2013 IG FINAL REPORT

Department of Mathematics (1151)

On Campus or Off Campus:
Flexible Math Courses for OSU Students

This project created a new version of Math 1151: Calculus 1 that affords students the flexibility to experience "lecture" anytime, anywhere outside of class and uses in-person recitation time for guided active learning opportunities. Students were able to participate in recitation sections from a distance, using CarmenConnect, enabling high school students to enroll. This project developed in collaboration with a team doing similar work for Math 2415.

The Ohio State University

Office of
Distance Education
and eLearning

Executive Summary

Goals

The goal of this project was to create a section of Math 1151: Calculus 1 which would be more flexible for student schedules, would be able to be taken from a distance, would be open to high school students for post-secondary credit, and which would implement the educational theories of active learning in the flipped classroom. Traditional lectures were replaced with online, interactive lessons. Recitations were HyFlex and made use of instructor-guided group work.

Outcomes

Overall students and instructors seemed to enjoy the Flipped and Flexible course format. Instructors were very positive about online lessons and group work during recitation on weekly surveys. Students generally completed their online lessons, came to recitation, and performed about as well as students in other sections on common departmental exams. Some students did not like the format as well as the traditional format, but many students expressed appreciation for the flexible schedule and the ability to rewatch online lessons. One group of high school students completed the course entirely from their school and were some of the best students in the class. Students from other sections of 1151 were able to access the online lessons through the MSLC website http://mslc.osu.edu/math-1151-online-lessons and many did so. The instructional videos for the lessons are also available and being used worldwide on YouTube.

Process Analysis

Overall, the project went very well. A diverse team of experienced teachers planned and executed a complex course revision within a limited timeframe. Meaningful data about the success of this project and students' preferences for hybrid education were gathered. There were complications: online lessons were time-intensive to create, the digital inking board in the classroom was not reliable, and the connection between the integrated online lessons and Carmen sometimes timed out while students were working.

What We Learned, in a Sentence

It is possible to have a single class with in person students and online students.

5 Talking Points

1. Many students expressed appreciation for the flexibility of this model, including student athletes, students who work full time, students with course scheduling conflicts, students with children and families, students on regional campuses, and high school students.
2. Articulate Storyline online lessons successfully replaced traditional live lectures, eliminating the need to schedule scarce large lecture rooms.
3. The learning outcomes in this pilot were essentially the same as other sections of Math 1151. The use of learning technologies allowed us to do the same amount of teaching and learning with less face time and greater flexibility.
4. This format enabled honors high school students to gain credit for freshman-level courses at OSU and have an experience equivalent to courses taken by on-campus OSU students, including interaction with them. According to the OSU Academy, it would be convenient for this group of students to have more courses offered this way.
5. There should be more classrooms like Baker 285. We demonstrated the high value of 30-35 person classrooms with a reliable digital inking device, tables for groupwork, and the ability for students to see even if they are facing the other way at their table. Students learn well here.

Project Committee

Department of Mathematics

Lead

- **Darry Andrews** <dandrews@math.osu.edu>, Course Coordinator

Team

- **Elizabeth Miller** <elizmiller@math.osu.edu>, Instructional Aid Associate
- **Heather Smith** <smith.9973@math.osu.edu>, Online Course Material Production
- **Victor Ferdinand** <ferdinand.1@osu.edu>, Recitation Activities Developer
- **Carolyn Johns** <johns.125@math.osu.edu>, Assistant to the Director

Task-Specific Team Members

- **Bryce Steel** <steel.28@math.osu.edu>, Tech Liaison

Office of Distance Education and eLearning (ODEE)

ODEE Project Lead

- **Henry Griffy** <griffy.2@osu.edu>, Grants Coordinator, ODEE Digital Scholarship

ODEE Constituents

- **Robert Griffiths** <griffiths.44@osu.edu>, Director, ODEE Digital Scholarship and Development

Project Goals and Objectives

Overview

The goal of this project was to create a section of Math 1151: Calculus 1 which would be more flexible for student schedules, would be able to be taken from a distance, would be open to high school students for post-secondary credit, and which would implement the educational theories of active learning in the flipped classroom. The traditional lectures would be completely replaced with online lessons which include videos, scaffolding, quiz questions, and choices for students such as what they want to learn next or how many examples they would like to see. HyFlex recitation sections would feature guided group work, allowing students to master concepts with instructor assistance. Students could attend recitations in-person or from a distance. This format would reduce class time from 5 hours a week to 2 hours a week; these 2 hours could be attended online or in person. The goal was that this course format would be satisfying to students who need a more flexible format without sacrificing any of the academic depth or rigor of the course and would allow students to perform similarly on common department exams. Students were supported from a distance through online tutoring, email, and a class discussion board in Piazza.

Goals for incorporating the flipped and flexible model into the 1151 curriculum involved improving student experience in several ways:

- Enable broader access (esp. for high school students)
- Stimulate active participation
- Provide flexibility and choice for students
- Incorporate more learning styles
- Deepen understanding of course material
- Enhance the departmental eLearning culture

In addition to improving student experience, this project aimed to develop a class model that would improve course delivery for the Math department:

- Collaborating with course coordinators should enable the team to develop course materials such that students in the flipped classroom model sections will have the same content and assessments as students in traditional sections.
- Material developed for the flipped and flexible class—lectures, demonstrations, and activities—will be available for use by other math 1151 instructors and students, so all the students will benefit, regardless of the section they are in or the recitation instructor they are assigned.
- Lessons about incorporating active learning will be leveraged to improve student

experiences across all sections of Calculus.

Goals achieved

We achieved all the major components of this project. In-person lectures were replaced with interactive online lessons. Those lessons were embedded in Carmen, simplifying access and streamlining grading. The recitation handouts were created, instructors were mentored to teach using active learning, and students worked in groups and presented solutions. CarmenConnect was set up and students were able to attend the recitation, work in groups, and present their solutions to the class online using Connect. One group of high school students completed the course entirely from their school and were some of the best students in the class.

- **Re-design and build materials for flipped presentation**
    - Provide online materials that students access before class, replacing traditional lecturing
        - *The online lessons are high quality and will be able to be used for many semesters to come. Students in traditional sections of Math 1151 are using them to study without active promotion. This work took significantly longer than expected and ended up being a large portion of the budget as well, but high quality, reusable materials were produced. Representative screenshots are included as Appendix A.*
        - *Learning to make these materials ADA compliant was a difficult and time consuming process, but hopefully others can learn from our experience so they will be able to get started right away. Style Guide included as Appendix B.*
    - Allow for flexibility and for the current instructor to add their own materials to the course
        - *We chose Articulate Storyline to create these online lessons, and it enables easy changes.*
        - *Create templates and style guides to ensure consistency and minimize instructor effort.*
- **Re-design and build activities for the course structure**
    - Develop an at-a-distance/asynchronous format which allows students to actively participate in the course online
        - *The team developed a full set of activities for Math 1151, designed to be suitable both for in-person and CarmenConnect-mediated group work.*

        - *We had trouble with the Epson smart board in Baker 285. This would not always write reliably, which would cause problems for the online students.*
    - Develop a HyFlex/synchronous format which uses technology to encourage active participation and group learning.

