The Flipped Classroom Experiment

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Abstract
This Think Big proposal requests funding to conduct experimental flipped classrooms in four core mathematics classes offered at High Point University. As higher education continues to compete for students with outside online establishments, this experiment is a way for High Point University to become a leading institution in teaching innovation by examining the effectiveness of two different models of mathematics instruction.

Introduction
Education in the 21st century is rapidly evolving towards technology-focused classrooms. Students in today’s society like immediate feedback and are constantly connected to the outside world through technology. While the traditional classroom structure of lecture in class and homework outside of class has worked well for hundreds of years, it is thought of as a “one size fits all model.” This model assumes that students learn best from a lecture based classroom and that all students learn at the same pace. The reality is that students learn at varying paces and at different levels, and allowing more one-on-one time should be beneficial to every student. Finding a new model for the way teachers deliver content is the premise of the flipped or inverted classroom. This model has potential for great success with 21st century students, providing instant feedback, increased conceptual insights, and active, individualized engagement in the classroom.

At the HPU faculty seminars in August, Dr. Carroll presented a TED Talks Video by Salman Khan titled “Let’s Use Video to Reinvent Education” that provided the inspiration behind this Think Big Grant. Khan talks about how and why he created the remarkable Khan Academy, a carefully structured series of educational videos offering complete curricula in math and, now, other subjects. He shows the power of interactive exercises, and calls for teachers to consider flipping the traditional classroom script -- give students video lectures to watch at home, and do "homework" in the classroom with the teacher available to help.¹

After the seminars, a group of faculty members in the mathematics department met to put in place a plan to implement the same idea here at High Point University. We believe that mathematics is a perfect discipline to apply the flipped classroom, as it has been proven successful in other models across the

¹ http://www.ted.com/talks/salman_khan_let_s_use_video_to_reinvent_education.html
Rather than start small, we plan to flip the four most common math courses taken at High Point University. This will impact a larger and more diverse group of students as well as broaden the field of data to help determine the success of this experiment. The four courses we propose to flip are Finite Mathematics, Pre-Calculus, Calculus for the Business and Social Sciences, and Calculus 1.

What a Flipped Classroom Is and What It Is Not

At the most basic level, flipping the classroom simply means reversing the traditional roles of what occurs inside and outside the classroom. Thus students watch prerecorded lectures at home (which would traditionally be given in class), and then class time is utilized to work on problems that would traditionally be completed as homework. In a typical non-flipped course, each student in the group listens individually to the lecture and then students are separated outside of class to complete their homework by themselves—precisely when collaboration would be most useful. The idea of the flipped classroom is that students will do the individual part of the class, the lecture, alone. For the collaborative parts of the class such as solving problems, having discussions, and group work, the students have time in class to work with other students and the professor.

The flipped classroom has a wealth of possibilities, though, and should not be construed as merely switching the places and times that learning is accomplished. A flipped classroom is not simply having students watching prerecorded lectures, and thus replacing the lecture with a video. Although there is an online component, it is not an online course where students are primarily watching a computer in isolation.

A flipped class can and should be much more than what is described above. Putting recorded lectures online allows students to learn at their own pace, rewinding the lectures and watching multiple times if necessary. Although students have a greater ability to internalize the lectures at their own pace, the course maintains the same timeline as a traditional course. A flipped class provides more flexibility, since students no longer have to worry about missing a lecture if they are sick or absent for a sports event, because they can always access the material online. Giving more time for the students to explore during the online lecture also allows for more varied use of technology without taking up a large piece of class time. For example, topics can be learned through online activities instead of lecture, activities that would not fit as well in a traditional in-class lecture. This individualized exploration of course content highlights one of the main benefits of a flipped classroom: students are forced to take more responsibility for their own learning. When more basic material is covered outside of class, students can be more engaged in class, working collaboratively with the professor and other students on questions that reach higher orders of critical thinking. This encourages students to become better learners, not only in the confines of the course but also for the rest of their lives.

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Mathematics is one of the most potentially fruitful disciplines in which to experiment with a flipped classroom. The online format allows students more time to explore content in a way that is not always appropriate for an in-class lecture. For example, when teaching parametric equations one could have a short online lecture introducing the topic. After the short lecture, students would be directed to an online applet game where they use parametric equations to navigate a maze, deepening the students’ understanding of how parametric equations work. Students can then come back to the online lecture and work on the types of questions that arise with parametric equations and calculus. In the traditional math classroom, students are introduced to the material through an in-class lecture and then left to solve the more difficult problems on their own outside of class. The flipped class allows for the easier material to be learned outside of class and provides in-class time for students to wrestle with more difficult problems that involve higher orders of thinking, precisely when collaborative work with other students and face time with the professor are most beneficial. Lastly, much of mathematics is now done in conjunction with technology: graphing calculators and computer algebra systems such as Maple are becoming ubiquitous. A flipped classroom gives students more time to explore such technology outside of class so that they have developed good questions to ask when they are in class.

