PERSONAL TIPS AND TRIPS FROM THE LIVESTREAM CLASSROOM

Violeta Vasilevska
Utah Valley University
800 W. University Parkway
Orem, UT 84058
Violeta.Vasilevska@uvu.edu

Abstract

This paper discusses some of the lessons learned from implementing various teaching activities and technology to engage students in LiveStream classes used during the pandemic. It will be shown how some in-class active learning approaches were changed to accommodate for diverse students' learning styles as well as for the change into the new LiveStream modality. In addition, some new activities added will be discussed (pre-class assignments, Microsoft Forms daily surveys, etc.). Many of these ideas have shown to be very useful in the back-to-in-person modality. Those active strategies improve student-learning experiences and prepare them better for future math classes. In addition, some students' feedback on the activities will be shared.

Introduction

Teaching in a LiveStream modality during the pandemic was filled with struggles, hardship, and uncertainty, and pushed many of us (educators) out of our comfort zones. On a positive note, we all gained something from this experience. For each of us those gains were different. For me, things that I learned from the LiveStream classrooms that I was able to bring back-to-in-person classrooms were designing more active learning strategies, creating strategies that are more diversified and inclusive, and using more technology tools.

As a longtime practitioner and supporter of active learning as a teaching approach, I appreciate the research done that confirms what I have observed with my own students about the effect of active learning on them. Bonwell and Eison [3] summarized the literature on active learning and concluded that it leads to better student attitudes and improvements in students' thinking and writing. The results shown in Prince's paper [14] about active engagement vs. traditional instructions for improving students' conceptual understanding of basic physics concepts are striking and show that active learning contributes to students' success. In addition, research shows that active learning increases performance in STEM and lowers the failure rates [7].

For me active learning is a process in which the instructor engages students in class in a meaningful learning experience by putting them in the center of the learning process, while the instructor provides guidance when needed and uses inquiry throughout the whole process. And I strongly agree that the core elements of active learning are student activity and engagement in the learning process [14].

The research shows that student involvement is one of the most important predictors of success in college [2]; hence, in my classes I strongly support, encourage, and implement student engagement. This engagement occurs through various forms of active learning including inquiry, discovery, in-class discussions, student presentations, in-class individual and group work, team quizzes, scaffolding, etc. The aim of each technique is to transform students into active learners and the teacher-centered classroom into a student-centered one.

During the COVID-19 pandemic I found myself struggling with the transition from face-to-face to LiveStream modality, especially with the effort to continue with this style of active learning and teaching. From a very articulate person who loves walking among different student groups and interacting with students in class, I became a person who sat on a ball chair for hours in front of the laptop screen and looked at still students' pictures. My interactive and engaged upbeat classroom became a still and quiet space. It was a very hard transition time, filled with lots of struggles, hard work in finding ways to engage my students in the virtual classroom, and strong pushback from them on some of the changes. During that time, I tried various strategies to involve my students in class – some showed to be successful, some failed, and some of the successful ones I have continued using in back-to-in-person teaching.

The importance of utilizing technology in class (as an important learning tool in supporting problem solving as well as promoting understanding [21]) has been growing in recent years. The experience that I gained using various technology tools during LiveStream teaching has shown to be invaluable in back-to-in-person teaching. For example, I started utilizing Canvas (the Learning Management System that our university is using [4]) fully and more intensively. In addition, using Microsoft Forms for pre-class activities proved to be a very effective tool. Moreover, some of the skills attained while using OneNote proved to be very valuable during the in-person teaching.

To accommodate various and different students' learning styles in a rather unprecedented situation, I worked hard on designing/assigning more flexible and diverse assignments. Many of these assignments I continue using in back-to-in-person modality.

In this paper I discuss some of a) the active learning strategies and assignments that I modified to fit LiveStream modality, b) the new and different assignments that I used, as

well as c) the technology used to enhance students' learning. The goal of these strategies and activities was to prepare my students better (be more comfortable and freer) to participate in LiveStream class, to add flexibility, and be more diverse in assessing student learning. In addition, I will discuss which of these assignments and strategies worked well in back-to-in-person teaching and share some students' feedback about these strategies and activities.

