

## BEST PRACTICES IN DESIGNING AN INVERTED CLASSROOM VIDEOS, CLASS PROJECTS AND ASSESSMENT, WHAT WORKS AND WHAT DOESN'T

**Reza O. Abbasian**

Texas Lutheran University  
Department of Mathematics and Computer Science  
Seguin, Texas, 78155 USA  
[rabbasian@tlu.edu](mailto:rabbasian@tlu.edu)

**John T. Sieben**

Texas Lutheran University  
Department of Mathematics and Computer Science  
Seguin, Texas, 78155 USA  
[jsieben@tlu.edu](mailto:jsieben@tlu.edu)

### Abstract

In this presentation we will discuss best practices in designing and conducting an inverted classroom. We will introduce practical advice about producing the short videos, designing in-class activities and projects, and motivating students in passive and active (videos and in-class work) learning components of a flipped classroom.

**Keywords:** math videos, inverted/flipped classroom, pen-tablets, iPad apps, math web resources

### Introduction

The authors are true believers in the power of technology in mathematics instruction and have used technology in the mathematics and statistics classes at Texas Lutheran University for three decades. We started with graphing calculators in 1980s. In the 1990s we incorporated Computer Algebra Systems (CAS) into our teaching, and more recently have utilized online resources such as WolframAlpha.

Two years ago we began experimenting with inverted classrooms, motivated by the work of Salman Khan and the MAA Curriculum Foundations Project report "Voices of the Partner Disciplines". Building a library of short Math videos is the first step in creating flipped classroom which will be the first topic of discussion in this paper. There is a growing number of products and online resources which facilitates production of the videos. We'll share our experiences in using various platforms (iPads or PCs plus graphic pad) and present a list of best practices.

In the second part of our paper, we will focus on the most important component of a successful flipped classroom, namely the in-class activities such as group and individual projects. We will talk about the reference material and types and frequency of assignments. Our presentation is intended for mathematics and/or statistics educators with interest in using instructional videos, online resources and flipped classroom approach to teaching and is appropriate for the newcomer to the flipped classroom as well as more seasoned practitioner.

## Creating Videos

There are two aspects to flipping the classroom: in your virtual presence you must deliver the content of your subject, in your real presence you coach students as they discover the applications of your subject. Considering the popularity of flipped classrooms, the instructors of mathematics will be spending enormous amount of time in dealing with the passive component (creating videos) for flipped classrooms. It is important to note that you may not need to make your own videos. Building a library of math videos is an essential part of creating a flipped classroom but that doesn't mean that you must create this content yourself. Currently there are several online sources which offer short high quality instructional videos on multiple subjects and specifically mathematics and statistics. The Khan Academy's web site [www.khansacademy.org](http://www.khansacademy.org) contains more than 3500 mini-lectures and tutorials, most of them about mathematics and statistics, which can be viewed on YouTube or directly from the Academy's web-site. These videos are offered to the public free of charge and contain most of the topics in undergraduate mathematics ranging from College Algebra to Multivariable Calculus. While there are too many other helpful online resources to list here we will note one more of special interest to mathematics educators. It is <http://www.learnerstv.com/Free-Maths-video-lecture-courses.htm> which offers a large number of short and long math videos.

However, because of varying styles of teaching, most mathematics instructors naturally wish to create their own library of videos and we hope this article will be helpful to them. There is a growing number of products, both hardware and software, promising to make the job of creating instructional videos, if not easy, at least less onerous. Currently, PCs with add-on graphic pads and tablet computers, like the iPad, are the most popular devices for creating these videos. We refer the readers to our paper [1] to see a step by step tutorial showing the audience the details of creating 10-minute videos using an iPad, a stylus pen, and Doceri software as well as using a PC, a Wacom INTOUS pen-tablet, and Camtasia Studio software. In [1] we have introduced the needed hardware and software, the essentials commands of the software, how to use the commands with the help of proper illustrations and the editing capabilities of the software. In the same paper we have also discussed the cost, merits and the shortcomings of each device.

