Seven Steps to Flipped Learning Design: A Workbook

Robert Talbert, Ph.D., Associate Professor of Mathematics

Grand Valley State University, Allendale, Michigan USA

Web: rtalbert.org
Email: talbertr@gvsu.edu
Twitter: RobertTalbert
Google+: http://google.com/+RobertTalbert
GitHub: http://github.com/RobertTalbert

Introduction/Overview

This document is mainly intended for the minicourse *"Creating Flipped Experiences in the College Mathematics Classroom"* offered at the Mathematical Association of America MathFest conference in Washington, D.C. on August 6–8, 2015. During this minicourse, participants will work in focused groups to design a complete lesson for one class using principles of flipped learning design. This workbook contains all the worksheets and some of the philosophy behind a seven-step process for flipped learning design that I outlined in this video.

The seven steps are:

1. Come up with a minimal but comprehensive list of learning objectives for your lesson.
2. Remix the learning objectives so that they appear in order of cognitive complexity.
3. Do a rough design of the in-class activity you intend students to do.
4. Go back to the learning objectives list, and split it into Basic objectives (to be addressed by student prior to class) and Advanced objectives (to be addressed by the class as a whole during and following class).
5. Finish the design of the in-class activity.
6. Design and construct the pre-class activity. (The *Guided Practice* model is given as an example format.)
7. Design and construct any post-class activities you intended students to do.

The inspiration for this workbook came from Dee Fink's article "A self-directed guide to designing courses for significant learning". That article serves as a highly useful guide for "macro" design of courses at the large scale, whereas this workbook hopefully is useful for designing lessons at the "micro" scale.

Each section of this workbook other than the opening and closing sections focuses on one of these steps. And in each of those sections are two subsections: *Philosophy* that gives some background behind the processes in the step, and then *Activity* which readers/participants should do to instantiate the step as part of building an actual lesson.

Step 0: What this process is for

The process and worksheets that follow are intended to help with **designing a single lesson of a single class from a flipped learning perspective**. The default value of "lesson" is a single 50- to 75-minute face-to-face in-class meeting. If your lessons are longer or shorter than this, adjust the worksheet accordingly.

By "flipped learning" we will adopt the definition for flipped learning found at FlippedLearning.org:

> Flipped Learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.

Note that very little about the specifics of flipped learning are given in this definition, and that's appropriate, since **"flipped learning" can look like many different things**. In all of what follows, **add, remove, or modify any elements of the process that make it fit better for your students, your institution, and your professional identity.**

Step 1: Designing learning objectives

Philosophy

To construct a useful lesson in such a way that we can gather evidence of student learning, we have to start with a **clear and unambiguous set of learning outcomes, or objectives** for students. We are answering the question:

> What constitutes acceptable evidence that students have learned what they needed to learn from this lesson?

Every appropriate answer to this question is in the form of a **task** that a student performs and which the instructor assesses, to determine whether the student has performed the task at a level that is acceptable in the instructor's best professional judgment. This means that learning objectives must be:

- **Unambiguous** – The student should be able to tell exactly what they need to do, and how exactly they will know if they have learned something.
- **Action-verb oriented** – Objectives should only refer to actions we can actually measure, rather than internal states of mind or other non-measurable things. As a consequence words like "Know" or "Understand" should not be part of a learning objective (although we obviously want students to know and understand things). Determine what, in your best professional judgment, could a student do to convince

you that he/she "knows" or "understands" something. That action is the real learning objective.

- **Comprehensive** – Everything of importance in the lesson should be addressed by a linear combination of learning objectives (if not by its own learning objective).
- **Minimal** – At the same time, we want to eliminate any redundancies in learning objectives so as to make the cognitive load on students as low as possible (but no lower!).

Step 1 Activity: Making learning objectives

Carefully examine the unit or lesson you have chosen and decide on a list of 3–8 learning objectives that meet the above criteria, and write them out. Remember to use action verbs; write clearly (because the student is the audience here); and make them comprehensive and yet minimal. You may need to make choices about what material to cover and what to leave out. Write those in a list in the space below. **Just list these in the order in which they appear, or the order in which they occurred to you.** We may change that order in Step 2.