Proposal
At its core, the flipped classroom experiment is very straightforward. We are requesting funds to help each of the four faculty members put together the best flipped classrooms possible for the students and for future classrooms. In order to prepare for flipping the classroom, each faculty member needs to spend time doing research on the best ways to implement the pedagogy. Then together we can discuss the many intricate details of how we think inverting the classroom should proceed. Researchers in mathematics education have yet to form a consensus on best practices for set up, implementation, and evaluation of a flipped classroom. Some pertinent questions include but are not limited to the following:

- How long should the videos be?
- What outside activities can be woven into the video segments?
- How do we assess whether students are watching the videos outside of class?
- What is the best way to structure in-class time?
- How do we make sure students are engaged and collaborating with their peers in class?

We plan to spend the spring semester meeting weekly to discuss these questions as well as the research regarding the different known implementations. Through these meetings we will formulate a cohesive, research-based method for inverting the classroom.

During the summer months, we plan to take our ideas and create the flipped classrooms for each of our prospective classes. This will entail planning and recording videos for the flipped classes as well as continuing discussions about the best ways to structure the classrooms. In the fall of 2013, the four investigators will each teach two sections of a course. We will teach one section flipped and one section in a traditional, lecture-style setting. Over the course of the fall semester, we will conduct several surveys

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in both classes to compare outcomes in the flipped classroom versus the regular classroom. We will use these surveys along with test grades to analyze the effectiveness of the flipped classroom as an innovative teaching model.

In the spring semester of 2014, we plan to analyze the data and examine our results. These results will then be put together in a paper to be submitted to a mathematics education journal. We feel that the results of a study conducted on four different classes could prove to be quite interesting and significant in the way all faculty members look at teaching future classes. There are studies involving a flipped classroom in one course over multiple sections\(^7,8\) but we are unaware of well designed studies comparing research and control groups across multiple courses. Thus, we believe this will be important new research. We then plan to present our findings to the faculty at the fall 2014 faculty seminars to encourage faculty to try flipping their own classrooms. We also plan to present our findings at two national mathematics meetings, one in August of 2014 and one in January of 2015.

**Target Audience**

The target audience for the project includes undergraduate students from High Point University, High Point University faculty, and practicing teachers and faculty from K-12 schools and other institutions across the country. The impact of the project will be felt specifically by the following groups:

- Undergraduate students enrolled in the following courses to be flipped:
  - MTH 1130- Finite Mathematics
    - Initially-30 students in the experimental class
    - Future-Approximately up to 150 students/year (based on 2011-2012 enrollment in MTH 1130)
  - MTH 1210- Pre-Calculus Algebra and Trig
    - Initially- 30 students in the experimental class
    - Future- Approximately up to 330 students/year
  - MTH 1310- Calculus for the Business and Social Sciences
    - Initially- 30 students in the experimental class
    - Future- Approximately up to 450 students/year
  - MTH 1410- Calculus 1
    - Initially- 30 students in the experimental class
    - Future- Approximately up to 360 students/year
  - Total High Point University Students-
    - Initially- 120 students in the experimental classes
    - Future- Approximately up to 1290 students/year
- Undergraduate students in other courses at High Point University with faculty who choose to flip their classrooms
- High Point University faculty who wish to be trained or encouraged to use the ideas and methods of the flipped classroom
- K-12 teachers and other university faculty as well as their students who may benefit from the presentation of research findings

\(^7\) [http://jointmathematicsmeetings.org/amsmtgs/2141_abstracts/1086-h1-1354.pdf]
\(^8\) [http://jointmathematicsmeetings.org/amsmtgs/2141_abstracts/1086-h1-406.pdf]
Budget Worksheet

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<th>Total Expected Expenses</th>
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<tr>
<td>Computer Equipment</td>
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<td>Tablet computers (4 @ $1175 each)</td>
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<td>Microphones (4 @ $75 each)</td>
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<td>Software (4 @ $180 each)</td>
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<td>Faculty Salaries (4 four-hour courses @ $4667 each)</td>
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<td>Conference Travel</td>
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<td>Total Funds Requested</td>
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</tbody>
</table>

Budget Narrative

Computer Equipment:
The four participating faculty members will be producing videos for students to watch outside of class. We plan to make these videos using the Camtasia software package on tablet computers.

The requested tablet computers allow faculty to write on the tablet screen with a stylus while recording our voices at the same time. Given the amount of mathematical notation used in our courses, this is an essential component to providing quality videos to our students. The faculty member can, for example, use color to emphasize an important point, cut/paste graphs from computer algebra systems, and even switch over to mathematical software packages, all while speaking directly to the student. This essentially allows us to simulate SmartBoard capabilities within our videos. We have priced the desired tablet computer at two different retailers, and the budget reflects current quotes as of January 15, 2013.  

The requested microphones will help to produce videos with optimal sound quality. When the tablet computer’s built-in microphone is used, two problems arise. The first problem is that the instructor’s voice is not easily heard unless he/she is only a few inches from the microphone. The second problem is that the built-in microphone picks up the sound of the stylus each time it taps the screen. Using a higher quality microphone ensures that the instructor’s voice is the primary sound heard.

We are requesting to purchase four copies of the Camtasia Studio software. The regular price is $300 per copy, but with an educator discount, the price is $180 per copy. The University currently has access to a similar product called Camtasia Relay. However, we believe Camtasia Studio will significantly enhance our abilities to produce high quality videos for our students.

