

## LINEAR ALGEBRA ONLINE LEARNING OBJECTS: RAPID DEVELOPMENT WHILE STILL FOCUSING ON PEDAGOGY

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### ABSTRACT

Due to the COVID-19 pandemic, faculty were asked to migrate courses into an online format within ten days. This study will share the research-based pedagogy used while creating online learning objects for a Linear Algebra II course. Six different data collection instruments were used including two Course Syllabus (prior face-to-face and current online); Before and After Response to Self-Efficacy Survey; How to Make Awesome Math Videos; Example Instructor Communication with Online Students; Instructor Responses to an Instrument for Teaching Online; and Midterm Student Perceptions of Online Learning. The findings indicate that factors affecting the effectiveness of the online course include implementing effective course design; awareness that learning outcomes should not be modified when migrating online; having an openness to quickly integrate teaching research; time management is critical; eliciting input from students can be helpful; early, humanistic communication is key to reduce anxiety and create a helpful classroom culture; and student perceptions indicate that they appreciated the use of VoiceThread platform; course design; instructor creating a welcome classroom; and feedback; would prefer some synchronous opportunities; more examples [many indicated nothing needed improved]; and have a very good disposition towards the online course, sharing word such as Great, Awesome and Excellent!

**Keywords:** Online Learning, High Impact Teaching Strategies (HITS), Inclusive Environments, Online Learning Objects (OLO), Learning Communities

### INTRODUCTION

This study was performed at a small, private university in China where half of the student population is from China and the other half are international students. The mission of this university is preparing students to be well-educated and globally-minded citizens and provide a solid academic foundation for success along with nurturing the creativity needed to become leaders and innovators in every field.

On January 26, 2020, the university was informed that the first day of class would be postponed; on January 30, the date was pushed back again; and on January 31, the faculty received official word that we could begin classes on February 17, although they would be held online until further notice. As the weeks progressed, faculty received updates which indicated in continuing to teach online until notified of the possibility of returning to campus. Due to COVID-19, other universities began to experience similar fluid schedules. This manuscript is prepared in the middle of the spring term to share the intense process taken to migrate a face-to-face (F2F) course online.

This study has an overarching research question focusing on creating online learning objects (OLO) for a Linear Algebra II course while maintaining a focus on research-based higher education pedagogy.

Creating an inclusive, accessible environment was found to be a major asset of online teaching and creating OLOs. When creating OLOs, we were able to attend to major attributes which Lawrie, et al. (2017) found to help all students connect to the learning. Some of these include helping students connect their prior knowledge to new learning; using a variety of teaching methods and modalities; provide multiple modes which are helpful to non-native English speakers; and clearly communicate the expectations and grading scheme for each assignment.

Due to the COVID-19 pandemic, it has forced colleges and universities to shut down their F2F instruction and transition to teaching courses remotely (Supiano, 2020). The move towards online comes as social distancing has been deemed as the most effective way to prevent cluster infections of COVID-19 (Park, 2020). Lecture halls empty, labs closed, concerts cancelled, sports practices called off, a massive shift unprecedented in higher education (Pfleger, 2020). It has changed how millions of students are educated around the world. Yet, in unprecedented times worldwide, COVID-19 has become a catalyst for educational institutions to search for

innovative solutions in a short period of time. There are signs suggesting that there could be a lasting impact on learning innovation (Tam & El-Azar, 2020). Faculty and campus centers for teaching and learning have supported each other by sharing their discoveries and tips as they navigate the online realm and thus promoting faculty development (Lau, Yang, & Dasgupta, 2020).

With the COVID-19 pandemic, there have been concerns from faculty on how to replicate the experience of their on-ground course to online and faculty are having to rethink assignments, especially the logistics of group work (Lau, Yang, & Dasgupta, 2020). The quick turn and shift online to platforms such as Zoom created a flurry of chaos and disrupting curricula, particularly faculty less familiar with managing a class virtually. Some faculty frustrated with technical difficulties or simply panicked with the prospect of teaching over a new platform (Iwai, 2020). Asking an instructor to go from an on-ground course to an online course without any previous online teaching experience can be a large undertaking and not done overnight (Pfleger, 2020). Prior to the circumstances of having to go online due to the COVID-19 pandemic, many faculty members avoided online teaching like the plague (Gannon, 2019). Faculty have had to scramble to revise syllabi, update presentations to be more appealing online, upload required reading, and post other teaching material online while coming to an understanding of what online instruction involves. IT and staff from other support departments have been working around the clock and stretched by the transition to all online (Lau, Yang, & Dasgupta, 2020). Although faculty and students have had challenges teaching and learning remotely, faculty are searching for better means to conduct their classes online (Park, 2020). The reality is that some subjects are much harder to transfer from on-ground to the online realm (Iwai, 2020). In cases of labs, many campuses have postponed them due to the difficulty of adapting it to an online setting at present (Lau, Yang, & Dasgupta, 2020).

Over the last few decades, there have been many studies done on online learning in higher education. The benefits of offering classes that can be taken anywhere and a lack of commute and yet, online learning has complemented and not threatened the traditional model of F2F learning. However, due to COVID-19, institutions of higher education around the world at the time of this writing have been scrambling with switching on-ground instruction to online/virtual in a matter of days. However, universities in China were at the forefront of having to make such decisions in late January 2020 and offered a blueprint on ways to continue instruction when teaching F2F was no longer a possibility. Decisions made to shift to virtual classrooms was to prevent the spread of COVID-19 from entering university populations and spreading to local communities (Iwai, 2020).