Hint: If you're using a textbook, sometimes it's helpful to simply read through the section in the book that your lesson will cover or even skim through the exercises. Between the text and the exercises you should have a fair idea of what the objectives should be according to the book. Then you can modify those using your own agenda for student learning.

If you need more space, or have more than 8 objectives, just put them in a Google Document or on a separate page.

1. Objective:
2. Objective:
3. Objective:
4. Objective:
5. Objective:
6. Objective:
7. Objective:
8. Objective:

Step 2: Remixing the learning objectives

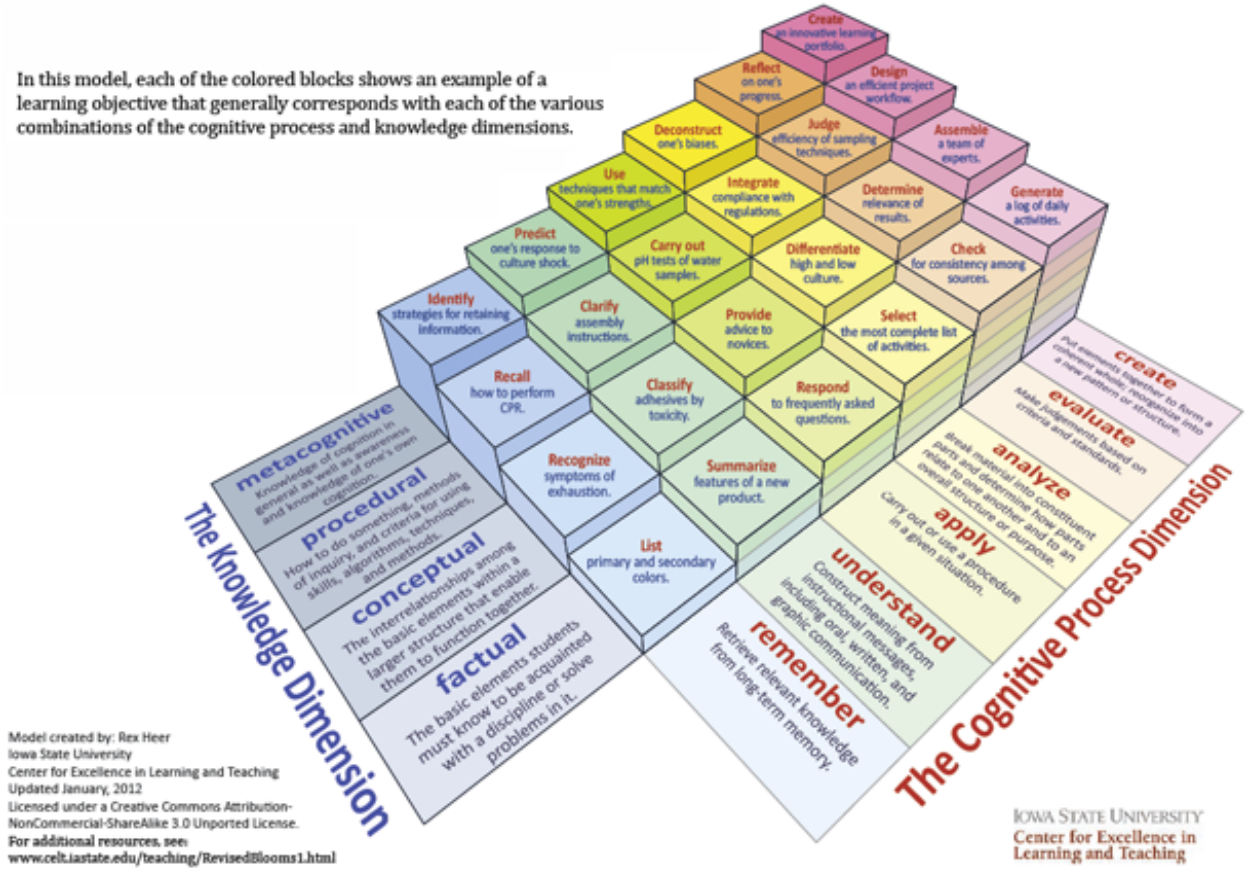
Philosophy

If we were to free-associate the learning objectives for a particular lesson – or even skim them from a textbook – there is a good chance that the order in which we list the learning objectives (in order of appearance, or the order in which we thought of them) is not in order in terms of cognitive complexity. For example we might have listed the most complex learning objective first because it occupies most of students' time; but in fact there may be other learning objectives further down the list that are more basic or simpler.