Lessons learned during the pandemic

As pointed out in the Introduction, during the COVID-19 pandemic I tried various activities in the LiveStream classroom with the aim to engage students in a meaningful and productive way in and out of class. Many of these activities proved to be successful in back-to-in-person modality as well. In this section some of these activities will be described.

a) Use of Canvas

The pandemic "forced" me to rethink the design of my Canvas course pages. I put a great effort to make them more friendly, easily accessible, and organized. They are now designed to allow students easy access to the class materials, assignments, class information, calendar events, assignments' due dates, etc. All this is organized in Modules (Figure 1). In addition, I have started using more features of Canvas as described below.

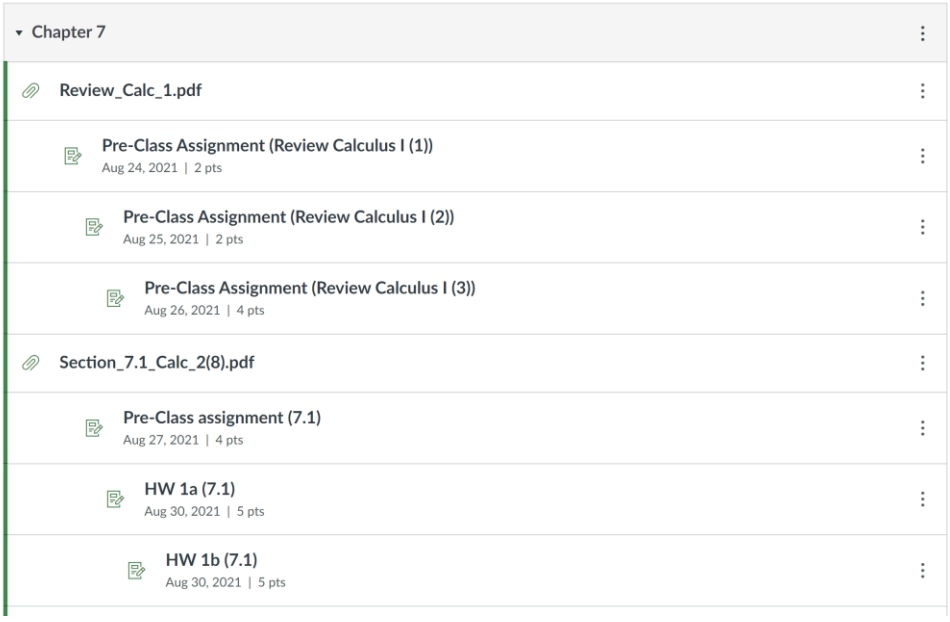

Figure 1: Sample Canvas Module design

b) Canvas Discussion Board: “Get to know your instructor and classmates”

In face-to-face modality, the first day of class was always used for students’ introductions, giving opportunities for students to get to know each other from the beginning. It was clear to me that this approach would not work well in the LiveStream classroom. Hence, in Fall of 2020, this introduction activity was substituted with a pre-class assignment on the Canvas Discussion Board: “Get to know your instructor and classmates.” I posted a one-minute video introducing myself and asked each student to do the same. In addition, students were asked to address a few prompts in the video: to explain why they took that class, to share their thoughts about math, and to reveal something unique/interesting about them. Furthermore, students were asked to comment on my video and on at least one of the classmates’ intro videos.