The outbreaks that occurred with SARS (2003), H1N1 (2009), and Ebola (2014) have given precedence on how technology can help to provide instruction when meeting F2F in a classroom was not possible. For example, during the SARS epidemic in 2003, China Educational TV provided a 'Classroom on the Air' program that provided a large-scale, short-term substitute for students looking to continue their education while confined to their homes (Trucano, 2014). The importance of closing campuses was realized as a means to create social distancing in helping to slow the spread of infection. When looking back to the Spanish Influenza, cities that closed schools earlier had lower death rates (Bailey, 2020).

There are benefits to a virtual classroom especially during times of a health emergency. Students can continue participating in the safety of their home or dorm room without having the anxiety of riding public transportation and being in a classroom during an ongoing health crisis. Another benefit is providing a safe environment to not have to experience potential in-person harassment due to the current outbreak (Iwai, 2020). Between the end of January and the beginning of online courses starting on February 17, 2020, the instructor has had substantial interactions with other colleagues also exiled. The instructor has been designing an online version of Linear Algebra II course with 35 students enrolled, while integrating high impact teaching strategies. During the two weeks prior to the first day of class, the instructor in the case study indicated that he benefited enormously from the intense exchanges on the topic of online learning with the campus's Center for Teaching & Learning (CTL). Conversations focused on designing and redesigning online learning objects based on the research of integrating functional technology into higher education.

One week prior to the first day of class, the instructor invited students to experiment with an audio/video software program called VoiceThread (VT) with his students. He first shared a VT and walked the students through the syllabus and they made their comments and questions. Then he shared another VT whose purpose was for him and each of the students to introduce ourselves. The last VT before the beginning of classes was one where he asked students to solve an exercise from Linear Algebra I which most of them completed in the Fall 2019. Prior to asking students to create videos, The instructor produced three different styles of video presentations: capturing a video of a piece of blank white paper while he wrote a mathematical proof; capturing the same piece of paper with the proof previously written, just explaining the proof with a pointer (finger or a pen); and recording the screen of his tablet while using effective software for handwriting. The instructor then

shared the process of how he had created his videos so the students would have at least one concrete technique on how to create their own videos (He also provided them flexibility to create videos in formats that they were already using). On the first attempt, almost all students created high quality videos for their assignments. During the weekend just prior to the first day of class, he used the Lecture 01 VT to explain an extremely detailed quantitative policy on how student participation and interaction would be graded. The goal was to disrupt the inertia caused and sustained by wallflower effect - introduce a social dynamic that might be artificial in the first day, but later would sustain itself spontaneously, by wallflower effect now playing in their favor to increase engagement in a low threshold way.

In the morning of the first class, while the instructor was sleeping in another time zone, the online class officially began. This is when a twenty-minute VT that he had created using a dozen slides became a complete two-hour interactive lecture. While and after viewing his VT, students began proving theorems themselves (instead of watching a talking head video); answering each other's questions; and providing constructive suggestions on how to improve their videos. When he awoke, he opened the student videos, pressed "play" and was delighted to view a "discussion-lecture" created by the students - on day one! The first two interactive lectures offered three hours of content, and we (as a learning community) discussed how to shorten the time. Now the duration of each lecture has been reduced to an average of 75 minutes. Throughout this entire process the instructor offered optimism and enthusiasm to his students, during a time of anxiety and fear.

To further create an engaging classroom culture, he asks students to submit two small assignments, one for each "interactive lecture," using a software program called Gradescope. These assignments are graded and returned swiftly, using an analytical rubric for consistent, timely formative feedback. To encourage a broad and inclusive student voice, he used Google Forms for them to provide timely feedback every day. In their responses, students have praised how helpful it is being connected to their colleagues' approach on the same theorem or proof. One student shared recently that, "Sometimes VoiceThread is better than face-to-face teaching."

## **LITERATURE REVIEW**

### **Online Learning**

Over the last 10 to 15 years, enrollment and fiscal pressures have pushed many institutions of higher education towards having an online presence that was once considered outside the higher education mainstream and opposite of what a college experience should be (Gannon, 2019). Online instruction has matured into the mainstream and legitimization (Lau, Yang, & Dasgupta, 2020). Perry and Steck (2019) found that faculty strive to provide quality online instruction, while promoting student engagement and active learning must be a priority. While technological advancements support online course delivery, the faculty member bears the responsibility for instruction quality and control.

### **High Impact Teaching Strategies (HITS)**

With the near sudden shift for universities to move their F2F instruction to online, measurable learning outcomes aligned with authentic assessments and active teaching methods that empower students to engage is critical for effective course delivery. High Impact Teaching Strategies (HITS) provides reliable instructional practices for teachers and professional learning communities can anchor their interventions in evidence-based practices and increase the likelihood of them being effective (Victoria State, 2019). Rodriguez and Koubek (2019) found that faculty in preservice teacher preparation programs had positive outcomes with students responding with stronger reported learning outcomes and high levels of engagement when several HITS were employed. Integrating HITS into an online environment can also be accomplished effectively (Puentedura, 2012).