For example, if teaching the Chain Rule in calculus, "Compute derivatives of composite functions involving two functions" is a good learning objective. But it presupposes another learning objective that instructors might choose to list separately, something like: "Given a composite function to differentiate, determine the inside and outside functions." The latter is clearly less complex than the former because the former contains the latter, but we might not think of them in that order.

Step 2 is about **putting the list of learning objectives, which are the result of a brainstorming process, into order in terms of cognitive complexity**. A useful framework for doing this is Bloom's Taxonomy. Bloom's Taxonomy is often depicted as a pyramid:

Here is a 3D depiction of Bloom's Taxonomy made by Rex Heer at Iowa State University that splits student learning activities into two dimensions (Knowledge and Cognitive Processes) and then vertically by complexity level:



The 3D version is particularly helpful in university-level mathematics where a distinction between **procedural knowledge** (recall of formulas and methods, and performance of mechanical computation) and **conceptual knowledge** (deeper understanding of mathematical concepts, as measured in different ways such as applications and proof) becomes important. If you go to the Iowa State CELT website, the graphic is interactive.

Use of Bloom-like hierarchies can be helpful in placing a partial ordering on the list of learning objectives we have created. The reason for this ordering will become apparent in Step 4.

Step 2 Activity: Remixing

Using one (or more) of the Bloom's Taxonomy visualizations, take the list of learning objectives that you wrote in Step 1 and reorder the items in the list in order from **least complex** to **most complex**. It's OK if you feel like there is more than one way to do this; you are probably right. Some professional judgment will be necessary here.

1. Objective:
2. Objective:
3. Objective:
4. Objective:
5. Objective:
6. Objective:
7. Objective:
8. Objective:

Step 3: Designing the in-class activity

Philosophy

The most important part of a flipped learning lesson is what happens *during*, not *before*, the main class meeting. This is because time in class is scarce, therefore valuable and to be spent on things that cannot be done with the same effectiveness individually. Those activities usually involve the items that are now in the bottom half of your remixed list of learning objectives. These objectives are at the heart of a university-level "understanding" of the subject, and therefore they are of utmost importance. (Which is why we are spending precious class time on them, and not something of lesser difficulty.)

The purpose of this step is to have a rough idea of what you will have students do in class, so that the pre-class activity you design will be focused and free of redundancies and unnecessary work (which will in turn raise the probability of being completed).

This step is also intended to clarify how you will be spending time on other items in your class meeting. For example, here are other activities that could take place during class:

- Beginning class with a brief entrance quiz over the reading and pre-class activity
- Beginning class with a time for Q&A over the reading and pre-class activity (in small groups or as a class)
- Having students present basic exercises (e.g. from a pre-class activity) at the board for the rest of the class to discuss
- Ending class with a one-minute paper or exit ticket

Since time is a scarce resource in class, you have to strike a careful balance between spending time on the main in-class activities and on these other, useful activities. For

example if you have a 50-minute class period, have designed an in-class activity that takes 40 minutes, and you want to spend 10 minutes on an entrance quiz with discussion and then a one-minute paper at the end, the math just doesn't work out and something has to give. You get to decide what, and how.

Here are some miscellaneous recommendations for freeing up more class time for student work, by streamlining or eliminating things we often do in class out of habit:

- **Don't give course announcements in class.** Make class announcements via email or your course's LMS instead. This way students will have a record of the announcement, and no class time is taken up. At the very least, you can put announcements up on the board prior to class or in a handout, and then move on, but if they are on the board (and written clearly) there's no need to reiterate them. It's the students' responsibility to handle information flow.
- **Don't hand back papers in class.** Try handing back papers prior to class time, or by appointment in office hours. I recently realized that if I spent 10 seconds per student in a class of 30 students handing back papers, that I've spent 5 minutes transferring pieces of paper, or 1/10 of the time in the class. We have better things to do.
- **Don't use paper at all.** Have students type up their work, or write it up neatly and then scan it to a PDF, then have them submit work via Dropbox or your LMS or a single-purpose GMail account.