This activity was received very well, and students seemed to enjoy getting to know each other in this way. Some were able to find classmates with similar interests and connect with them. Others went one step further and were interacting with more than one of their classmates by commenting on their videos. As a result, the Discussion Board became a very lively environment where students were free to exchange their thoughts and comments and engage in discussions. The most meaningful and interesting of these discussions for me were the ones connected to their thoughts about mathematics that they shared. Following up on the positive feedback received about this assignment, I continue assigning this assignment for in-person classes with the same success.

c) Welcome presentation

On the first day of each class, I generally go over the syllabus (objectives, evaluation, schedule, etc.), talk about what I expect from the students as well as what students should expect from me, and usually this is a very interactive part of the class meeting with lots of students’ questions and discussions about these topics. After the spring semester in 2020, I realized that this approach would not work well in LiveStream modality. Hence, I prepared a slideshow for the first day of class that I posted on Canvas as well. The slideshow included the regular topics covered during the face-to-face modality but with inclusion of lots of pictures designed to make it more attractive and keep the attention of the virtual students. In addition, the slideshow included some math jokes to make the virtual atmosphere lighter and more informal. Moreover, I made sure the presentation communicated that I would be available through a virtual presence and that my virtual class environment would be inviting and safe. I tried to reflect more openness and availability by inviting them to contact me and talk to me whenever they had any questions or concerns.

Furthermore, I felt the need on the first day of class to set the tone of an active learning classroom while respecting diversity, equity, and inclusiveness. Hence, the slideshow displayed a clear message that in my classroom everyone was welcomed and encouraged to share their ideas, discuss ideas of their classmates, and give constructive feedback to peers, all while maintaining a positive and respectful class environment where we cared for and respected each other and showed kindness and empathy for everyone in class. The emphasis was on the idea that discussions and collaborations are encouraged in class as a way to grow and learn.

Similarly, as with the "Get to know your instructor and classmates" assignment, the welcome presentation was well received, became very popular, and was a great success. Hence, I continue using it even in the back-to-in-person classes.

d) Respecting personal identities - addressing students in class and pronouns

I strongly believe that all people have the right to be addressed and referred to based on their personal identity. During the pandemic, addressing students in the virtual environment became even harder. To solve this problem, I created a survey using Microsoft Forms. Namely, at the beginning of the semester, students were given a chance (on the survey) to indicate the name they would prefer to be called in class as well as the pronouns that they would like to be addressed with. Their preferences were shared with the class (with the students' permission) and I tried to encourage everyone in class to address and refer to the classmates by their choices. I have continued using this type of survey in the back-to-in-person classroom. Students seem to appreciate the opportunity to identify themselves and respect classmates' preferences.

e) Pre-class assignments

In the face-to-face classes before the pandemic, I used pre-class assignments to some extent. But during the pandemic, I started utilizing pre-class assignments to a greater extent and continue doing so in the back-to-in-person modality. For example, in my flipped College Algebra classes, students are required to watch videos and do online homework before they come to class [19]. In class, during the 30-minute Q&As students are encouraged to ask questions about concepts that they struggled with during the pre-class assignments (videos and homework). However, in the LiveStream classroom, it was a struggle to engage students in class to let me know what they had learned and what problems/concepts they had struggled with, so it took a big portion of the class time to accomplish this task. As a result, I started assigning daily pre-class surveys utilizing Microsoft Forms. The surveys asked students to provide feedback on what they had learned from that section, which concepts they had problems with, what type of applications of the new concepts they encountered during the videos and homework, etc.

These assignments were due 30 minutes before class and served two purposes: they provided me with feedback on what type of problems to concentrate on during the Q&As and in addition, they saved valuable time in class. I continue using these daily pre-class surveys in the back-to-in-person classes, because of the valuable input on students' learning I gain from them before going to class.

In addition, I started using and assigning pre-class assignments for my other classes as well.

In some of my classes, pre-class assignments involved watching short videos introducing the new concepts through engaging and fun applications. For example, in my Calculus I classes, many of the videos from the Calculus Videos Project [18] were assigned as pre-class tasks. In addition, students were asked to provide short feedback about the watched video(s) by filling out a Microsoft Forms feedback survey. These surveys allowed me to monitor if students were watching the assigned pre-class video(s) and hence, were getting ready for the in-class work, as well as kept the students on task and accountable for their academic responsibility.