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9 http://www.officedepot.com, item #619814
10 http://www.newegg.com, item #N82E16834158363
With Camtasia Relay, instructors do not have the ability to fully edit their videos. For example, an instructor cannot take two short videos and put them together or take a longer video and extract a few minutes from the middle. With mathematics content, in particular, we believe it will be very valuable to be able to record short segments of content and then “paste” them together in a strategic way. This will also allow us to better customize our online content to the needs of our specific groups of students. For example, we will likely record most of our videos in the summer months. During the regular semester, we may realize that students are struggling with a particular topic. With Camtasia Studio, we could record a couple of extra examples and weave them into previously recorded videos. These features would also allow instructors to continue to customize their content for future groups of students.

After the fall of 2013, these computers along with their software and microphones would go to the IT department to be available for other faculty members across campus to request in order to develop their own video content.

**Summer Salary:**
Each of the four faculty members has a significant amount of advance preparation to do to ensure a successful flipped classroom during the Fall 2013 semester. Courses taught in the traditional lecture format typically meet for approximately 40 hours per semester. Each instructor will need to prepare videos that address the same amount of content covered in these typical classes.

The physical preparation of the videos requires significant time on the faculty member’s part. However, equally important is the faculty member’s planning of how the content will be delivered to students in these videos. We aim to create many short, engaging videos that hold students’ attention and challenge them to work to understand the material as they watch. The summer salary requested will enable each faculty member to devote a large portion of his/her summer to this endeavor.

Please note that we were instructed not to include fringe benefits on the summer salary in this budget.

**Travel**
The faculty members plan to present the findings of our work at the two national meetings of our main mathematics professional organizations. These are MathFest (to be held August 2014 in Portland, OR), and the Joint Mathematics Meetings (to be held January 2015 in San Antonio, TX). Two or more of the faculty members participating in the experiment will travel to these conferences to present our findings. This travel money would serve to supplement our professional growth funds for this purpose.

**Partial Funding Options**
We recognize that the committee may not be able to fully fund our proposal. With that in mind, we now provide four possibilities for savings to the overall budget. If the committee decides not to fund the project in full, savings could be achieved via one or more of the changes below.
<table>
<thead>
<tr>
<th>Potential Change to Proposed Budget</th>
<th>Potential Savings</th>
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<tr>
<td>Remove travel funding</td>
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<tr>
<td>Purchase 2 computers rather than 4</td>
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<tr>
<td>Compensate faculty for 3 credit hours each, rather than 4</td>
<td>$4667</td>
</tr>
<tr>
<td>Compensate faculty for 2 credit hours each, rather than 4</td>
<td>$9334</td>
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If travel funding were removed from the budget, the faculty members who present the results of this research at national conferences would apply their faculty development funds toward this travel. Please note, however, that we regularly use our professional growth funds for conference travel to support our traditional mathematics research. If the committee were to decide to approve the purchase of two tablet computers, rather than four, the four members on the project would share computers.

**Timeline**

- **March-May 2013**
  - Submit research surveys to be conducted in the classrooms for IRB approval
  - Meet weekly to discuss implementation of the flipped classroom
- **Summer 2013**
  - Prepare to turn each course into a flipped course by
    - creating all videos necessary for the flipped classroom
    - planning how to manage in-class time for the flipped classroom
    - conducting meetings on how to equalize assessment between the flipped classroom and the regular classroom
- **Fall 2013**
  - Implement the Flipped Classroom Experiment
    - 4 sections total to be flipped
      - 1 Section of MTH 1130-Finite Mathematics taught by Dr. Karen O’Hara
      - 1 Section of MTH 1210-Pre-Calculus taught by Dr. Adam Graham-Squire
      - 1 Section of MTH 1310-Calculus for the Business and Social Sciences taught by Dr. Laurie Zack
      - 1 Section of MTH 1410-Calculus 1 taught by Dr. Jenny Fuselier
      - Conduct research surveys at 3 different times during the semester in both the flipped course and the non-flipped course
- **Spring 2014**
  - Analyze data
  - Begin work on research paper to be submitted in mathematics education journal
- **August 2014**
  - Present work at MathFest-The Mathematical Association of America National Meeting, Portland, Oregon
- **Fall 2014**
  - Present results to HPU faculty to encourage the use of flipped classrooms
• January 2015
  o Present work at Joint Mathematics Meeting-The American Mathematical Society National Annual National Meeting in San Antonio, TX.

**Conclusion**
We believe there is significant interest in the direction of creating a more virtual classroom for the 21st century student. Flipping classrooms has become a buzzword over the past few years in the realm of education. We feel that the scope and magnitude of this project is on such a large scale, and can have such a major impact, that if properly executed we can become a leading institution of innovative higher education. This means investing the time and resources to create truly productive and engaging flipped classrooms, which can endure and be utilized by other faculty here at High Point when teaching the same classes. By creating these flipped classrooms and promoting this idea amongst our colleagues, we can hopefully have lasting effects in transforming the way education is delivered at High Point University and elsewhere.