Step 3 Activity: A rough design of the in-class activity

- What are the **main objectives to address** from your list of learning objectives during in-class work? This should be a **relatively short list** of tasks that students should perform that address the most complex items they need to learn, from which students will benefit by working together and with you present as the instructor to help on the spot.

- Generally speaking (you'll flesh out the details later), what are you going to have students *do* in class to show you how well they are mastering those learning objectives you just listed? (In other words, what's a rough outline of the tasks you are going to give to students?)

- In your best professional judgment, about how long will this take? (*Recommendation*: **If your in-class activity is taking up more than 70% of your contact time (e.g. 35**

out of 50 minutes), it needs to be shortened. Can some of it be done prior to class? Can some of it be moved to post-class? Can you give a simpler activity that still engages students at a high level?)

- What *other* activities do you want students to do in class? How long will they take? When are they going to happen during the meeting? (Also: Are all of these necessary or useful enough to justify spending class time on them?)

Step 4: Splitting the list of learning objectives

Philosophy

We now have a list of learning objectives that's ordered by cognitive complexity, and a sense of what is going to happen in class. Now we move backwards and look again at the objectives.

The list of learning objectives shows all the tasks that students should be able to do in order to provide evidence os mastery – *eventually*. The *timing* of that evidence matters, however. We don't need students to show they've mastered *every* learning objective *prior* to coming to class; that's unrealistic, and if it were the case then there wouldn't be much of a need for a class.

So in this step we are going to do students a favor and specify **what they need to be able to do before arriving at class**, and **what they will focus on doing during and after class**. We do this by simply splitting the list of learning objectives in two – drawing a line that separates the pre-class objectives from the in-class objectives. We'll call those objectives **Basic** and **Advanced** respectively.

Where this line is to be drawn is a function of your professional judgment. Look at your ordered list of learning objectives and ask: *Which of these objectives is the most advanced*

task I can reasonably expect a student to be fluent with, through independent study? Just beyond that task, draw the line.

While this document won't discuss much about the *dispositions* that both students and instructors must have for a successful flipped learning experience, here it's important to note that **you should assume that students will do their pre-class work and have meaningful engagement with it through independent pre-class activities**. Decide on your Basic and Advanced lists based on this assumption. Yes, some students may not do the pre-class work. But we are making a choice here to design the class with *success* in mind and let that choice permeate our management of the class. It would be a mistake to design the class around the students who do not choose to engage, because this attitude fails students who do engage. A "Plan B" for non-engaged students would be a good idea – but this is not "Plan A".

Step 4 Activity: Splitting the list

Go back to your ordered list of learning obejctives from Step 2 and draw a line that demarcates Basic Objectives from Advanced Objectives. **Ask yourself**: Why am I drawing the line here?

1. Objective:
2. Objective:
3. Objective:
4. Objective:
5. Objective:
6. Objective:
7. Objective:
8. Objective:

Step 5: Finishing the design of the in-class activity

This step has no separate "Philosophy" and "Activity" sections. All you need to do at this point is finish out the in-class activities you planned in Step 3 – both the main activity and the other activities. Here are some questions to answer as you do this:

- Is the main activity aligned with the Advanced Learning Objectives?

- Are there parts of the main in-class activity that seem too simple (i.e. would fit better in pre-class activities), too advanced (i.e. would be better done after class), or redundant in a non-productive way?

- Are the activities in your main activity substantive, challenging, appropriately pitched to the audience?

- Do you plan on grading the in-class activity? If so, what does the rubric look like, and how will students use the feedback to make improvements?

- Do the other activities for your class session (entrance quizzes, exit tickets, etc.) make sense in the overall context of the class session? Do they take up too much time?

Before moving on, and after answering the questions above, make out a rough timetable for what will happen and when during your class session below.

For MathFest minicourse participants: Please go to your working group's shared Google Drive folder and write up your in-class activity as a Google Document.

Step 6: Designing and constructing the pre-class activity

Philosophy

Now we move on to designing the pre-class activity. **The main purpose of this activity is to prepare students to work productively during the class meeting**. Now that you have designed your in-class activities, you should have a very good sense of what that will take. We want to design an activity that is:

- **Minimal** – It should ask students to do no more than is necessary to demonstrate fluency on the Basic learning objectives and prepare them to work well in class.
- **Simple** – The structure of the activity, and the student work contained in it, should be easy to understand and lead students to the learning activities along a clear path.
- **Engaging** – The work students are asked to do should spark their interest and not discourage them.