Kuh et al. (2017) detailed eight features of HITS: 1) Performance expectations set at appropriately high levels; 2) Significant investment of concentrated effort by students over an extended period of time; 3) Interactions with faculty and peers about substantive matters; 4) Experiences with diversity, wherein students engage in ideas that differ from their own; 5) Frequent, timely, and constructive formative feedback; 6) Opportunities to discover relevance of learning through real-world applications; 7) Public demonstration of competence; and 8) Periodic, structured opportunities to reflect and integrate learning.

### **Inclusive Environments**

When designing learning opportunities, we should ensure that a safe, inclusive and accessible environment is created. During the migration of F2F courses to online, this may present another layer of challenge. The Center for Research on Learning and Teaching at the University of Michigan discusses the use of inclusive teaching to cultivate a learning environment where all students are treated equitably, have equal access to learning, attend to social identities, and influence course and curriculum design (Center, 2019). Rice University's Center for Teaching Excellence created a resource to address unequal access to technology, hardware, and software;

provide a balance between asynchronous and synchronous tools and course materials; and create an environment that includes and values all students (Rice University, 2020). To address cognitive diversity through pedagogical design, multiple means of representation through assistive technologies with access to different types of tools for content creation would provide more means of engagement for individual learning, collaboration, and teamwork (Holeton, 2020).

### **Online Learning Objects**

Online Learning Objects (OLO) are derivatives of Learning Objects developed in the 1990s with the goal of creating a method for students to engage in material that provides scaffolded means to empower their processing of information on a concept. Learning Objects can be a “packet” of lessons, activities and assessment while being designed in a linear or non-linear way and the objects can be modified, reused and adapted (Hargis, 2014). This conceptual model for content creation and distribution can increase and improve the effectiveness of learning and performance. Learning Objects can also bring about high levels of efficiency in content development and delivery (Hodgins, 2006). When teaching online, OLO can help to break the instructional materials down and then reassemble in ways that support instructional goals via digital instruction. This can help to potentially increase the efficiency and speed of instructional development (University of Toronto, 2019).

During online instruction, much of the advantages of the objects can be maintained and at times, heightened. An advantage of OLO’s is that learners can use preview and review based on their way of learning, time frame prior knowledge, which they connect to increase current conceptual understanding. If designed and implemented effectively, OLO’s can create inclusive, accessible learning opportunities for students (Hargis, 2014). Information technology allows the means to capture knowledge, so that the data can be analyzed, reused, shared with others, and used to create new knowledge (Hodgins, 2006).

### **Learning Communities**

Learning communities (LC) are groups of individuals that engage collaboratively in a learning endeavor that works toward a common goal for a set period of time in a safe and secure learning environment. The instructor’s role in fostering a strong learning community is to model best practice, believe in students’ abilities to achieve, and create an effective learning culture. Major attributes of a LC include Shared Goals, Objectives, Values, Vision; Connectedness and Trust; Supportive Environment; Open Communication; and the Instructor Role is primarily as a facilitator (Northern Illinois, 2019). Laufgraben and Shapiro (2004) defined the concept as an instructional strategy of people working together toward a common outcome. A course management concern for faculty switching over their F2F courses to online and impeding LC has been witnessing students preferring to turn off their cameras, leaving instructors with lecturing to blank screens and tended to be fewer questions online for some. Others have been encouraged to see more participation from students who were typically shy about speaking in F2F and utilizing the chat feature or written format to engage in an online setting (Lau, Yang, & Dasgupta, 2020).

## **METHODS AND RESULTS**

This study was conducted at a small private joint China/US international university. Data was collected during the spring semester, 2020. A qualitative case-study design was used to collect and analyze the data. The participants for this case study is one higher education mathematics assistant professor teaching Honors Linear Algebra II. Data collection using six different instruments:

1. Syllabus (Includes learning outcomes, assessments and online active learning methods compared to a prior F2F syllabus of the same course)
2. Before and After Response to Self-Efficacy Survey
3. How to Make Awesome Math Videos
4. Example Instructor Communication with Online Students
5. Instructor Responses to an Instrument for Teaching Online (Benton, 2012)
6. Midterm Student Perceptions of Online Learning

A qualitative analysis was performed on the following data collection instruments:

1. Course Syllabus. A prior F2F syllabus from last spring 2019 and a current spring 2020 syllabus was requested of the author.

