps method for instruction of STEM faculty, we adopt a policy of "see one, do one, teach one." We also suggest a similar strategy with STEM graduate students. The online module provides the "see one" stage of our approach. Students could be presented with a case in the classroom to analyze in small groups or dyads and then present to the class. Finally, students (in small groups, dyads, or solo) can write a case and present both the case and the analysis to the class.
 - Additional cases that can be used for 12-steps analysis can be found on the Rock Ethics Institute YouTube Channel, "Academic Integrity": <https://www.youtube.com/playlist?list=PL5D0FE90E1C6811D3>
 - STEM-based cases can be adapted from:
 - *On Being a Scientist*
Freely available at: <http://www.nap.edu/catalog/12192/on-being-a-scientist-a-guide-to-responsible-conduct-in>
 - The author has adapted the "Who Should Get Credit for the Discovery of Pulsars?" vignette for this exercise and found

it to work well. Other vignettes from this book may also work well.

- EDSTEMR Analysis
 - Can use the concepts presented in the EDSTEMR module to have students reflect on previous topics covered in your course. Using the EDSTEMR lens, prompt students to think about the EDSTEMR in these topics and present to the class. You can also present additional case studies as in-class prompts. Make sure the case studies you use reflect the learning objectives of your course.
 - RI cases can be found at:
<https://nationalethicscenter.org/>
<http://ori.hhs.gov/>
 - You can also have students engage with the “The Lab” role-playing game offered by the Office for Research Integrity:
<https://ori.hhs.gov/thelab>
 - For broader impacts cases, you can present your own or have students discuss the relevant National Science Foundation literature around broader impacts.
 - *Role-play*: The Introduction to Moral Literacy module features a video vignette. Using this vignette, you can design an in-class role playing activity where students take on the role of students, faculty, the person who left the test on the copier, and the general public while having an in-class discussion or debate that you frame.

We also envision that you could use the flipped classroom to prime course-long projects such as:
-Practice grant or proposal writing projects
-Argument analysis (using 12-steps analysis and/or EDSTEMR) in the scientific literature presented throughout the course

If you have tried any of these activities, please let us know how it went!

Email: rocketics@psu.edu

Subject Line: “Introductory Module Flipped Classroom”

Using the Biofuels Module in a Flipped Classroom

The best way to assign the Biofuels module for a flipped classroom is as an out of class homework assignment. This module has been designed to approximate a week's worth (~three hours) of instructional time and students will need time to complete the introductory module(also ~three hours), so please take both this information and your own experience with completing the module into consideration when determining the length of time to give students to complete the assigned material. Use this experience as one to increase the amount of interacting you do with your students and make sure to poll them afterwards about what they thought did and didn't work.^{1,10}

New York University's "Steps to Flipping Your Class" suggests that the first ten minutes of your class be used to get "...students in the right frame of mind."¹⁰ They suggest review-style activities like an overview of the pre-class content, a Q&A session about the pre-class content, or a quick quiz to see where the students are with respect to the material.¹⁰ We suggest that the latter could inspire a clicker-based (or low-tech, hands-raised) activity for real-time results on where students may be struggling.

Here, we've listed and adapted activities inspired by personal communications¹¹ and found in several flipped classroom guides^{1,6,8,12} to the Biofuels module (note: these activities conform to what Coursera calls an *instructor-led flipped classroom*¹) for use during the rest of class time:

- Depending on the size of your class, you may consider:
 - Partner activities
 - Small group discussions on the material structured with questions that you provide
 - Group debates based on small group discussions
 - Host a debate around any of the following topics where you ask students to bring in their own literature and research as well:
 - Anthropogenic causes of climate change
 - Use of geospatial analysis in the food versus fuel debate
 - Use of geospatial analysis by different communities of researchers
 - Impacts of biofuels crops on different stakeholders including: farmers, policy makers, scientists and researchers, local populations, entire nations
 - Ethical implications of different biofuels crops in different locations
 - If your university has access to the journal articles used in the module, also consider structuring discussions around these articles. Here are links to both:
 - Goldemberg *et al.*