Sometimes students were asked to submit solutions to some problems (due before class) on Canvas. Then I would choose a solution of a student who did not often actively participate in class, shared it on OneNote, and asked the student to explain to all of us their work. In addition, in upper-level classes, students were asked to "fill in" assigned pages from the lecture notes and submit them on Canvas. In class, we worked through them and addressed any concerns, as well as discussed and corrected any mistakes they made. This allowed me to run the class as a modified flipped Inquiry Based Learning (IBL) modality [17]. These types of pre-class assignments showed to be very beneficial in allowing me to involve not so active students in class and to encourage more participation from them. I noticed that pre-class assignments helped those students to be more confident and more open to participate since they had seen and worked on the problems and material before discussing them in class.

These pre-class assignments were graded mostly on completeness and were very helpful in engaging students in class and allowing diverse assignments to help different students' learning. As with the daily College Algebra pre-class surveys, I continue using these types of pre-class assignments in all of my in-person classes.

Students' feedback indicated that they liked the pre-class assignments and pointed out that they would recommend using them for future classes. In addition, the Calculus students agreed that the pre-class videos were beneficial and informative.

f) Collaborative group problem-solving work

For almost of all my classes, I make my own fill-in worksheets. During class, in face-to-face modality, students would work in groups on the worksheets, present on the whiteboard, and the whole class would have discussions on the presented work. In the virtual classroom the in-class participation worked up to some degree, but I struggled with a few things: taking participation, utilizing the chat feature while sharing screen, having students participate without their cameras on, etc. In addition, I was not able to manage students' presentations on virtual boards. Hence, I felt the need to modify how I run my class in LiveStream modality.

While the collaborative group problem-solving in face-to-face modality has been working great, in the LiveStream classroom I had mixed results. I used Microsoft Teams Channels for these activities. In my flipped College Algebra classes [19], students were divided in groups for the last 20 minutes of class (*Group Problem-Solving* part) to work collaboratively on similar problems as the homework ones. I visited each group and helped by guiding them when needed. Each student submitted their own solutions on Canvas. For these classes the collaborative group work using Microsoft Teams channels worked perfectly. However, for my other classes that required to place the students in groups in Microsoft Teams Channels for a short period of time and several times during the class meeting – it was very hard to utilize. Part of the problem was not having a nice feature (at that time) on Microsoft Teams that would allow for the teacher to bring all groups together quickly. Without that, it was a waste of valuable class time to get all students back in the main channel and continue the work as a class. In those classes I stopped using group work.

Hence, for those classes in the LiveStream modality, instead of breaking the class in teams I tried to use a different approach. I became a scribe (using OneNote or Doc Camera) to allow students to participate in class through asking/answering questions and solving problems without worrying about using virtual boards and students' ability to write on them. In addition, this approach saved me valuable class time. Because the "scribe" role saves class time, I continue using this method frequently for back-to-in-person teaching using the whiteboard.

As a scribe I write what students are directing me to do for every single step – so we all work as a group together, establishing great class collaboration and engaging in wonderful discussions. I usually ask for volunteers and if there are none, I call upon a student to start the problem. When they get stuck during the solving part, other students help with hints or someone else continues with solving the problem. As a scribe, I do tend to write an incorrect statement if a student tells me to do so and wait for that student or other classmates to notice that error and alert us – then I go back and make corrections as

per the students' decision. Often, I ask if the class agrees with what was written on the OneNote/whiteboard (especially when something is wrong with the solution). The students are constantly reminded that in my classes "Being stuck is OK!" and "Mistakes are Good." As a class, we constantly use these mistakes as a stepping point to learn, clear confusions, and grow in our knowledge. In addition, students are frequently encouraged to participate in class and reminded that all answers, ideas, and contributions are welcome and appreciated.

Moreover, in back-to-in-person classes I started occasionally using the scribe role even when students work in groups – especially when none of the groups came with a complete and correct solution. Instead of calling a group to present their work on the whiteboard I utilize the scribe role. It is a great way to allow every group to add to the solution by putting together the pieces as a class.

g) Homework

The effect of the homework as a teaching tool continues to be a topic of conversation with arguments on both sides of the spectrum [5, 6, 8, 13]. Personally, I strongly believe that homework as an (out of class) problem-solving practice is a great away for students to either get ready for class (as a pre-class assignment) or solidify their knowledge after class, as well as to refine their skills and become responsible for their learning. Following some of the ideas suggested by Vatterott [20], during the pandemic I tried to revamp my homework assignments to allow more diversity, add flexibility, and use alternative grading strategies (e.g., complete/incomplete). All the homework techniques and strategies that I developed during the LiveStream teaching, I have been using them in the back-to-in-person teaching as well.