**Table 1:** Comparison of Syllabus Components Between Online and F2F.

| Online Course (Spring 2020*)  | F2F Course (Spring 2019)   | Major Differences Between the Courses   |
|---|--|---|
| <p><b>Learning Outcomes:</b> Upon completion of this course, students will be able to recognize, analyze and describe linear operators in abstract vector spaces, find orthonormal bases, diagonalize operators, analyze self-adjoint operators, perform singular-value decomposition, and find Jordan decomposition.</p> | <p><b>Learning Outcomes:</b> Upon completion of this course, students will be able to recognize, analyze and describe linear operators in abstract vector spaces, find orthonormal bases, diagonalize operators, compute self-adjoint operators, perform singular-value decomposition and find Jordan decomposition.</p> | <p><b>Learning Outcomes:</b><br/>None (expected)</p>  |
| <p><b>Assessment:</b><br/>Active Participation 30%<br/>Homework 20%<br/>Midterm Exam #1 20%<br/>Midterm Exam #2 30%</p>   | <p><b>Assessment:</b><br/>Active Participation 0%<br/>Assignments 20%<br/>Exam #1 40%<br/>Exam #2 40%</p>  | <p><b>Assessment:</b><br/>30% more for participation<br/><br/>Homework is worth the same, but modified<br/><br/>Less emphasis on exams</p>  |
| <p><b>Instructional Methods:</b><br/>Twice a week:<br/>Lecture, didactic<br/>Instructor explaining and students asking questions.<br/><br/>Once a week: discussion, collaborative, problem solving<br/>Students split into groups, sent to the board to discuss, collaborate, solve problems</p>                          | <p><b>Instructional Methods:</b><br/>Both lectures (2x/w) and recitation (1x/w) mix:<br/>Lecture, didactic<br/>Active learning<br/>Students at board<br/>Discussion<br/>Collaborative<br/>Problem solving<br/>First one is exclusive for lectures; last three are more present in recitation</p>                         | <p><b>Instructional Methods:</b><br/>More student engagement<br/><br/>Less instructor explaining<br/><br/>More discussion, more student solving, talking about problem-solving<br/><br/>More use of functional technology</p> |

\*Spring 2020 Specific Sections. Subject to Change Statement. The syllabus and course schedule may be subject to change. Changes will be communicated via email. It is your responsibility to check email messages and course announcements to stay current in the online phase of the course. We will use mostly VoiceThread and Gradescope instructional technology resources in this class. You are responsible for communicating with me in a timely fashion if you are facing any challenges using these tools.

## 2. Before and After Response to Self-Efficacy Survey

In this modified Tschannen-Moran, Woolfolk-Hoy, and Hoy (1998) survey, we collected three types of responses: 1) general information regarding faculty's discipline areas, years they have been teaching in higher education and in the current institution, as well as their own reporting of experience in teaching with online tools; 2) a self-efficacy scale survey composed of ten statements, where respondents choose a score between 1 and 4 (from 1 Not at all True; 2 Somewhat True; 3 Moderately True; and 4 Exactly True); 3) open-ended input where respondents can share the major difficulties when they were trying to migrate courses online and details of their plan; and an optional blank box where they can share the details of the percentage of lecture in their usual F2F courses, their decision of the online format (a/synchronous), and the percentage of active learning components.

**Table 2:** Case Study (n=1) Self-Efficacy Responses

| Question   | Survey #1: Four Days Prior to the Start of the Term | Survey #2: Five Weeks After the Start of the Term |
|--|---|---|
| Academic Area  | Mathematics   | Mathematics                                       |
| How long have you been teaching in higher ed?          | 3-5 years   | 3-5 years   |
| How long have you been teaching at this university?    | 5 years   | 5 years   |
| What is your experience in teaching with online tools? | No experience at all                                | 5 weeks   |

**Table 3:** Faculty Response to Self-Efficacy Surveys

Directions. Please read each question and respond using the scale 1-4, where: 1 is Not at all True; 2 is Somewhat True; 3 is Moderately True; and 4 is Exactly True.

| Self-Efficacy Attribute  | Survey #1 | Survey #2 |
|--|-----------|-----------|
| I am confident that I can create and deliver high-quality online teaching.                                   | 4         | 4         |
| I understand the effort I need to create and offer effective online teaching                                 | 4         | 4         |
| I believe there are big differences between F2F and online teaching  | 3         | 4         |
| I am able to offer the same type of active learning and engagement while online                              | 3         | 2         |
| I will have to modify my assessment strategies significantly for online teaching                             | 2         | 2         |
| I am confident that I could adjust my teaching efficiently with unexpected events                            | 3         | 4         |
| I know how and where to seek help if I meet any difficulties with online teaching                            | 3         | 3         |
| I know how and where to seek help if I meet any difficulties with technology                                 | 3         | 2         |
| I will be able to develop a similar rapport with my students online  | 3         | 2         |
| I have built a network of resources to help resolve challenges while offering online learning opportunities. | 3         | 3         |

|  |   |   |
|--|---|---|
| <p>What are the major difficulties you have encountered when migrating your course to an online model?</p>   | <p>Planning methods that would ensure student engagement.</p>   | <p>Understanding the implications of each proposed activity on the social dynamics in the student population and planning accordingly.</p>  |
| <p>Please share with us more about your teaching. Here are several questions, which could guide your response: In your face-to-face (F2F) course format, what percent of the course is lecture? What percent of the F2F course is a group discussion or other active learning format? What is your chosen online format (a/synchronous) and why did you choose this?</p> | <p>Two lectures with instructor speaking, 1 recitation with group discussion. I chose asynchronous because synchronous technology is not ideal. If the technology allowed me to quickly see each of my student's faces and students to see each other in real time, and it was failproof, also if there was no time zone issue, I would go synchronous, even though the speed of light would play a role here (a couple of seconds of delay between China and US, even with futuristic science-fiction-level of technology). However, the current situation is so far from ideal that synchronous teaching became unfeasible.</p> | <p>F2F 66% is lecture<br/>F2F 33% is a group discussion or other active learning</p> <p>Completely asynchronous. When I chose it, I thought synchronous for a large class would be impractical. Now I think I made the right choice but for the wrong reasons. I am happy with asynchronous because it allows all students the opportunity to reflect and make their thoughtful contribution regardless of being shy, outspoken, confident, fast-thinking, etc. Students don't feel self-conscious about "interrupting the professor" and "taking away precious lecture time from their peers."</p> |