- <http://www.sciencedirect.com/science/article/pii/S0301421508001080?np=y>
- Liska *et al.*
 - <http://www.nature.com/nclimate/journal/v4/n5/full/nclimate2187.html>
- *Role-play*: The Biofuels module features two country/crop specific case studies. Using the country and crop, or the papers, you can design an in-class role playing activity where students take on the role of farmers, policy makers, scientists of different backgrounds, or members of the public while having an in-class discussion or debate that you frame.
- *Presentations*: Have students create videos or presentations on key points in the material that they present to the class during classtime. For example, the assessment case study can be used by students for in-class presentations or discussions. Students can provide their own answers to the prompt. Additionally, you could assign students to bring in their own article (as well as share it with you and their classmates) on the subject matter and perform an ethical analysis of it for their classmates.
- *12 Steps + EDSTEMR*
 - You can use the concepts presented in the EDSTEMR module to have students reflect on previous topics covered in your course. Using the EDSTEMR lens, prompt students to think about the EDSTEMR in these topics and present their own decision problem, unpacked with EDSTEMR and/or the 12-steps method to the class.
 - You can ask students to create and present their own unpacked case studies. Suggestions include, but are not limited to, case studies based on the following crops in various locations:
 - Switchgrass/Miscanthus
 - Jatropha
 - Willow
 - Oil Palms

We also envision that you could use the flipped classroom to prime course-long projects such as:

- Practice grant or proposal writing projects
- Coding-based projects (here, we leave coding vague so that you can adapt it to the type of coding (R, Python, SPSS, Excel) that you employ in your classroom)
- Argument analysis (using 12-steps analysis and/or EDSTEMR) in the scientific literature presented throughout the course

If you have tried any of these activities, please let us know how it went!

Email: rockethics@psu.edu

Subject Line: "Biofuels Module Flipped Classroom"

Using the Solar Photovoltaics Module in a Flipped Classroom

The best way to assign the Solar Photovoltaics module for a flipped classroom is as an out of class homework assignment. This module has been designed to approximate a week's worth (~three hours) of instructional time and students will need time to complete the introductory module(also ~three hours), so please take both this information and your own experience with completing the module into consideration when determining the length of time to give students to complete the assigned material. Use this experience as one to increase the amount of interacting you do with your students and make sure to poll them afterwards about what they thought did and didn't work.^{1,10}

New York University's "Steps to Flipping Your Class" suggests that the first ten minutes of your class be used to get "...students in the right frame of mind."¹⁰ They suggest review-style activities like an overview of the pre-class content, a Q&A session about the pre-class content, or a quick quiz to see where the students are with respect to the material.¹⁰ We suggest that the latter could inspire a clicker-based (or low-tech, hands-raised) activity for real-time results on where students may be struggling.

Here, we've listed and adapted activities inspired by personal communications¹¹ and found in several flipped classroom guides^{1,6,8,12} to the Solar Photovoltaics module (note: these activities conform to what Coursera calls an *instructor-led flipped classroom*¹) for use during the rest of class time:

- Depending on the size of your class, you may consider:
 - Partner activities
 - Small group discussions on the material structured with questions that you provide
 - Group debates based on small group discussions
 - Host a debate around any of the following topics where you ask students to bring in their own literature and research as well:
 - Use of different materials for solar photovoltaics
 - Use of solar photovoltaics in different cities worldwide
 - Solar resource in different cities worldwide
 - Life cycle assessment and the ethical implications of this technique for solar photovoltaic production
 - Solar photovoltaic manufacturing processes
 - If your university has access to the journal articles used in the module, also consider structuring discussions around these articles. Here are links to both:
 - Fthenakis *et al.*
 - <http://pubs.acs.org/doi/pdf/10.1021/es071763q>
 - Dale and Benson

- <http://pubs.acs.org/doi/abs/10.1021/es3038824>
- *Role-play*: The Solar Photovoltaics module features two case studies that focus on different levels of photovoltaic production. Using the level of production or the technologies presented in the module, you can design an in-class role playing activity where students take on the role of stakeholders. They can have a have an in-class discussion or debate that you frame. The role play activity can also be based on the Section 4 12-steps scenario of where to purchase photovoltaics or the final assessment scenario.
- *Presentations*: Have students create videos or presentations on key points in the material that they present to the class during classtime. For example, the assessment case study can be used by students for in-class presentations or discussions. Students can provide their own answers to the prompt. Additionally, you could assign students to bring in their own article (as well as share it with you and their classmates) on the subject matter and perform an ethical analysis of it for their classmates.
 - *Elevator Pitch*: Have students craft an elevator pitch for solar photovoltaics in your area (or present students with an assumption such as “Assume you live in the Pacific Northwest). Have them build an argument to counter misperceptions and present them with an assumption about their target audience (ex: investors, the general public).
- *12 Steps + EDSTEMR*
 - You can use the concepts presented in the EDSTEMR module to have students reflect on previous topics covered in your course. Using the EDSTEMR lens, prompt students to think about the EDSTEMR in these topics and present their own decision problem, unpacked with EDSTEMR and/or the 12-steps method to the class.
 - You can ask students to create and present their own unpacked case studies. Suggestions include, but are not limited to, case studies based on the following ideas:
 - Governance of emerging solar photovoltaic technologies
 - Life cycle assessment versus life cycle cost analysis
 - Tiers of photovoltaic production
 - LCA of different materials for photovoltaic production
 - Where to place solar photovoltaics

We also envision that you could use the flipped classroom to prime course-long projects such as:

- Practice grant or proposal writing projects
- Coding-based projects (here, we leave coding vague so that you can adapt it to the type of coding (R, Python, SPSS, Excel) that you employ in your classroom)

-Argument analysis (using 12-steps analysis and/or EDSTEMR) in the scientific literature presented throughout the course

If you have tried any of these activities, please let us know how it went!