Since the spring of 2020, I have utilized Canvas to a great deal for the homework and assignments submissions. Canvas allows easy access to the submissions. In addition, it allows for smoother communication with the grader. Moreover, it allows for the enforcement and flexibility of assignment due dates. For example, in my Calculus classes the homework sets are listed at the end of each lecture notes and posted on Canvas. In 2020 I started a different approach to the homework (based on student feedback) – instead of one set deadline for homework from a section, I split the homework into two parts.

Part A contains only two problems and is worth 50% of the homework score. This part of the homework is due the day after we finish with a section and there is no late submission for this part. The grader provides feedback for these homework problems and grades on completeness and correctness.

Part B contains the rest of the homework problems due the day after a section is finished for a full credit or by the upcoming chapter exam covering that material for late submission for 60% of the part B homework score. This part of the homework is graded on completeness.

It is worth noting that even with the late submission of part B of the homework, students can receive up to 80% of the total homework score.

Since 2020, all homework in my upper-level classes has been graded as complete/incomplete (using alternative grading scale). Students receive a lot of feedback and are allowed to resubmit the homework as many times as they need (to receive the 'complete' designation) until the upcoming chapter exam covering that material.

Received students' feedback demonstrates that they appreciate the flexibility of the due dates as well as the opportunity for resubmissions. Their comments have been overwhelmingly positive and showed appreciation for the given opportunities.

h) Alternative assessment and evaluation

Another positive effect of the pandemic was the access of more professional development opportunities that were offered virtually and mostly free. I heavily took advantage of the ones that discussed alternative assessment and evaluation (e.g., learning circle on ungrading [9], various conferences and/or workshops on alternative grading, specification grading [11, 12], mastery grading etc.).

Objectives Retesting Final Exam

In 2021, I started implementing some of these ideas in my classes. One strategy that I tried in my upper-level class in spring 2021 as well as in my Calculus II class in fall 2021 is Objectives Retesting Final Exam. Namely, during the semester students were given three (in the upper-level class) and five (in the Calculus II class) chapter exams that were graded in a traditional way and covered all of the material from a particular class. Each graded chapter exam was returned on Canvas, so students and I have access to them at any time. Note that for the in-person classes this part was time consuming: scanning each graded exam and then returning them to students by posting them on Canvas. In addition, in my Calculus II classes, complete solutions to chapter exam problems were provided on Canvas after each exam so students were able to see where they made mistakes (if any) and how to correct them.

After the last chapter exam, students were given an option to retest objectives (missed on the chapter exams) during the optional Objectives Retesting Final Exam.

For the upper-level class, students who opted to take this optional exam were asked to schedule a 30-minute meeting with me after the last chapter exam. During that meeting we went over all their chapter exams and decided which objectives they would retest. For this class there was no limit of how many objectives students could retest nor was there a score cutoff to retest on an objective on a chapter exam.

However, this proved to be extremely time consuming for me, so in the fall of 2021 I changed the conditions for taking the optional Objectives Retesting Final Exam for the Calculus II class. Namely, for the Calculus II optional Objectives Retesting Final Exam, I set a few restrictions:

- a maximum of five objectives (total) could be retested,
- no more than two objectives from a chapter exam could be retested,
- an objective can be retested only if a student scored 50% or less on that objective when it was tested on a chapter exam.

Students who opted to take the Objectives Retesting Final Exam, were given a list of all objectives, Objective Table (Figure 2), as they appear in each problem/chapter exam.