        - *Allowing online students to smoothly participate in the in person class ended up requiring an undergraduate class assistant in the classroom during each recitation to facilitate the transition between in person and online. This worked quite well.*
    - Work with the MSLC to provide online tutoring for these courses.
        - *Online tutoring was provided for these courses, although not as many students took advantage of it as we expected.*

- **Re-design and build assessments suitable for distance/flexible course structure:**
    - For high-value assessments (exams): Organize a structure for administering proctored / written exams for online students
        - *All students except high school students took the common evening exam or common makeup exam. High school students took their exam at their high school, proctored by a high school teacher.*
    - For lower-value assessments (quizzes):
        - *We used MyMathLab to administer quizzes which are usually given in class. Students still submitted written work to get feedback before exams.*
        - *Online lessons included formative assessments which were integrated with the Carmen gradebook through SCORM. These questions motivated students to be engaged with the online lessons and gave recitation instructors information about student comprehension before class.*
    - Design and provide online homework/assessments
        - *Online homework was already available through MyMathLab to all 1151 students, but we did develop a method for online quizzing (see above) and for grading the online lessons through embedded, scored questions.*

- **Choose, integrate, and configure Learning Management System(s)**
    - Platform to deliver course content to enrolled students only (e.g., Carmen)
        - *Carmen was used to deliver the course content to enrolled students. This worked well, except for the online lessons. The online lessons in Carmen would sometimes have trouble loading and the scores would not always transfer. This seemed to be due to internet connection issues and Carmen overload issues.*
    - Platform to make course content available to wider audience (e.g., iTunes U)

        - *Online lessons are available to other Math 1151 students on the Mathematics and Statistics Learning Center website. http://mslc.osu.edu/math-1151-online-lessons This website is also open to the world. Videos used in the online lessons are available on youtube as well.*
    - Chosen and configured for wide future adaptability: suitable for other math courses, available on multiple platforms and devices, accessible to all users, etc.
        - *Articulate Storyline produces HTML files which are rendered in Flash, HTML5, or a native iPad app, depending on the user's device. Unfortunately, the iPad app does not yet support integration with the Carmen gradebook, so students with i-devices had to use the HTML5 version for a grade.*
        - *The online lesson set-up is suitable for other math classes, and will be expanded to Math 1152: Calculus 2 for Autumn 2014.*
- **Develop implementation plan and materials**
    - For instructors: Provide training to enable instructors to teach these classes during the project term
        - *Recitation instructors were trained before the semester began in the course set-up and technology, but most of the mentoring occurred during weekly meetings held throughout the semester. In these meetings, we discussed how the course was going and how best to implement active learning in the recitation sections.*
- **Project and Process Goals**
    - To develop expertise and team structure for offering technology enhanced and distance courses in the math department.
    - To replace the existing CROSU program with a program which allows both high school and OSU students to participate in the same sections of the same course and also allows for other distance students to join the course as well.
    - To enable active learning during class time.
        - *These were all accomplished.*

Goals partially achieved

- **Develop implementation plan and materials**
    - Recruitment and orientation materials: clear communication to students about their choices for these courses *before* they sign up for classes (for OSU students and for high school and distance students)

        - *About 50% of students indicated on the survey that they were aware they were signing up for a hybrid, tech-enhanced section of Math 1151.*
        - *High school students were made aware of the project, but the time frame made it difficult for many high schools. They begin making decisions about the courses their students will take in Autumn the previous Autumn. We did have a group of 4 students from DeSales High School which took the course, did well, and their teacher was very positive about the course.*
    - Documentation of how these courses are taught for future semesters, and a clear plan on how these courses will be overseen
        - *This is ongoing this semester. The same instructor (Elizabeth Miller) is "lecturing" this course again this spring, and we are making small revisions, documenting, and planning for future semesters.*
        - *The department decided that the recitation instructors for these Flipped and Flexible courses will be instructors at the lecturer or post-doc level and not graduate students. This means that these recitation instructors are natural candidates to "lecture" the course in future semesters.*
    - Recruit future instructors by exposing TAs and interested faculty to some information about the project so they can choose whether to participate
        - *This is an ongoing goal. Some basic information about the pilot was presented at a recent department faculty meeting. A meeting was also held to discuss the pilot and results with department administrators, including those in charge of staffing this course in future semesters.*
- **Integrate Pearson MyLabsPlus (MyMathLab) with Carmen**
        - *This has been an ongoing project since before this pilot, but one which this pilot course uses heavily and relies on. Grades were able to be automatically transferred from MyMathLab to Carmen at the end of the semester for the pilot course and all other Math courses using MyMathLab (about 6000 students in Autumn 2013). The technology is now in place for these grades to be updated every 24 hours throughout the semester. This is currently being piloted in the Flipped and Flexible course in Spring 2014 and will likely be turned on for all math courses using MyMathLab later this semester.*

Goals not achieved

- **There were no goals not achieved.**

Goals not actively pursued

- **Develop a synchronous, at-a-distance equivalent for office hours**
    - *With online tutoring and in-person office hours, there was not an apparent need for this.*
- **Choose and implement an in-class response system (BYOD clickers)**
    - *It was decided that with the small size of the recitation classes, introducing another system for polling would not be worth the added complexity for the students and instructors.*

Project Implementation

Students affected by pilot

There were 184 students in the pilot section. There are 2152 other Math 1151 students during Autumn 2013 who had access to the online lessons. The MSLC website which hosted the online lessons had 4,383 visits during Autumn semester. The YouTube page for just the additional lecture videos (not counting the MOOCulus videos or the extra example videos) had 17,617 views for 59,498 minutes during Autumn semester.

We intend to offer one lecture section of Math 1151 each semester and, beginning in Autumn 2014, one lecture section of Math 1152 as well. This means approximately 1000 students will be taught in this format each year. There will also be approximately 5000 other students in 1151, 1152, and 1172 each year who will benefit from access to the online lessons. There have also been 5870 views of the YouTube page referenced above this month alone.

Approximate time spent by department faculty and staff on the project

TEAM MEMBER	HOURS
Elizabeth Miller	600
Darry Andrews	25
Carolyn Johns	50
Vic Ferdinand	150
Heather Smith	450
Undergrad Class Assistants	180
Recitation Instructors (Extra Meetings and Training)	50
Work-study Students Transcribing Videos	75 (continuing on 1151 materials)

Total	**1,580**

Approximate total cost (not including ODEE staff time)

RESOURCES	COST
Articulate Licenses	3,500
Heather Smith - to assist in creating Online Lessons (SU13 and AU13)	9,000
Class Assistants during Recitations	2,400
Web Camera to allow online students to see the recitation	100
Total	**15,000**

Project Implementation Process/Timeline

MILESTONE/DELIVERABLE	TARGET	ACTUAL
Recruitment plan for HS students completed	Mon 3/4/2013	April
Recruitment materials for HS students completed	Mon 3/11/2013	April/May
Contacts for HS Student Recruiting Made	Sat 3/16/2013	April/May
Advertisement to current Pre-Calculus Students	Tue 3/19/2013	On time
Finalize Charter	Mon 3/18/2013	On time
Recruitment of OSU students	Fri 3/22/2013	On time
Demo of Videos & Branching Points (accessible)	Mon 3/25/2013	On time
Department contacted upcoming TA	Sat 3/30/2013	On time

needs		
Report on research into methodologies for activities done	Mon 4/1/2013	On time
Contact made with TAs who might be interested/skilled for teaching in Autumn	Sat 4/6/2013	Instructors assigned through usual department process - August
Consult with UCAT	Mon 4/8/2013	On time
First Online Activity Prototypes (Mind-maps, storyboard, etc.)	Fri 4/12/2013	On time
Decisions made about media types for online activities (based on online activity prototypes)	Mon 4/15/2013	Delayed by ADA concerns - June
Summer TA hired (Heather Smith)	Sat 4/20/2013	On time
Carmen and MyMathLab integrated	Tue 4/23/2013	Still ongoing, although progress has been made
Media templates and shared style guide completed	Mon 4/22/2013	Delayed by ADA concerns - June
1 online activity prototype of each course created	Fri 4/26/2013	Delayed by ADA concerns - June
1 online activity prototype of each course reviewed	Mon 4/29/2013	Delayed by ADA concerns - June
Response system chosen	Mon 5/6/2013	We did not end up piloting a response system.
CarmenConnect rooms training	Wed 5/8/2013	On time
Course Syllabi Drafts	Sat 5/11/2013	August
CarmenConnect rooms designed and built	Mon 5/13/2013	August