3. How to Make Awesome Math Videos

The instructor shared the following information on students creating videos for the course assignments. “*Making a video solving exercise was an awesome experience! It was so nice to see students choosing beautiful problems and confidently showing a video with their solution! Now let’s each one of us watch a dozen different videos and add to our table of what makes a good math video so we can continue to enhance our videos in the future - this is a sign of a successful person, continuous improvement.*”

**Table 4: Do’s and Don’ts of Making an Awesome Math Video**

| Try to Do  | Try to Avoid   |
|--|--|
| <ul style="list-style-type: none"> <li>● Use landscape format</li> <li>● Zoom in when emphasizing words and zoom out after</li> <li>● Capture your work in a well-lit space</li> <li>● Make sure all the video area is occupied by your presentation</li> <li>● Keep camera stable and close to the paper</li> <li>● Film only part of solution rather than whole</li> <li>● Let the camera follow your explanation</li> <li>● Imagine how solutions will look in a small window</li> <li>● Elevate your voice and project it toward the microphone</li> <li>● Pronounce and articulate each word clearly</li> <li>● Change the tone of your voice to emphasize major points</li> <li>● Speak confidently</li> <li>● Make the handwriting big and clear</li> <li>● Write the proof on a single page</li> <li>● Be concise, focus more on the main steps</li> <li>● Write all the steps before the presentation</li> <li>● Limit the time of the video</li> </ul> | <ul style="list-style-type: none"> <li>● Using portrait format</li> <li>● Forgetting to check proper orientation (upside up)</li> <li>● Making long videos (longer than 2 minutes is too much)</li> <li>● Skipping important steps</li> <li>● Writing with unclear small letters</li> <li>● Covering previous work when writing</li> <li>● Pronouncing your words in an unclear way or mumbling</li> <li>● Being afraid to use color to highlight the meaning</li> <li>● Cramming your writing into one part of the paper</li> <li>● Simply saying “clearly or instantly” without explaining why</li> <li>● Posting a video that reproduces a mistake that has already been pointed out in another solution</li> </ul> |

The goal of this data was to empower students to be part of the online learning objects and offer an opportunity for them to guide the direction, quality and function. For this major aspect to be effective, the instructor needed to motivate students to not only create media, but useful, high quality video, which this shared Google Document was able to accomplish. Ultimately, this teaching approach mimicked a similar method which the faculty employs in F2F, which is to ask his students to stand up and solve problems on a physical whiteboard in class.

#### 4. Example Instructor Communication with Online Students

**Table 5:** Example of Instructor to Student Communications

|   |
|---|
| <p>Dear students,</p> <p>We are all anxious and excited about the beginning of classes, aren't we?!</p> <p>On page "Week 01" of our CMS, I shared the resources and guiding material that should make our beginning of classes smooth and easy. That includes a preview of Lecture 01. Your comments and suggestions are more than welcome.</p> <p>The VoiceThread of Lecture 01 is open for preview but not yet for comments. It will be open on Monday morning. Participation in Lecture 01 is already counting towards your final grade. I will send an email one hour before opening it for comments, so you don't need to refresh your browser every 2 minutes.</p> <p>There will be a small written assignment as follow-up to Lecture 01. Gradescope will open the exercise on Tuesday at 06:00 (China) and accept submissions until 22:00 of the same day. If extenuating circumstances make this time window unfeasible for you, please let me know by Monday morning. Lecture 02 will become available on Wed, both for view and comment.</p> <p>Please do not hesitate in contacting me if you have any questions. I mean -any- questions! Looking forward to Monday!!! Best regards,</p> <p>PS: A few of you have not yet submitted our mock assignment on Gradescope and any of the mock tasks on VoiceThread. They will remain available until Monday evening. Anyway, they do not count for grade and will eventually be removed from the Gradebook.</p> <p>Best Regards, Instructor</p> |
| <p>Dear students,</p> <p>Our two first lectures were fantastic!!!</p> <p>But a bit too long... For Lectures 03 and 04 on Week 02, you are only asked to produce one video solution and one reply. The video solution will be required either on Monday or on Wednesday, and the reply will be required on the other day.</p> <p>Monday or Wednesday?</p> <p>Please use this <a href="#">webform</a> to indicate your preference by Friday afternoon (and also to give feedback about our first two lectures). Priority will be given first to students who have a strong preference for one of the days, and second to students who have a slight preference. If more than 17 students have the same preference, priority will be given to those who complete the webform earlier.</p> <p>About your videos</p> <p>Please go back to the video you posted last week and the two videos you posted this week. There is feedback both by students and by me. A path to success includes being open to feedback and seeking continued improvement.</p> <p>About your replies</p> <p>When you reply to someone's video, try to include: (0) Mathematical mistakes or omissions, if any (1) Aspects that impressed you positively (2) One aspect that can be improved for the future. A path to success includes knowing how to give constructive feedback.</p> <p>Accidental posts on VT</p> <p>If you wanted to make a Reply but accidentally made a new Comment:</p>                                      |



- 0) Read these instructions slowly and carefully
- 1) Add a Reply to your own Comment asking other viewers to reconsider it
- 2) Add the Reply to the Comment that you originally wanted to reply to
- 3) Add a Reply to my Comment on the slide asking me to delete your accidental comment
- 4) Try not to do it again

Please let me know if you have any questions or comments. Best wishes, Instructor

Note: The goal here was to quickly assure students that this online experience would take a humanistic approach. Students were anxious and worried due to the current world events, many of them having family members and friends who are in poor health. Thus, the instructor had to be empathetic, yet also maintain rigor and clear expectations of course learning outcomes.