Objectives

Calculus II (Fall 2021)

Exam #	Problem #	Objective: Student will be able to	Achieved (A)/ Not Achieved (NotA) If NotA – write % scored	Exam # 2 Problem # & Achieved (A)/ Not Achieved (NotA)/ N/A	Exam # 3 Problem # & Achieved (A)/ Not Achieved (NotA)/ N/A	Exam # 4 Problem # & Achieved (A)/ Not Achieved (NotA)/ N/A	Exam # 5 Problem # & Achieved (A)/ Not Achieved (NotA)/ N/A
1	1	use and apply integration by parts					
1	2	approximate Integrals					
1	3a	integrate rational function					
1	3b	use trigonometric substitution					
1	3c	integrate improper integrals type 2					
1	3d	integrate improper integrals type 1					
1	4	integrate trigonometric integrals					
2	1	find the centroid of a region		X			
2	3	find the length of an arc of a curve		X			
2	4	find the area of a surface		X			
2	5	find the probability		X			
2	6	use Comparison Theorem		X			
2	7	find the hydrostatic force		X			

Figure 2: Part of the Objective Table for Calculus II class

Students were asked to go over each of their graded chapter exams, identify if they achieved the objective accessed and in which of the problems/chapter exams that was achieved and fill out the Objective Table with the obtained info.

- Achieved (A) objective meant that the student received 70% or above of the score for that particular objective.
- Not Achieved (NotA) meant the score was below 70%. In that case they were instructed to provide the % scored
- N/A meant that the objective did not appear on that problem/chapter exam
- X sign in the table meant that entry should not be filled (those were passed chapter exams).

This strategy provided a great way for students to review the overall material. Note that they needed to identify if any of the objectives tested were used in a problem where another objective was accessed. The students were also given a sample with detailed instructions on how to fill out the Objective Table (Figure 3) and in addition, I held an hour long out-of-class session to answer any questions students had about the Objectives Retesting Final Exam.

How to fill the table?

Example:

Exam #	Problem #	Objective: Student will be able to	Achieved (A)/ Not Achieved (NotA) If NotA – write % scored	Exam # 2 Problem # & Achieved (A)/ Not Achieved (NotA)/ N/A	Exam # 3 Problem # & Achieved (A)/ Not Achieved (NotA)/ N/A	Exam # 4 Problem # & Achieved (A)/ Not Achieved (NotA)/ N/A	Exam # 5 Problem # & Achieved (A)/ Not Achieved (NotA)/ N/A
1	1	use and apply integration by parts	NotA 30%	Ex #2 Prob #1 NotA	Ex #3 Prob #2a A	Ex #4 Prob #8 A	N/A

Meaning:

On Exam #1 – I did Not Achieved the objective of using and applying Integration by parts. I earned only 30% of the score for that problem.

On Exam #2 – Integration by parts appeared on Problem #1 but I did not solve the integral so Not Achieved that objective (NotA)

On Exam #3 (Prob #2a) and Exam #4 (Prob #8) Integration by parts appeared again – I used it and solved each integral – so Achieved (A) the objective.

On Exam #5 – Integration by parts did not appear (so N/A)

Figure 3: Instructions of how to fill out the Objective Table

The students were instructed to send me their filled out Objective Table and schedule a 30-minute meeting with me so we could go over their Objective Table together. During the meeting, the student and I discussed the objectives chosen and decided on which particular objectives the student should test. After the meeting, I sent a confirmation e-mail to the student with the objectives we decided to be tested on their individual Objectives Retesting Final Exam.

At the end of the semester students who opted to do so (for both classes), took the optional individual Objectives Retesting Final Exam (scheduled during the university scheduled final exam time). The Objectives Retesting Final Exam allowed students who missed to achieve an objective in previous chapter exams to be able to demonstrate that

they achieved that objective. To score Achieved on an objective on this exam, a student needed to solve the given problem *correctly and completely.* No partial credit was given nor considered. If an objective was Achieved – then the score for that particular problem on that particular exam was replaced with a full score. For example: Assume a student scored 3 points (out of 10) on a problem of Integration by Parts on chapter exam 1 (problem #1) and the student tested Achieved on that objective on their Objectives Retesting Final Exam. Then student's score of 3 was *replaced* with 10 on the chapter exam 1 (problem #1).