First in class prototypes	Sat 5/18/2013	June
Piazza or other discussion system chosen, designed, and configured	Mon 5/27/2013	August
Logistics for high school students' participation established	Fri 5/31/2013	On time
Recruitment of freshman	Sat 6/1/2013	Throughout summer orientation
IRB surveys and assessment plan completed	Sat 6/1/2013	July
Carmen designed	Mon 6/3/2013	August
CITI training complete	Sat 6/8/2013	July
Demo of inclass activities with all technology	Mon 6/10/2013	August
Decision about the amount of in class support (TAs, tutor, something else) necessary	Mon 6/10/2013	July
1151 All materials (flipped material and in-class activities) for 1st third of course	Sat 6/15/2013	August
IRB submission	Sat 6/22/2013	July
TA Training materials (Carmen)	Mon 7/1/2013	August
TA Training materials (CarmenConnect)	Mon 7/8/2013	August
1151 All materials (flipped material and in-class activities) for 2nd third of course	Sat 7/13/2013	September
Testing arrangement planned (for off-campus students)	Sat 7/27/2013	On time

TA Training Material loaded in Carmen course	Mon 8/5/2013	On time
1151 All materials (flipped material and in-class activities) completed	Sat 8/10/2013	November
First day of class prep	Mon 8/12/2013	On time
Final courses built & ready	Sat 8/17/2013	On time
Standing meeting times established for TAs/Tutors/etc	Wed 8/21/2013	On time
TA/Instructor Training conducted	Wed 8/21/2013	On time
First day of classes	Thu 8/22/2013	-
Final day of classes	Wed 12/4/2013	-

Relation of Charter Timeline to Project Timeline

The project fell behind the Charter timeline during the spring and early summer. The main reason was that a program for creating online lessons could not be purchased until June because it had to be confirmed that the program we intended to purchase was ADA compliant. Beginning on the online lessons so late meant that we were still creating them throughout the Autumn pilot semester, working frantically to stay ahead of the students. It also took longer than expected to make arrangements with OSU Academy about recruiting high school students. Additionally, it was not possible to identify recitation instructors for the pilot as early as we had hoped due to the department instructor scheduling process. The integration with Carmen and MyMathLab continues to run into technical difficulties, but has been steadily progressing over the last two years.

Project Assessment

Outcome summary

Overall students and instructors seemed to enjoy the Flipped and Flexible course format. Instructors were very positive about online lessons and group work during recitation on weekly surveys. Students generally completed their online lessons, came to recitation, and performed about as well as students in other sections on common departmental exams. Some students did not like the format as well as the traditional format, but many students expressed appreciation for the flexible schedule and the ability to rewatch online lessons.

Overview of Assessment Plan and Methods

In order to assess the success of the Flipped and Flexible course model, we looked at:

- Student grades on common exams compared with students in other sections of Math 1151 in Autumn 2013
- Student usage of the online lessons, both graded and the review lessons
- Student attendance at recitation
- Student responses to a pre-survey. (We intended to look at a post survey as well, but the response rates were so low that the data was meaningless.)
- The responses from students in other section to the online lessons on the MSLC survey
- The number of page views of the online lessons on the MSLC website, and the number of views of the YouTube videos
- Weekly surveys of instructors

Highlights from Assessments

- Students performed on average about the same as students in other sections of Math 1151, despite the major revisions of the course.
- Numbers suggest that students spent more time in class and with lecture materials than in a traditional class.
    - On average, online graded lessons were watched by 81.5% of students and students received a score of 95.6% on average.
    - Students spent 1 hour and 11 minutes, on average, on each lesson, which is longer than a traditional 55 minute lecture.
    - Review lessons were watched by 32% of students on average.
    - On average, students attended 92% of recitation classes.

- The MSLC survey showed that many Math 1151 students appreciated the online lessons. Due to the anonymous nature of the survey, it is impossible to tell which students were in the pilot section or the regular sections.
- Recitation instructors, on average, felt that the online lessons improved students' experience and learning. They felt that the technology in recitation resulted in about the same experience and learning as traditional methods but the groupwork/active learning in recitation also improved students' experience and learning.

Details from Assessments

COURSE	EXAM 1 MEDIAN RANK	EXAM 1 AVERAGE RANK	EXAM 2 MEDIAN RANK	EXAM 2 AVERAGE RANK	EXAM 3 MEDIAN RANK	EXAM 3 AVERAGE RANK	FINAL EXAM MEDIAN RANK	FINAL EXAM AVERAGE RANK
night class	2	2	3	1	6	10	1	1
traditional	6	7	2	2	6	3	2	2
traditional	5	3	1	3	2	1	3	3
traditional	1	1	3	4	4	6	7	4
traditional	2	5	5	5	3	4	5	5
traditional	6	8	6	6	10	8	6	6
traditional	6	6	10	10	1	2	3	7
flipped and flexible	10	10	6	12	6	9	8	8

traditional	9	11	10	9	12	12	11	9
traditional	12	9	6	7	10	11	10	10
traditional	2	4	9	8	6	7	9	11
traditional	10	12	12	11	4	5	12	12

Grade Data

Students performed slightly lower than average compared to other sections of Math 1151, but still within the realm of normal for the course. Students who choose the more flexible format are often subgroups of students, such as non-traditional students, that do perform slightly lower on average, so this might explain this result. More research needs to be done on the level of the students when they entered the course.

Pre-Survey

The pre-survey was given right before the first exam during the third week of the semester, and there were 98 valid responses.

Demographic questions reveal an interesting range of prior student experience with calculus, online learning, or both.

- 71% of students who responded to the pre-survey had already taken some form of calculus before this course.
- 52% were incoming freshman and 48% were returning students.
- Only 4% had never taken a course with learning technology before.
- 28% had taken and online or partially online course before.
- Only 6% of students were repeating Math 1151.

Questions gauging students' experience of the course model during the first weeks of the semester and their expectations for the remainder of the term revealed optimism for performance in the course and mixed expectations about the benefit of course materials.

- 69% of students expected to use all of the required online materials throughout the course. 26% said they would use some of the online materials,

and only 4% said they were planning to use little or none of the online materials.
- Only 6% expected to come to recitation online often.
- Considering "Neither Agree or Disagree", "Agree", or "Strongly Agree" as positive responses, 79% expected that they would feel confident in their understanding of the concepts each online lesson covered.
- 73% of students expected to benefit from working with others to solve problems in class.
- 83% expected to have a positive opinion of the math department after taking 1151, and 60% said they would choose to take a section designed like this one again.