5. Instructor Responses to an Instrument for Teaching Online (Benton, 2012).

- How would you describe your prior experiences teaching online?

None.

- How did you feel when you heard that you would be teaching online?

Vertigo, Pressed, Challenged, Responsible.

- Describe the type of training you had before you began teaching online?

Only email exchanges with the Center for Teaching & Learning (CTL).

- How do you collaborate with colleagues when teaching online?

With my teaching assistant (TA) we use WhatsApp and email. I propose the work, we discuss, then we do it. With my peers (not on the same course) we exchange ideas, tips, do's and don'ts, ask each other for advice.

- How have you overcome the challenges of teaching online?

I think I have.

- If I were a student in your online class, how would my learning experience be different?

You would be having much more access to the way the material is seen by students rather than conveyed by the instructor.

- Describe the planning process required for developing an online lesson.

Know your students' background with respect to the material of your course.

Make a first draft of a weekly routine, learning objects, and how these are connected.

Discuss with experts in pedagogy, get feedback, update your draft, repeat this step n times.

- Share specific activities in which your students have engaged online.

My lecture is like a movie, I'm the director and the students are the protagonists. 80% of the contents of this movie are produced by students based on guiding questions and hints spread over the slide, but without any real-time help from me. They ask questions about the theory, provide analyses of the examples I propose, proofs of the theorems that I state, and sometimes they even answer each other's questions with precise explanations.

- Describe your beliefs about the impact that online will have on student learning.

Asynchronous online teaching favors deliberate thinking and gives a chance to all students to formulate their thoughts without time pressure to think or social pressure for interrupting the lecture. It fosters the participation of students that would otherwise have remained quiet for the entire semester.

- Additional Instructor Comments

"I want to share that the 'shy and introverted' students of Linear Algebra II, were confident enough to produce two hours of lecture in only one morning. They are answering each other's questions and giving each other suggestions on how to improve their solutions."

"I don't think synchronous or even F2F would allow for the program to be covered using these instructional methods with the same intensity. Didactic would have been predominant (but not exclusive) in lectures, unless I had a whole day with the students instead of 75 minutes."

“It’s amazing how I was overconfident when I filled the survey five weeks ago! When I filled the form for the second time, I was sure that my level of self-confidence had increased. It was an interesting surprise (after answering the self-efficacy survey for the second time).”

#### 6. Midterm Student Perceptions of Online Learning

The instructor administered an online midterm student perception form, with only the author of this research having access. A summary of 29 of the 33 students enrolled, who responded are presented.

1. What is contributing to your online learning in this class, i.e., what is going well?
  - Voicethread (VT) was cited as very helpful to their learning (9 times)
    - VT creates an academic atmosphere for students to fully engage in the class. I benefit a lot from my peers’ comments and questions. Using VT, each student has an equal chance to participate in the lecture.
  - For me, everything is beyond expectation right now.
  - The instructor has been devoted to establishing an environment where students are encouraged to interact.
  - This is better than sitting in the classroom and letting the professor prove the theorem.
  - Almost everything is helpful. The lectures are very engaging and provide a great chance for us to communicate with other students.
  - The instructor sends careful feedback to every student's comments and this can help students to make sure that their understandings are correct.
  - Online learning allows more time for us to raise questions and digest the knowledge by listening to what we don't understand many times.
  - Being able to slow down and try to prove the theorem on my own makes me understand them better to some extent.
  - In terms of teaching methodology, this is the best among five courses I take this semester.
2. What might need improvement to enhance your online learning?
  - Nothing (4)
  - More examples (3)
  - I am longing for a synchronous office hour supported by Zoom, which provides direct interactions with the instructor (2)
  - I think the recitation mode is not perfect since it is really hard to get together with the group members and discuss online (2)
  - My Wifi speed. A dedicated period of time when we can discuss problems in real time.
  - maybe the recitation also need to upload some videos
3. What is one concrete action which the instructor can do now to improve your online learning?
  - Nothing, it’s all good (7)
  - Regular synchronous meetings can be held to serve as the office hours (3)
  - Provide a written proof (2)
  - The TA select more challenging exercises in our recitation (2)
    - More challenging exercises occasionally, as well as showing the relationship between what we are learning with coding more often
  - Maybe we can hold some discussion or send some tips on the common mistakes that students made or nice proofs shown in lectures
  - One thing that I think is helpful is that after the professor watches all our questions and answers, can he summarize the important parts?
  - Give Sample Midterm
4. What is one word that describes how you feel about this online course now?
  - Great (5)
  - Awesome (4)
  - Excellent! (3)
  - Acceptable (3)
  - Comfortable (2)
  - Smooth (2)
  - Brilliant (2)
  - Helpful (2)
  - Productive
  - Beneficial

- Interesting
- Nice
- Intrigued

## DISCUSSION

This study has an overarching research question focusing on creating online learning objects for a linear algebra II course while maintaining a focus on research-based pedagogy. The research was conducted during intensive, stressful times, which was both an asset (of capturing authentic data); and a disadvantage (of finding time).