Following is a list of our recommendations for creating videos:

- Plan your week's work. Break the material into a series of short presentation.
- Search online for the videos. You might want to spend your energy creating for your students a viewing sequence of the best of the thousands of video lessons that are already available on the web. If you can't find what you want, then create your own.
- Keep them short (5 to 10 minutes as a guide).
- Scripting your videos is a good idea. It helps you keep within your 10 minute goal and alerts you to tools that you may need to complete the lesson, e.g. virtual calculator, graphing software, spreadsheet, etc.
- Bright colors on a dark background works best. It is most appealing to students.
- Use your own handwriting; avoid duplicating book pages as in a power point.

- It is best if the video shows your work and features your voice and not the full image of you. This gives the student the impression that you are sitting next to her/him and tutoring them through a problem, not lecturing to them.
- If possible have a colleague review your video before posting. This is no different from enlisting an editor to look at your written work before publishing.
- Arrange to host your videos on a server convenient to your student. That may be your department server or YouTube of something in between. You must create a clear index of your videos and be sure students know when to watch them and in what sequence to watch the videos.

### Class projects

This is considered the active learning portion of an inverted classroom. In the traditional class review session the students ask questions and the instructor answers them. Students spend their time copying down answers rather than thinking about the material. In an active review session the instructor poses questions and the students work on them in groups. The instructor goes around the room answering questions, asking further questions, keeping the groups on task, and so forth. This has often been cast as the analogue of coaching students toward an understanding, a version of the Socratic method, definitely not the “sage on the stage” model. After an appropriate time for group discussion, students are asked to share their discussion points with the rest of the class. For more discussion on active learning consult the following web page: <http://www.calstatela.edu/dept/chem/chem2/Active/>

Some of the best practices in class projects are:

- Good projects start with data,
- Require application of skills currently being studied,
- Are somewhat open ended, i.e. requires a basic answer but allow additional work that results in a more complete answer,
- Lend itself to work by a team,
- Are related to “real world” applications

### A Sample Project

Information on times and depth of tides at the Tower Bridge in London UK can be found at:

[http://www.bbc.co.uk/weather/coast\\_and\\_sea/tide\\_tables/2/113#tide-details](http://www.bbc.co.uk/weather/coast_and_sea/tide_tables/2/113#tide-details)

Note that Tower Bridge is also called London Bridge. From this website pick about 10 pairs of (time, depth) measurements for Monday December 2, 2013. Use midnight December 2 as time zero. Information for high and low tides is printed on the left hand side of this webpage, but if you mouse over the graphic you can find times and depth for almost all points.

With the table that you have just built, using  $y = \sin(x)$  as the base function, construct a model for tides at the Tower Bridge. Your finished model will look like  $y = A \sin(Bx + C) + D$  for well-chosen values of A, B, C, and D. How accurate is your model for tides on Monday December 2, 2013? How accurate is it for Wednesday December 4, 2013? Same question for Friday December 6. If you find it is losing accuracy speculate on why.

You may work in small groups on this project. I would like at least one group to present their work on Wednesday. A written copy of your work is due on Wednesday December.

As students work on this project they discuss the role of the parameters A, B, C, and D (amplitude, period, phase shift, vertical shift) and how these relate to the real world tides at London Bridge. They will obtain a model that is easy in the short run but loses accuracy as days go on. The groups of students who think about this deeper or do a bit of additional research will discover that the period is related to a lunar time frame, not a solar timeframe. With that adjustment the accuracy is dramatically improved.

### Conclusions

If we can give students basic tools and inspire them to become life-long learners we have done our job. The inverted classroom will help us do both. This paper was a modest effort to summarize best practices in both passive and active components of designing an inverted classroom.

### ACKNOWLEDGEMENT

We would like to thank the Texas Lutheran University Research and Development Fund which partially supported this research.

### REFERENCES

- [1] Reza Abbasian and John T. Sieben “*Creating Math Videos: comparing Platforms and Software,*” accepted for publication at the Journal of PRIMUS
- [2] Reza Abbasian and John T. Sieben, “*Creating an Inverted Classroom*”, ICTCM, Boston, MA, March 2013
- [3] Reza Abbasian and John T. Sieben, “*Inverted Classrooms: the what, the why, the how,*” Texas Section, Mathematical Association of America, Lubbock, TX, April 2013.
- [4] Reza Abbasian and John T. Sieben, “*A Brief Tutorial on Building a ‘Flipped’ Classroom,*” Annual Joint Meeting of MAA-AMS, San Diego, CA, January 2013