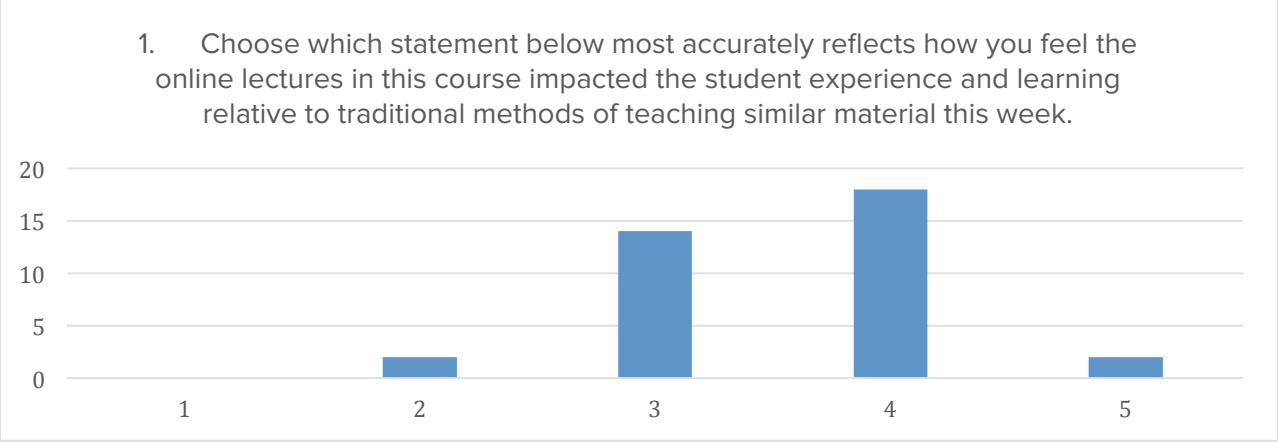
Analysis results indicated that the biggest indicator of how students would perform in the Math 1151 Flipped and Flexible Class was the highest level of math the student had taken previously (i.e. Pre-Calculus, Calculus AP (AB), Non-AP Calculus etc.).

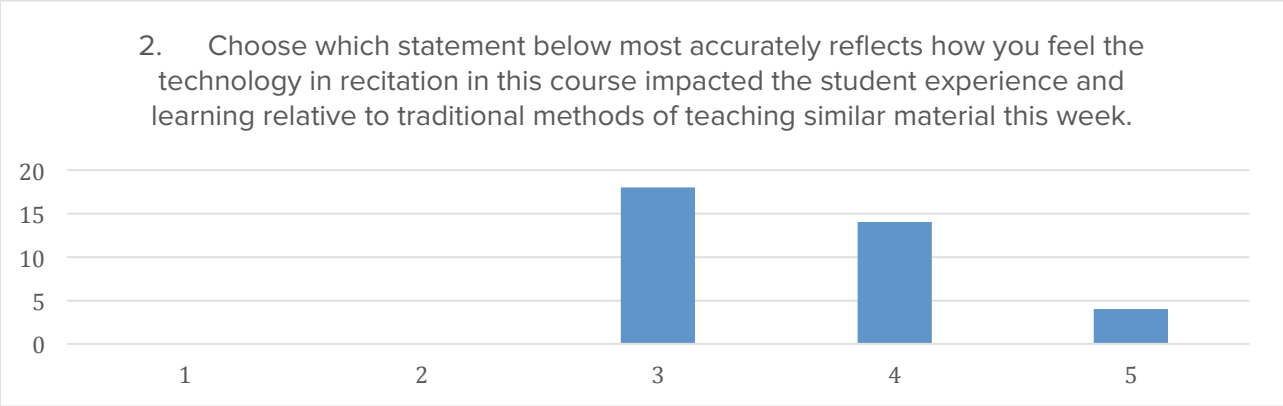
MSLC End-of-Semester Survey

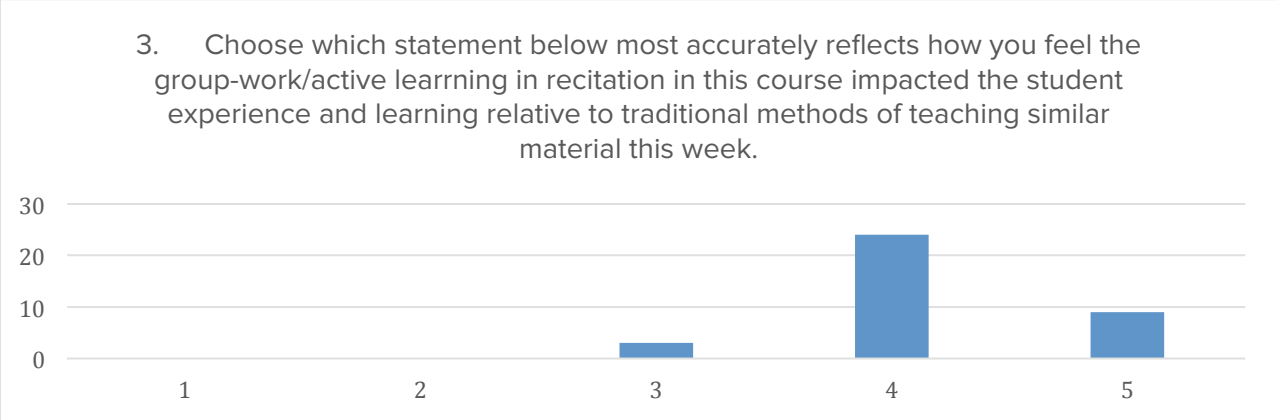
Some students comments about the online lessons from the MSLC survey were:

- "I loved the online lessons. They did a great job explaining things that I didn't understand."
- "only if I missed lecture, they were good."
- "I used, very important. I wish this Online lessons should also be available for math 1172 and above."
- "I really liked the online lectures. It was nice to be able to rewatch things I didn't understand and also to be able to watch the lessons when it was convenient for me."
- "They were very helpful, more helpful than the in class lectures"