Email: rocketics@psu.edu

Subject Line: “Solar Photovoltaics Module Flipped Classroom”

Using the Sea Level Change Module in a Flipped Classroom

Use this experience as one to increase the amount of interacting you do with your students and make sure to poll them afterwards about what they thought did and didn't work.^{1,10}

New York University's "Steps to Flipping Your Class" suggests that the first ten minutes of your class be used to get "...students in the right frame of mind."¹⁰ They suggest review-style activities like an overview of the pre-class content, a Q&A session about the pre-class content, or a quick quiz to see where the students are with respect to the material.¹⁰ We suggest that the latter could inspire a clicker-based (or low-tech, hands-raised) activity for real-time results on where students may be struggling.

Here, we've listed and adapted activities inspired by personal communications¹¹ and found in several flipped classroom guides^{1,6,8,12} to the Biofuels module (note: these activities conform to what Coursera calls an *instructor-led flipped classroom*¹) for use during the rest of class time:

- Depending on the size of your class, you may consider:
 - Partner activities
 - Small group discussions on the material structured with questions that you provide
 - Group debates based on small group discussions
 - Host a debate around any of the following topics where you ask students to bring in their own literature and research as well:
 - Anthropogenic causes of climate change
 - Effects of sea level change on specific cities (suggestions below)
 - Ethical implications to consider in decision analysis
 - Future methods for informing decision analysis for sea level change
 - If your university has access to the journal articles used in the module, also consider structuring discussions around these articles. Here are links to both:
 - Van Dantzig
 - <http://www.jstor.org/stable/1911632>
 - Lempert *et al.*
 - <http://www.energy.ca.gov/2012publications/CEC-500-2012-056/CEC-500-2012-056.pdf>
 - Task students to create their own Shiny apps using climate change or sea level rise data from a variety of papers and share their apps with the class via report-outs or screencasts.
 - *Role-play*: The Sea Level Change module features two country/decision problem specific case studies. Using the country and decision problem

presented in the module, you can design an in-class role playing activity where students take on the role of stakeholders in the decision problem. They can have a have an in-class discussion or debate that you frame.

- *Presentations*: Have students create videos or presentations on key points in the material that they present to the class during classtime. For example, the assessment case study can be used by students for in-class presentations or discussions. Students can provide their own answers to the prompt. Additionally, you could assign students to bring in their own article (as well as share it with you and their classmates) on the subject matter and perform an ethical analysis of it for their classmates.
- *12 Steps + EDSTEMR*
 - You can use the concepts presented in the EDSTEMR module to have students reflect on previous topics covered in your course. Using the EDSTEMR lens, prompt students to think about the EDSTEMR in these topics and present their own decision problem, unpacked with EDSTEMR and/or the 12-steps method to the class.
 - You can ask students to create and present their own unpacked case studies. Suggestions include, but are not limited to, case studies based on the following locations:
 - Tuvalu
 - Port of New Orleans
 - Port of New York
 - Maldives
 - Bangladesh

We also envision that you could use the flipped classroom to prime course-long projects such as:

-Practice grant or proposal writing projects

-Coding-based projects (here, we leave coding vague so that you can adapt it to the type of coding (R, Python, SPSS, Excel) that you employ in your classroom)

-Argument analysis (using 12-steps analysis and/or EDSTEMR) in the scientific literature presented throughout the course

If you have tried any of these activities, please let us know how it went!

Email: rocketics@psu.edu

Subject Line: "Sea Level Change Module Flipped Classroom"

Author

Stephanie E. Vasko, Ph.D.

References

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- 9 7 Things You Need to Know about Flipping the Classroom. (2011). <<http://tlt.psu.edu/wp-content/uploads/sites/7104/2011/09/2011-Flipping-the-Classroom.pdf>>.
- 10 *Steps to Flipping Your Class*, <<http://www.nyu.edu/faculty/teaching-and-learning-resources/instructional-technology-support/instructional-design-assessment/flipped-classes/steps-to-flipping-your-class.html>> .
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