- **Productive** – By doing the work in the pre-class activity, students should be well prepared for the more challenging in-class activity coming up.
- **Low-risk** – The pre-class activity should be relatively forgiving, even welcoming, of initial mistakes. Mistakes and errors should not be a source of stress. Rather, they should be collected and used as learning data.

There are many ways to set up effective pre-class activities that satisfy these properties. One method that I've used for several years that works well is called *Guided Practice*. The name suggests to students that what they are doing in this activity is *practice* on essential ideas, with *guidance* in the form of structured activities – and that they are not being thrown into the deep end of the pool, left to their own devices to learn difficult material without help.

Guided Practice activities consist of the following sections:

1. **Overview**. This is a short (one-paragraph) overview of the material students are about to encounter, with an emphasis on how it connects to other things they have learned. This need not be text; a short video would suffice, or a mind map, or some other way of introducing the material and its connections to past content.
2. **Learning objectives**. Here we simply reproduce the split list of learning objectives, clearly labeled "Basic" and "Advanced" so students will know, that we created in Step 4. We give students this list because one of the basic principles of self-regulated learning is that self-regulating learners are in possession of standards against which they can judge their progress as they learn. Eventually in life, students will make up their own objectives. For now, we are traning them to do so.
3. **Resources for learning**. This consists of a recommended "playlist" of items that will help students engage with the basic learning objectives productively and set themselves up for success in the exercises that are coming up. Here we list any text, video, multimedia, or other resources that would be helpful for these tasks.
4. **Exercises**. This section is the main area of activity for students. It consists of a small list of exercises that will instantiate the Basic learning objectives – giving students the "practice" part of Guided Practice.
5. **Instructions for submitting work**. In the final section we give clear instructions on how to submit work. This is an important and often-overlooked step. Students in a flipped learning environment for the first time often feel disoriented, and clear instructions for turning their work in may seem like an obvious thing, but it goes a long way to helping students acclimate.

Below are some actual Guided Practice exercises for some college-level mathematics courses I have used in the past:

- Calculus: The derivative function
- Calculus: Elementary derivative rules
- Calculus: Derivatives of inverse functions
- Calculus: Applied optimization
- Discrete Structures for Computer Science: Closure operations of relations
- Discrete Structures for Computer Science: Connected graphs
- Modern Algebra: Isomorphisms of rings (I was experimenting with a different structure for Guided Practice in this class, so this shows how the basic form above can be altered.)
- Cryptography and Privacy: The affine cipher, cryptanalysis, and number theory

Here are some thoughts about points 3–5 above.

- *The resources for learning should contain a mix of media* – both text and video, as well as interactive websites, podcasts, and anything else that seems relevant and useful.
- *Students should have choice in how they learn the material.* Rather than trying to "make sure students have done the reading", give students a smorgasbord of resources and then endow them with the ability to choose the resources that work best for them. The only thing that matters in the end is whether they have engaged with the Basic objectives and prepared for in-class work. The means by which they did it is a secondary issue.
- *You don't have to make videos if this doesn't fit your situation.* YouTube is a treasure trove of video content, and you can curate pre-existing video materials if you lack the time, resources, or interest in making them yourself. Curating and creating take about the same amount of time if you do thorough quality-control checking of existing videos.
- *Students should not have an undue work load placed on them before class.* A good rule of thumb is that video content should be no longer than a typical in-class lecture would be. Another good rule of thumb is that students should spend 2–3 hours outside of class for every hour of in-class meetings; this rule can be used to judge whether the pre-class activities are too long.
- *Student work on pre-class assignments should be collected before class if possible* so that the instructor knows what students know before the in-class activities begin. Electronic methods of submission are probably the best way to do this. Google Forms are free, simple, and easy to use; students could also submit by email or using online surveys or even web-based classroom response systems. Turning in Guided Practice at the beginning of class on paper is discouraged because instructors should have student learning data from pre-class work before the class starts to know what adjustments to make.

Step 6 Activity: Making a Guided Practice assignment

Note: In the MathFest minicourse, the following are to be done on the Google Document that is set up for your working group.