Instructor Weekly Surveys







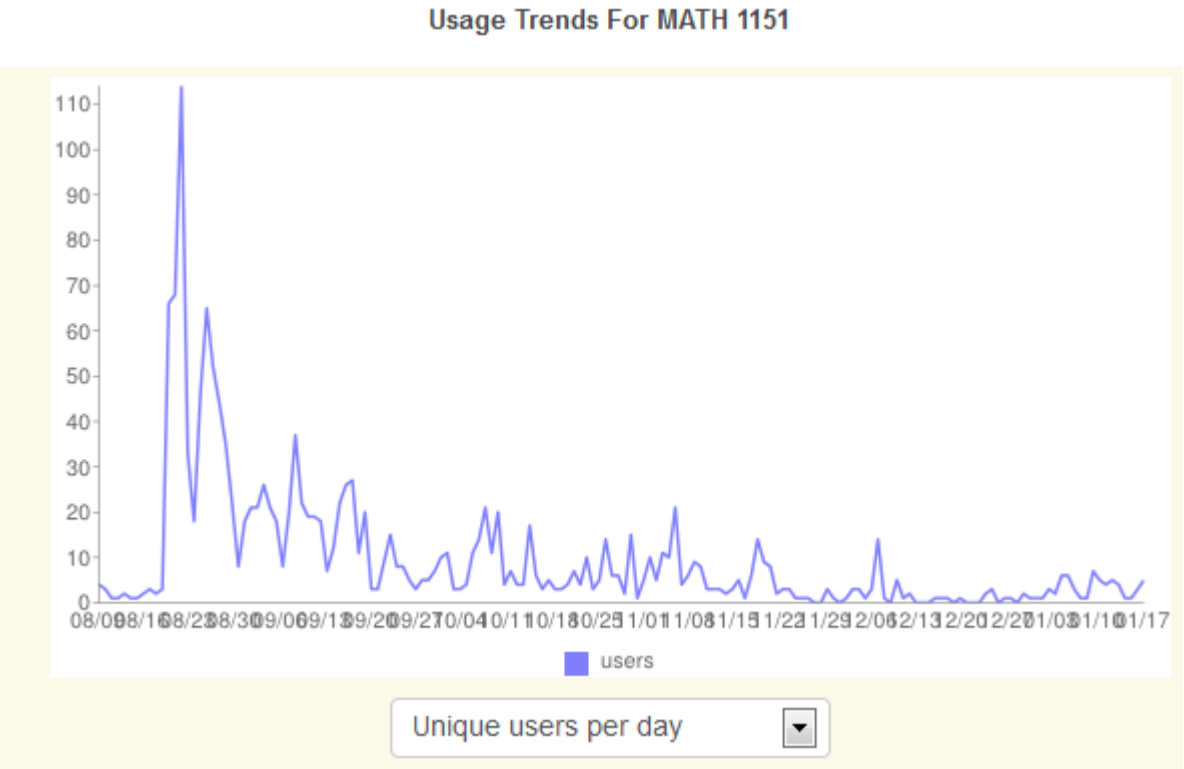
RANK	DEFINITION
1	Very negatively impacted students' experience and/or learning

2	Reduced students' experience and learning
3	Resulted in about the same experience and learning as traditional methods
4	Improved students' experience and learning
5	Very positively impacted students' experience and/or learning

Usage Data

OBJECT	NUMBER OF UNIQUE USERS	USAGE AMOUNT
Online Lessons	172	5,511 total hours
Carmen Content	172	10,468 total hours
Piazza	199	437 contributions; 4,218 views
Carmen Connect	170	7 students/ recitation on average
MyMathLab	195	3,905 assignments completed

Piazza


Usage Trends For MATH 1151
110
100
90
80
70
60
50
40
30
20
10
0
users
Unique users per day

Experience of Teaching with Learning Technology

Survey

Please indicate how strongly you agree or disagree with the following statements:

1. The use of technology improved student learning in my course.

   Agree

2. The use of instructional technology improved my teaching.

   Agree

3. My students had the technology skills needed to succeed in my courses.

   Agree

4. My students had adequate access to hardware and software.

   Agree

5. There was adequate network access for all on-campus activities.

   Disgree

6. I spent too much class time teaching technology to my students.

   Agree

7. Additional comments or feedback

   Although students seemed to, overall, have adequate technology access and technology skills, the technology still presented a frustration sometimes. Because the lecture component of this course was completely online, students who did not read instructions carefully often had problems. Piazza (our class online, social discussion board) helped with this. As the online lecturer, I spent a significant amount of time providing tech support to the students. Sometimes the technology in the Baker 285 classroom, especially the Epson board, would actually get in the way of learning because the instructor was distracted by struggling with it. The online lessons in Carmen had trouble loading for some

students or their scores did not transfer. The Carmen logs say that the online lessons often "timed out", which I take to indicate that either Carmen was overloaded or the Internet where the students were (dorms maybe?) was overloaded.

Effect of Learning Technologies on Instruction

I've been experimenting with learning technologies for about 5 years now, so it is hard to tease out what effect this particular project has had. One thing I know for sure; creating online lessons makes you really think about what the most important to convey to students in a short amount of time. Developing the lessons with a team of instructors with different perspectives was very enlightening in terms of how certain concepts should be presented. Every aspect of the lesson has to be deliberate. Meeting regularly with the recitation instructors for my class, talking about the best way to get students to discuss, participate, and learn was extremely illuminating for all of us.

Effect of Learning Technologies on Learning Outcomes

The learning outcomes in this pilot were essentially the same as other sections of Math 1151. Learning technologies allowed us to do the same amount of teaching and learning with less face time and greater flexibility.

Best examples of effect of technology on teaching

The best examples of the effect of the technology were the stories I heard from students who were taking the course for whom a traditional class would have been inconvenient, at best. This included a group of high school students taking the class from a distance, a student who was working full time and gained custody of a 4-year-old child in the middle of the semester, a student athlete who was able to watch lectures while traveling for tournaments, and students who take most of their classes at a regional campus.

Challenges

The online lessons were much more difficult to create and more time consuming than we originally anticipated. It was challenging to ensure that the lessons were ADA compliant. It took a lot of work and dedication during the autumn semester to ensure they were available to the students in time.

Assessment of Assessment Plan

The student surveys were very frustrating and are practically unusable. The first survey that we sent out had an excellent response rate from the pilot group and from the traditional students, essentially 50% in both cases. Unfortunately, for all the interesting

questions about the course, we used the word "expect" such as "Do you expect to find the multimedia materials enjoyable?" Unfortunately, we realized afterward when we looked at the data that we could not tell if the student interpreted that question as "Do you think the multimedia materials ought to be enjoyable?", "Before beginning the course, did you predict that the multimedia materials would be enjoyable?" or "Does your experience in the class so far make you think that the multimedia materials are and will continue to be enjoyable?" This makes a significant difference in how we interpret the data, because many students might not be giving us any insight into how they are actually currently finding the materials.

The post-survey was better designed, but almost no students answered it. The response rate was about 10% and not indicative of the overall course feeling, from other indicators. It appears as though a majority of the students who answered the post survey were the ones who did not like the course. I think there was some confusion among the students because during the same week, they were asked to fill out multiple online surveys which were all related to their calculus course: an online survey for the MSLC (which included questions about the online lessons), the online survey for this pilot, and their SEI's. There was a low response rate for all these surveys; this leads me to believe that asking students a survey during finals week is not the best practice because students are more worried about their finals than online surveys at that point in time.

We are planning to ask one survey between exam 2 and exam 3 this semester in an attempt to obtain more reliable data.

Experience of Tech-enhanced Teaching

For me, this was an entirely different experience from teaching a regular Math 1151 lecture. Because I was the online lecturer, I never saw the students. Once the online materials were created, my main role with the students was organizer, cheerleader, and tech support. I did feel like I wasn't as connected with the students and they were not as connected or comfortable with me. For example, when I teach a regular Math 1151 lecture, I usually have 5-10 students come to office hours each time. In the Flipped and Flexible class, almost no one came unless they wanted to talk about their grade. I have been more proactive this semester about encouraging the students to come to me for help and in regularly visiting the recitations; I think this has helped to bridge this barrier.

I think the opposite was true, though, about the recitations. I had a much better relationship with my recitation instructors than I have ever had in a traditional Math 1151 course. We met weekly and talked about how the students were doing, how the course was going, and what we could do to make it better. I believe the whole course really benefitted from those discussions. Also, I feel that the students made a much better connection with their recitation instructor than in a regular class. The group work really created a community of learners during the recitation. They were able to have many of their questions addressed in the recitation.

Moving Forward

We will definitely be teaching this Flipped and Flexible course again. This spring we are teaching a session in Math 1151, and will be teaching a session of Math 1151 and a session of Math 1152 in this format in the fall. We are planning to develop the online lessons for Math 1152 using the same process and personnel as we did for 1151; we hope to develop these materials in SP14 and SU14 and have them completed before Autumn semester when they will first be used. The lessons we learned about how do develop these materials during the impact grant period will certainly make this process go much more quickly and smoothly for the second course.