### Data Collection Instruments

1. Syllabus (Includes learning outcomes, assessments and online active learning methods compared to a prior F2F syllabus of the same course)
2. Before and After response to Self-Efficacy Survey
3. How to Make Awesome Math Videos
4. Example Instructor Communication with Online Students
5. Instructor Responses to an Instrument for Teaching Online (Benton, 2012)
6. Midterm Student Perceptions of Online Learning

There were several major findings of this research (each supported by at least two data collection instruments):

1. Understanding and implementing effective Course Design (well-written, measurable learning outcomes; authentic assessment and active teaching methods) is critical (Wiggins & McTighe, 2011) [from Data Collection Instruments #1, 5].
2. Aware that Learning Outcomes should not be modified when migrating online, although assessments can be more authentic and interactive; and teaching methods should be significantly modified to capitalize on available useful technology [from Data Collection Instruments #1, 2, 5].
3. Possessing a background in pedagogy or at least an openness to quickly integrate research on effective teaching is critical [from Data Collection Instruments #2, 5, 6].
4. Time management is critical for effective online course delivery (Perry & Steck, 2019) [from Data Collection Instruments #2, 3, 4, 6].
5. Initial perceptions of self-efficacy for teaching online can be falsely elevated, even for faculty who have little experience with online teaching. This can result in unsuspected insights throughout the experience [from Data Collection Instruments #2, 5, 6].
6. Eliciting assistance from students and their perceptions can be helpful, especially when they are asked about how they can create electronic artifacts (videos) [from Data Collection Instruments #3, 4].
7. Early, humanistic communication with students is key to reduce anxiety and create a helpful classroom culture [from Data Collection Instruments #1, 3, 4, 6].
8. Highlights of the midterm student perceptions of online learning indicates that students
  - a. appreciated the use of VT videos; course design; instructor creating a welcome classroom; and feedback;
  - b. would prefer some synchronous opportunities; more examples [many indicated nothing needed improved]; and
  - c. have a very good disposition towards the online course, sharing words such as Great, Awesome and Excellent! [from Data Collection Instruments #3, 6]

Our findings align with earlier concepts of how instructors can “develop effective classroom culture within a learning community through creating a humanistic approach (Raygoza, León, & Norris, 2020).” Attributes which support this approach include being present, start and end on time, engage students in a “temperature check” at the beginning of class, have an agenda with learning outcomes and activities, provide an array of instructional activities, engage students in reflective, metacognitive activities such as exit tickets, and be flexible and patient. In addition, we found that offering a midterm student perception session can provide useful anonymous feedback to an instructor at a time when they can make modifications (Achen & Lumpkin, 2015).

### Further Work

The instructor plans on using some of the approaches that he has created and used this term in future F2F classes. He has indicated that he plans to keep the basic format where didactics is predominant in lectures and group discussions predominant in exercise sessions and plans to incorporate more discussions into the lectures. He will collect homework electronically if there is a convenient tool available such as Gradescope. He will increase students' voices and ask for feedback more regularly. He will build roadmaps and send students more detailed guidance on how to learn more effectively. The instructor plans on requesting or accepting to teach online in the future if the institution is willing to take into account that it takes 3-4 times more work to teach an online course

and provide corresponding preparation time and credit. The instructor is and will continue to assist other faculty in teaching online in the future as he has been receiving questions from other colleagues and for this reason he started a YouTube channel and blog.

Through the current crisis, it seems apparent that higher education does not have a culture built on how to teach effectively online. This research shares ideas and data collection instruments that worked for this instructor and might work for others. One final suggestion from this research is that when we plan to migrate our courses online, it may serve instructors well to contact teaching and learning experts (such as in Center for Teaching and Learning departments) to create effective online learning objects.

### List of Abbreviations

CTL - Center for Teaching & Learning  
 CMS/LMS - Course Management System/Learning Management System  
 COVID-19 - Coronavirus  
 F2F - face-to-face  
 H1N1 - Influenza Type A  
 HITS - High Impact Teaching Strategies  
 LC - Learning Community  
 OLO - Online Learning Object  
 SARS - Severe Acute Respiratory Syndrome  
 TA - teaching assistant  
 VT - Voice Thread