1. Write out an overview for your lesson; or give a mind map or similar means of introducing the new material and connecting it to previously-learned materials.
2. Copy the split lists of learning objects you made in Step 4.
3. Gather any text, video, or other resources for learning that you can find or make and include this as a list in your document. Remember not to make this too long; and encourage students to add resources that they find and exercise choice in what resources they use.
4. Write up a short list of exercises – "low hanging fruit" that students can do that will lead them through successful engagement with the Basic learning objectives.
5. Determine how students will submit their work, and give clear instructions on how to do this. If you have time, actually make up the form for submitting work and include a link to it.

Step 7: Designing and constructing post-class activities

Philosophy

By the time students finish their in-class work, the work of learning the material in the lesson isn't done. There could be learning objectives that take significant time and space to master, more time and space than are available in a class meeting. It's completely within the definition of flipped learning to have students doing extended work, to reach the uppermost levels of Bloom's Taxonomy, through post-class work – through

Step 7 Activity: Writing post-class activities

- What advanced learning objectives from your list will need further attention after the in-class activity has been completed?

- What other learning objectives (Basic or Advanced) would benefit from further practice?

- What activities outside of class would provide continued engagement with the Advanced learning objectives?

- What activities outside of class would provide further depth and breadth with Basic learning objectives?

- Now make a list of activities to assign for post-class work. Estimate the time required for the average student to complete these activities.

- **[Skip this step for the MathFest Minicourse unless you have time]** Write up the assignments you intend to give for post-class activity.
- Looking at the time estimates for the post-class activities and the time estimates for the pre-class activities, determine whether your total time requirements for out-of-class work average out to 2-3 times the amount of time spent in class. If it's more, then think of ways to trim back the size or extent of some of your activities.

Additional questions to ask as you plan a flipped learning experience

There are many things not addressed in this workbook, but which you should think about and plan for. Some of those are addressed by the questions below.

- How are you going to deploy your materials? Through a LMS, a website, paper handouts, etc.?
- Are you going to grade any of the activities that you've made up here? If so, how?
- How will you handle issues involving access to technology? (For example, will you require all students to have 24/7 access to a high speed internet connection – and what if a student doesn't have that?)
- What plan do you have in place if a student arrives at class having not engaged in any meaningful way with the pre-class activity? What if it's more than just "a" student but a significant group of students?
- What plan do you have in place if a student complains of having to "teach themselves the material"?
- What plan do you have in place if a student complains that you "aren't teaching"? (Or, that the student is "paying tuition to have a teacher" and you are not delivering?)
- Are you going to contact your department head and/or academic dean prior to running a flipped learning designed class?

- Are you going to "flip" an entire class, or just part of one? If just a part, which parts – and why not the others? Also, if you are only partially flipping, then how will you help students to adapt to the two different teaching modalities in your course?
- Are you going to make your own content for the course? If so, will you be doing your own video, your own text, or both of these? What tools will you use? What is your plan for completing the content in a timely way?
- If you are *not* creating your own content, where will you look for curated content, and what will be the basis on which you decide to give a resource to students?
- What plan do you have in place for making your flipped learning materials usable in the long term, so you don't have to rewrite them all the next time you teach the course?
- What plan do you have for sharing your work with others, either in your department or online?
- Are you connected in with a network of colleagues, either in person or online or both, who are also flipping the same class or the same subject? If not, have you considered using Twitter or Google+ to make those connections?

Conclusion

This workbook is just a template for one way of designing courses for flipped learning experiences. There are potentially more that are better in practice for different individuals. What's important in flipped learning is that the **students are the ones who are constructing the meaning and understanding of the material, through intentional design and productive independent learning experiences that are integral to the course**. How you make this happen is up to you and is largely a matter of experience, professional judgment, and personal taste.

The emerging research on flipped learning is showing that flipped learning environments are good for students in almost every way. Students get greater ownership over their learning and practice with lifelong learning skills. Student attainment on course content objectives, across different disciplines, is never worse than in a traditional setting and is in most cases better. Flipped environments make it easy to use the kinds of active learning techniques that are proven, through decades of research, to benefit student learning more than traditional lecture environments. All signs are pointing to flipped learning as an emerging normative practice in K-12 and higher education. We owe it to ourselves professionally, and to our students, to embrace flipped learning and build it into our teaching.