During this semester, we are making minor improvements to the 1151 courses as well. We are adding additional feedback to the online lessons and revising the recitation handouts. We also increased the presentation requirement in recitation from 1 to 5. Our group work strategies were improved to get more students involved. We are redoing our survey and giving it in a different point in the semester and are putting the online lessons up earlier so students can work ahead if they want, making the course even more flexible. We are also going to start recruiting and training other instructors to be the online lecturer for this course.

Impact Grant Experience

Survey

Please indicate how strongly you agree or disagree with the following statements:

1. I am satisfied with the communication I received from the ODEE staff.

   Agree

2. I am satisfied with the grant project contributions I received from the ODEE staff.

   Neutral

3. I have learned the skills necessary to continue related work on my own.

   Strongly Agree

4. I found the ODEE staff approachable.

   Agree

5. The lessons learned during this pilot will guide future course design.

   Strongly Agree

6. Additional comments or feedback

Reflections on the grant process—what went well

I think the course set up worked well, and the online lessons seem very effective for communicating content. Another Math 1151 lecturer stopped by my office a few days ago and commented that the online lessons were "beautifully done" and joked that they should get rid of all the lecturers and just have the online lessons. We had a very good system between Heather and myself to create the lessons, and the department has hired her to continue working with us to develop online lessons for Calculus 2.

The group work based recitations also worked well, and I could clearly see the growth in the instructors (and myself and the other course designers) through our weekly meetings. Two of the instructors are teaching the Flipped and Flexible Math 1151 again this semester, and it is clear that they have built upon their experiences last semester to create an even better classroom environment this semester.

Also, I think it was important that we kept in touch with was happening in Math 2415 and tried to coordinate how we set up the classes whenever possible. This made positive steps towards a cohesive vision of learning technology for the department.

Reflections on the grant process—what did not go well

I often felt like I was struggling against Henry instead of working with him. We had very different ways of approaching problems and of organizing our thoughts and our project. While I appreciated that Henry was always willing to help and to do work on the project, I often felt like he was trying to push me to do things his way instead of trying to help me to be successful. Some of this feeling might have come from the impact grant process being more formal in some ways than last time I went through it, although I feel that did not account for everything. For example, I felt Henry kept insisting we use Softchalk instead of Articulate Storyline long past when we had weighed the benefits and costs and decided we definitively preferred Storyline. This contributed significantly to us falling behind on our timeline and made it so we had to scramble in Autumn to get the lessons completed on time. I would have preferred if he would have immediately helped us figure out how to make Articulate Storyline presentations ADA compliant.

I was very frustrated with the entire planning phase and felt that in many ways, the first 6 months of the grant were wasted. We spent a significant amount of time in meetings without results. Over time, there was a marked decline in the number of people who came to the meetings. Because of this, there was a rush to get everything together at the last minute in August and all through Autumn semester. Many things were not done as well as they could have been because of this time crunch. For example, there were many nights when I was in my office until 8:00 or 9:00 at night getting the online lesson ready for the students for the next day. Also, Henry was overseeing the development of the survey questions with two graduate students, and we ended up having to significantly revise the student surveys at the last minute because of quality concerns.

I would like to say, though, that I felt that Henry really wanted the project to be successful and was willing to work hard to make that possible. He was approachable, and kept things very well organized.

Key lessons learned

Developing quality online lessons takes a lot of time, effort, and coordination. Students and instructors have to be convinced about group work, but once they are convinced it can work very well. It is difficult, yet important, to ensure that all your online materials are ADA compliant.

Suggestions for future recipients

When they tell you it will take 2 hours for a 5 minute video, believe them. Developing materials for a technology enhanced, hybrid, or online course takes significantly more time and effort than you expect (even if you expect a lot), and things that seem like small deviations from what you are currently doing can turn into major projects. That said, it is definitely worth it and you will feel very proud of what you created when you are done.

Three words to describe working with the ODEE Team

1. Challenging
2. Frustrating
3. Educational

Ah-ha moment of the grant process

An ah-ha moment for me was when we mapped out all the pieces and parts to this project that would have to be accomplished on Simplemind; then we saw everything that would have to work together and be in place to pull off the final vision of the project.

Department Chair Statement of Impact

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Jan 31, 2014

To Whom it may concern:

First I would like to convey our department's gratitude for the OSU Office of Distance Education and eLearning Impact Grant that we received in early 2013 and to express my satisfaction with the outcome of its application to the development of a Flipped and Flexible section of our largest course, Math 1151: Calculus I. In the early 1990's, our department began an outreach program to Ohio high schools called Calculus Remote at OSU (CROSU) which allowed high school students to complete an OSU calculus course at a distance for OSU credit. CROSU was based on our Calculus with Mathematica course sequence, which we no longer offer. In 2012, I tasked a committee in the department to replace the CROSU program with a new program that would still allow high school students to complete the course remotely, but which would give high school students as close an experience as possible to the experience of current OSU calculus students. The result of this challenge was the conception of the Flipped and Flexible course setup, which not only let high school students remotely attend the same class as OSU students, but which provided a more flexible format for current OSU students and implemented many tenants of current educational research on active learning, all while staying within the current coordinated framework of Math 1151. The Impact Grant and OSU technical support came along at just the right time to help us implement this new course format.

This course format could be correctly described as distance, hybrid, flipped, or hyflex. In the pilot course, the lectures are presented online using Articulate Storyline lessons developed by our project team. These lessons build upon the high quality videos created for our MOOCulus course by reworking them to follow the current Math 1151 course and surrounding them with worked example videos, scaffolding slides, imbedded quiz questions, and choices for students in their path through the material, including how much help they need on specific topics. The recitations for this course are held in classrooms at OSU, but students can attend online through Carmen Connect if they choose. These recitations are groupwork-based, and students present their group solutions to the class. Homework and quizzes are online, but the exams are proctored, paper-and-pencil for security. High school students can take the exams at their high schools, and other OSU students only need to come on campus for the evening common exams. This makes this course format a very good choice for non-traditional students, students on regional campuses, student athletes, and students working full time.

Although there were small technical difficulties, the pilot went quite smoothly. Students performed essentially the same as students in other sections on common exams. We are quite satisfied with this result, considering the students met with an instructor at most 2 hours a week instead of the usual 5 hours a week. It is my impression that students were very satisfied with

the course as well. Students especially commented on how they really appreciated the flexibility of the online lectures. Many students in traditional sections also accessed the online lessons through our Mathematics and Statistics Learning Center website to help them learn the material. A positive consequence of this course format is the ability to offer a large course section without having to find a large lecture hall. Also, students who need to join Math 1151 after the beginning of the semester are still able access the lectures they otherwise would have missed.

I believe that there is definitely a group of students for whom this course set-up is highly beneficial, and the department is committed to continuing to offer a section of Math 1151 in the Flipped and Flexible format, as well as expanding to offer a section of Math 1152: Calculus 2 in this format in Autumn of 2014.

Sincerely yours,

Luis Casian

Professor and Chair

By ODEE Team

Goals and objectives pre and post relation/connection

This project achieved its goals. Math 1151 was presented in a Flipped and Flexible model, coordinating multiple technologies to provide students with a new format. That it was possible to undertake a major revision of the course without decreasing student learning is itself a success, and it seems likely that gains in student learning will become demonstrable in future terms.