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### REFERENCES

- Achen, R. M., & Lumpkin, A. (2015). Evaluating classroom time through systematic analysis and student feedback. *International Journal for the Scholarship of Teaching and Learning*, 9(2), 1-4.  
 doi:10.20429/ijstl.2015.090204
- Bailey, J. (2020, March 9). Closing schools to slow a pandemic. *Education Next*. Retrieved from <https://www.educationnext.org/closing-schools-to-slow-a-pandemic-coronavirus-covid-19-public-health>
- Benton, B. K. (2012). The iPad as an instructional tool: An examination of teacher implementation experiences. Unpublished doctoral dissertation, University of Arkansas, Fayetteville, AR.
- Center for Research on Learning & Teaching, University of Michigan. (2019). *The Research Basis for Inclusive Teaching*. Retrieved from <http://crlt.umich.edu/research-basis-inclusive-teaching>
- Gannon, K. (2019, March 24). 4 lessons from moving a face-to-face course online. *The Chronicle of Higher Education*. Retrieved from <https://www.chronicle.com/article/4-Lessons-From-Moving-a/245926>
- Holeton, R. (2020, February 28). Toward Inclusive Learning Spaces: Physiological, Cognitive, and Cultural Inclusion and the Learning Space Rating System. *Educause Review*. Retrieved from <https://er.educause.edu/articles/2020/2/toward-inclusive-learning-spaces>
- Hargis, J. (2014). Can students learn science using the Internet? *ISTE Journal of Research on Computing in Education*, 33(4), 475-487.
- Hodgins, H. W. (2006). The future of learning objects. *Educational Technology*, 46(1), 49-54.
- Iwai, Y. (2020, March 13). Online learning during the COVID-19 pandemic. *Scientific American*. Retrieved from <https://blogs.scientificamerican.com/observations/online-learning-during-the-covid-19-pandemic/>
- Kuh, G., O'Donnell, K., & Schneider, C. G. (2017). High Impact Instructional Practices (HIIPs) at ten. *Change: Higher Learning*, 49(5), 8-16.
- Lau, J., Yang, B., & Dasgupta, R. (2020, March 12). Will the coronavirus make online education go viral? *Times Higher Education (THE)*. Retrieved from <https://www.timeshighereducation.com/features/will-coronavirus-make-online-education-go-viral>
- Laufgraben, J. L., & Shapiro, N. S. (2004). *Sustaining & improving learning communities*. San Francisco, CA: Jossey-Bass.
- Lawrie, G., Marquis, E., Fuller, E., Newman, T., Qiu, M., Nomikoudis, M., Roelofs, F. & van Dam, L. (2017). Moving towards inclusive learning and teaching: A synthesis of recent literature. *Teaching & Learning Inquiry: The ISSOTL Journal*, 5(1), 10.
- Northern Illinois University, Faculty Development and Instructional Design Center. (2019). *Learning Communities*. Retrieved from [https://www.niu.edu/facdev/\\_pdf/guide/strategies/learning\\_](https://www.niu.edu/facdev/_pdf/guide/strategies/learning_)

communities.pdf

- Park, J. (2020, March 19). Online education now the new normal due to the coronavirus pandemic. *The Korea Herald*. Retrieved from <http://www.koreaherald.com/view.php?ud20200319000682>
- Perry, D. & Steck, A. (2019). Changes in faculty perceptions about online instruction: Comparison of faculty groups from 2002 and 2016. *Journal of Educators Online*, 16(2). Retrieved from <https://eric.ed.gov/?id=EJ1223933>
- Pfleger, P. (2020, March 13). The coronavirus outbreak and the challenges of online-only classes. *National Public Radio (NPR)*. Retrieved from <https://www.npr.org/2020/03/13/814974088/the-coronavirus-outbreak-and-the-challenges-of-online-only-classes>
- Puentedura, R. (2012). The SAMR model: Background and examples. *Ruben R. Puentedura Weblog*. Retrieved from <http://www.hippasus.com/rrpweblog/archives/000073.html>
- Raygoza, M., Raina, L., & Aminah, N. (2020). Humanizing online teaching. [paper]. <https://digitalcommons.stmarys-ca.edu/school-education-faculty-works/1805>
- Rice University, Center for Teacher Excellence. (2020). *Inclusion, Equity, and Access While Teaching Remotely*. Retrieved from <https://cte.rice.edu/blogarchive/2020/3/13/inclusion-equity-and-access-while-teaching-remotely>
- Rodriguez, R. J. & Koubek, E. (2019). Unpacking High-Impact Instructional Practices and Student Engagement in a Teacher Preparation Program. *International Journal for the Scholarship of Teaching & Learning*, 13(3). <https://doi.org/10.20429/ijstl.2019.130311>
- Supiano, B. (2020, March 20). ‘Nobody Signed Up for This’: One Professor’s Guidelines for an Interrupted Semester. *The Chronicle of Higher Education*. Retrieved from <https://www.chronicle.com/article/Nobody-Signed-Up-for/248298>
- Tam, G. & El-Azar, D. (2020, March 13). Three ways the coronavirus pandemic could reshape education. *World Economic Forum*. Retrieved from <https://www.weforum.org/agenda/2020/03/3-ways-coronavirus-is-reshaping-education-and-what-changes-might-be-here-to-stay>
- Trucano, M. (2014, September 14). Education and technology in an age of pandemics. *World Bank Blogs*. Retrieved from <https://blogs.worldbank.org/edutech/education-technology-age-pandemics-revisited>
- Tschannen-Moran, M., Woolfolk-Hoy, A., & Hoy, W. K. (1998). Teacher-efficacy: Its meaning and measure. *Review of Educational Research*, 68(2), 202-248.
- University of Toronto Libraries. (2019). *Digital Pedagogy: A Guide for Librarians, Faculty, and Students*. Retrieved from <https://guides.library.utoronto.ca/c.php?g=448614&p=3523799>
- Victoria State Government of Education and Training. (2019). *High Impact Teaching Strategies (HITS)*. Retrieved from <https://www.education.vic.gov.au/school/teachers/teachingresources/practice/improve/Pages/hits.aspx>
- Wiggins, G. & McTighe, J. (2011). *Understanding by Design guide*. Alexandria, VA: ASCD.