Number and roles of ODEE individuals involved in the grant project

Four ODEE staff played significant roles in this project.

- Henry Griffy, Grants Coordinator, was project lead for ODEE. He convened regular standing meetings, facilitated the planning and implementation of the project, and coordinated the participation of relevant experts when needed.
- Robert Griffiths, Director, Digital Scholarship, consulted on the project at crucial moments.
- Andrew Kuhar, Learning Spaces, provided training and support for the experimental classrooms where the recitations were held.
- Sam Craighead, Learning Spaces (now Digital First), helped identify and schedule experimental classroom space for the recitation section.

Two additional ODEE staff worked with the project team on a distinct project that impacted this project's success:

- Valerie Rake and Vedu Hariths helped establish (and troubleshoot) SCORM-integration of the Articulate learning objects produced for this project.

Approximate number of ODEE people-hours spent on the grant project

TEAM MEMBER	HOURS
Total	**240 (including 1151 and 2415)**

Reflection of what aspects of the grant process, procedures, and collaboration worked at or above expectations.

This was a complex project, involving several people with several roles, multiple technologies, and other complications. Given the number of people and systems involved, there were far fewer disruptions than might be reasonably anticipated.

The team: It was possible to recruit people with the required skills, and the people on the team stepped up and did what was needed.

Departmental support: The Math department supported this project above and beyond their initial commitment. They allowed all needed team members to participate as much as required, in addition to allowing us to recruit student team members.

ODEE systems and support: Most of the tools needed to provide this model of education are already available as supported services, though some of these (i.e., experimental classroom spaces) are too scarce to rely on. The various staff who support these services were available to provide training and quick to respond to disruptions in services.

Accessible online calculus materials: Before starting this project, I had assumed that most online math courses were accessible to people with disabilities, especially given how clear the law on the matter is. It turns out that this is not the case. That this team put forth the effort to make all materials accessible thus had even more value than anticipated.

This grant project was to some extent a "two-fer" in that the single grant allowed us to support major revisions to two distinct courses. In addition to maximizing the use of ODEE resources, this dual model had other benefits. Meeting together helped the two teams share insights and solve shared problems together. Using similar tools allowed the teams to learn together.

Reflection of what aspects of the grant process, procedures, and collaboration were below expectations.

The research: Research participation was low. In addition to the low participation in the post-course survey, zero students agreed to participate in focus groups. The questions on the preliminary survey could have been better, despite having involved almost all project participants in their composition. While some data was acquired during this project, much more could have been done in this area.

Effortfulness: It is time-consuming to produce effective, accessible online learning objects. While software can reduce the time required, those efficiencies are limited. Even if the project had used a more efficient tool, such as Softchalk, this part of the work would

have taken longer than anticipated. On the plus side, a lot was learned, and documentation about how to make accessible learning objects was produced.

The two-for-one model had some drawbacks, however. Significant differences between the courses meant that some team members' time at some meetings was not well spent. Also, because the courses are (roughly) the beginning and end of a sequence, it was not always clear how to maximize alignments between them.

Three words to describe working with the recipients.

1. Diligent
2. Dedicated
3. Challenging

Describe an "ah-ha" moment during the grant project.

Seeing the recitations in progress clarified both the benefits and difficulty of this educational model. The benefits were clear in the students' engagement with active problem-solving. No one was facebooking or sleeping or reading a newspaper. Students not in the room were able to participate. However, the recitations also illustrated that this is a complex and thus vulnerable model. Success requires that several systems function at the same time. On one class visit, the Epson board marker was malfunctioning, which interrupted scheduled class activities. That day, the fix was easy, but the basic insight remained that this model is not easy.

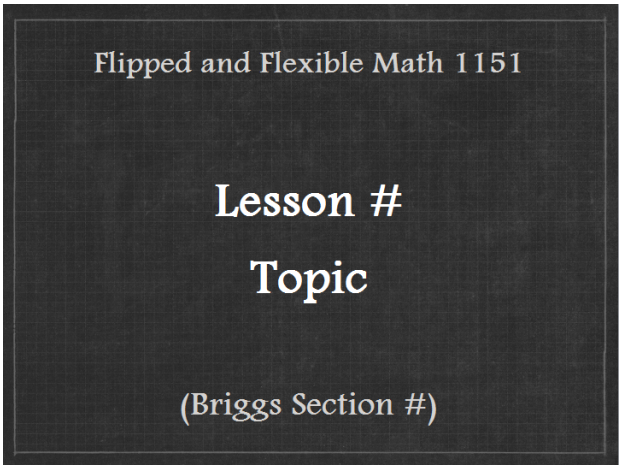
Changes to our processes from this grant experience

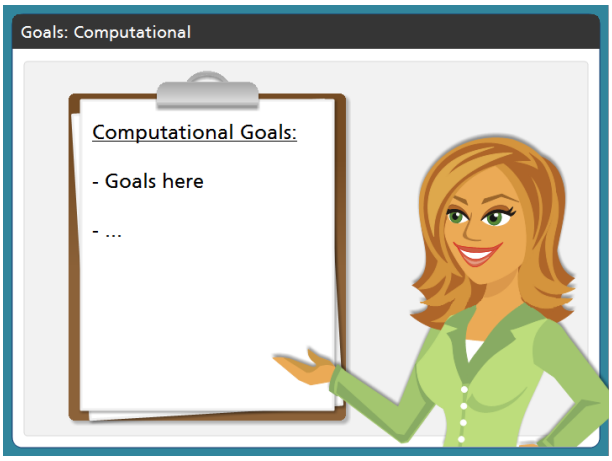
Most changes to the grants process will involve seeking to replicate and expand on what went well with this project: seek teams with existing experience and momentum; seek departments willing to support projects and build on previous elearning projects; maximize the impact by coordinating as many people as possible.

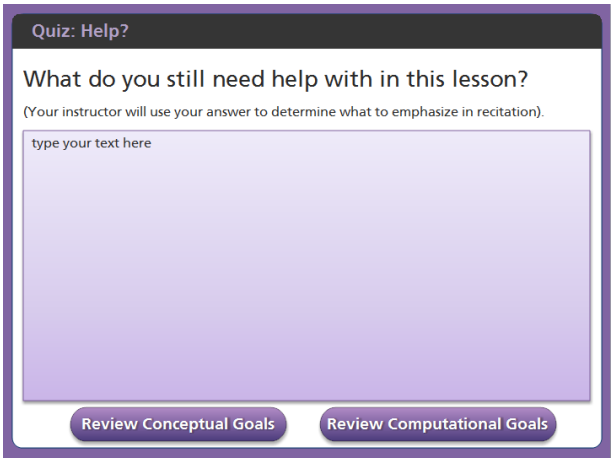
This project also reinforces a lesson that most course-level design projects teach: a year is not long, so minimize delays and start as soon as possible. We have already taken steps to streamline the planning phase so that work can begin as soon as possible.

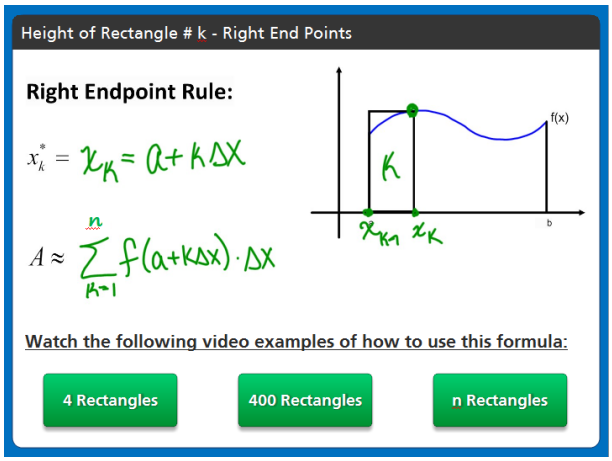
Appendix A

Sampling of Style Guides and example slides for our Articulate Storyline lessons

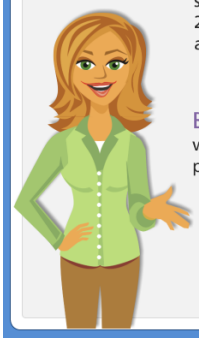








Instantaneous velocity and limits



So... to find the *instantaneous velocity* (the slope of the tangent line), we want our 2nd point to be as *close* to point we care about as possible.

But... we can't actually be at the point we care about because we need two points to find a slope (or we'd get 0/0).

This is why we need the mathematical idea of a **Limit.**

What would you like to do next?

- See how to find this limit graphically.
- See another example of limits estimated with a table.
- Continue the lesson and learn about one-sided limits.

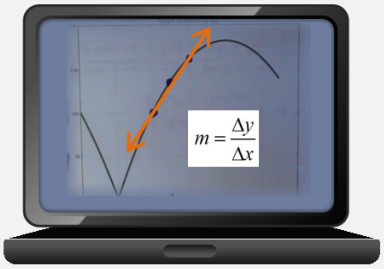
Try working out the following problem on your own paper.
(This is just for practice.)

A rock is thrown vertically upward from the ground with a velocity of 70 ft/s. If we ignore air resistance, the position of the rock after t seconds is given by the function below. The position, s, is measured in feet with s=0 being ground level. Find the average velocity of the rock between t = 2 s and t = 4s

$$s(t) = -16t^2 + 70t$$

Click next when you are ready to check your solution...

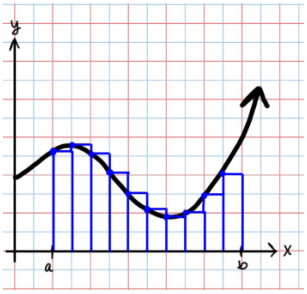
Secant lines



When Jim is calculating average velocities, he is dividing the change in the y-values by the change in the x-values. Therefore, he is actually finding the slope of the line between those two points. We call that line the **secant line**.

What will the formula look like?

$$Area \approx \sum_{i=1}^{n} (height\ of\ i^{th}\ rectangle)(width\ of\ i^{th}\ rectangle)$$



$$\sum_{i=1}^{n} h_i \cdot w$$

Optional:
Video motivating the formula by finding the exact area under a curve.

Continue to the next slide to develop the general formula....

Appendix B

Guidelines for Using Articulate to Produce ADA-compliant materials

1. If a slide has multiple layers, screen reader will *sometimes* read items from base layer (even if they are not visible visually) unless they are made "invisible" – I'm not sure why this happens sometimes and not others. To make invisible, select the appropriate layer in the "Slide Layers" area. Under the timeline tab, scroll through the various slide elements until you reach the heading "Base Layer Objects". Click the arrow to expand this heading if needed. Next to each element you want to hide, click the eye. Once the eye is closed, that element is hidden while on that layer, both visually and to the screen reader.
2. Markers: Markers are actually surprisingly functional. When the screen reader user tabs to a marker, the reader will say "Marker Button". Upon pressing enter, the user will hear the title of the marker read. If they click the tab, the reader will then read the marker main text. The next tab should close the marker. Continuing to tab will then bring them to other components of the page, as usual.
3. The screen reader will read every image on your page unless it is turned off to the screen reader. This includes rectangles that are part of the background of the slide, any characters you use, lines, etc. Consider "turning off" any images that are not necessary to the content of your slide to avoid bogging down the screen reader user. If it a necessary image (graph, chart, etc.), you will need to give it alternative text. The screen reader will read this "alt text":
    a. Click on the image. Click on "Format" on the top bar. In the "Size" box on the top bar, there is a small down arrow. Click this arrow. Click the "alt text" tab. Uncheck the box labeled "Object is visible to accessibility tools". To make sure you got all the images, check the "Timeline" area of the slide. Here, all slide elements are listed.
    b. Instructions for "turning off" slide background shapes
    c. ** Follow the instructions above. However, leave the box checked and write your alternative text in the designated area. Be careful with symbols in your alt text. I haven't tested all symbols, but here's what is read for a few of them: +=plus, - = dash, (= left paren,) = right paren.
        i. ! exclaim
        ii. @ at
        iii. # number
        iv. $ dollar
        v. % percent
        vi. ^ carrot

        vii. & and
        viii. *star
        ix. , comma
        x. When in doubt, just write it out!!
    d. Note that there is an unfortunate glitch in Articulate. If you use the "zoom picture" feature on an image (the little magnifying glass that allows for enlargement of the image), the screen reader will NOT read the alt text. Instead it says something like "unassigned image".
4. Videos: We generally used the "insert web object" feature to embed videos (from Youtube) into slides. This seems to be the most functional way to do things. However, the screen reader seems to have trouble getting into the video frame and the user can not play/pause the video easily. We got around this by creating a button that allowed the user to open the video in a new window. The user could then (more) easily tab to play the video and also use the spacebar to play/pause the video.
5. Buttons: I have also given alt text to buttons. I believe that if you didn't do this, the screen reader would simply read the text of the button and say, for example, "Video Button". However, for extra clarity, I like give an alt text that says, for example, "Click to watch a video about the Squeeze Theorem".
6. Tab order: Generally seems to go top to bottom and left to right. If there are layers or other complicated features, this seems to sometimes throw off the tab order and make it somewhat unpredictable. Unfortunately, there doesn't seem like there is a way to control the tab order – changing the order of elements on the timeline doesn't seem to have any effect.
7. Sometimes it is helpful to "consolidate" alt texts for different, related images into the alt text for one image. For example, consider the following scenario: On the slide is one image with several lines of mathematical work – the solution to a problem. Overtop of this image and to the side of each line, is a small text box with a description of what was done in that step. For the user tabbing through this, they will here all of the alt text for the image first (the steps of the problem), then afterward they will tab through the textual descriptions (which, by intention are meant to be read after each respective line of math). Add to this the fact that tab order if often unpredictable. Rather, in the alt text of the image, include these textual explanations. What I do personally is say something like "This is an image that shows several lines of a mathematical solution with text explanations for each line of work. Line 1. F of X equals...(math description).... The explanation reads Use the quotient rule to take the derivative. Line 2...
and so on. Then, make the text boxes invisible to the screen reader.
8. Alt text for text boxes – sometimes helpful. It may seem strange to use alt text for a text box and generally this is not needed. However, if your text box has a lot of strange characters/notation (such as mathematical notation, superscripts, and the like), I can imagine it coming through fairly garbled in the screen reader. For example, even a simple

mathematical notation such as $f(x)=x^2$ would sound like "f open paren x close paren equals...". (I'm not sure what it does for subscripts or superscripts, but even if it just said 2, that would be confusing). So, in these situations, it may be helpful to have an alt text for the text box, but write out the questionable notation long-hand, such as "F of X equals X squared." To save time, you can copy and paste the text from the text box and simply edit it.