Personally and based on student feedback, I strongly believe this is a great way of alternative assessment for students, however, it required lots of work on my end. I have been trying to revisit and find a better way to implement the Objectives Retesting Final Exam without requiring too much of my time. It is worth mentioning that only meeting individually with each student who opted for this assessment and writing the individual exams for each of these students, was overwhelming and time consuming. I plan to participate in a few professional development opportunities on this topic in the near future and look forward to implementing what I learn there in my classes and hopefully make this process smoother and less time consuming.

Reflective Final Exam

During the pandemic, the need to reinvent and reimagine assessments was even more appealing and needed than before. Francis Su in his book [16] talks about the importance not just of developing skills but also of building virtues that our students should develop through problem-solving. But those virtues have not been part of my class objectives list nor assessments before the pandemic. Namely, before the pandemic, I usually added one or two reflective questions on the final exam assessment, but they usually asked students to reflect on the class content and structure of the class – what worked/did not work well and what suggestions for improvement they could offer. And those questions were usually given as a very small extra credit.

But then in 2020, Su [15] blogged about the idea of giving a Reflective Final Exam – containing reflective questions "that attempt to explicitly assess the development of virtues." In addition, his blog triggered huge discussion among the mathematical community on Mathematical Association of America (MAA) Connect [10] about the need to use alternative final exam students' assessments.

Hence, in 2021 (for both classes discussed in the previous section), I decided to try Su's suggestion of Reflective Final Exam as an alternative assessment and evaluation in addition to the optional Objectives Retesting Final Exam. Students in both classes received a Reflective Final Exam (that was *not* optional). The first question on the

Reflective Final Exam for the Calculus II class (Appendix A), asked students the following:

> Choose 6 problems that illustrate the variety of (diverse) ideas from this course that you might put on a final exam for this class if you were teaching this course. Make sure that each problem comes from a different chapter. Then for each problem do the following:
>
> - solve the problem
> - explain why you chose that particular problem from that particular chapter
> - describe what that problem is assessing.
>
> Additional scores will be awarded based on how difficult the chosen problem was, whether it represents diverse and good ideas to be tested on a final exam, etc. Students must choose the problems solely based on their opinion of the problem.

Students were advised that they cannot choose problems assigned for homework, solved in class or textbook, or given on a chapter exam.
The goal with this question was for each student to review the material while choosing these problems, reflect on their choices, and display understanding of what skills/virtues each problem assessed.

For the upper-level class this question asked the following:

> Write 10 true/false statements that illustrate the *variety* of (*diverse*) ideas from this course that you might put on a final exam for this class if you were teaching this course.
>
> Then provide the answers and explain why you chose these particular questions and what you hope they will assess.
>
> Note: Do not use questions/problems given on exams/homework (for this class) so far.

The rest of the problems for both classes were reflective questions (Appendix A). They asked the students to illustrate the following virtues: persistence, curiosity, creativity, and disposition toward beauty using examples and ideas they encountered in that class.

Based on the students' feedback, it seemed that they enjoyed and appreciated the Reflective Final Exam, although most of them commented that the reflective part was something that they had never done before, and it was definitely something out of their

comfort zone for a math class. I plan to continue using this assessment in my in-person classes.

Oral Part of the Midterm & Final Exams

In Fall 2020, the midterm and final exams for my upper-level class (Graph Theory and its Applications) contained two parts – written standard exam and follow-up oral exam. Each student was asked to schedule a 15-minute meeting after the midterm exam and a 30-minute meeting after the final exam. During each meeting, we went over their respective exam and discussed their solutions and work. Students were asked to choose one problem that they either did not solve, or the solution was incorrect or contained mistakes. They were given an opportunity to try that problem and reflect on the mistakes and correct them (if they could) through a very productive discussion. In addition, during the meeting following the final exam, the rest of the meeting was spent on discussion of reflective questions similar to the ones discussed in the Reflective Final Exam.

Students enjoyed and liked the oral part of the exams. It is worth noting that, when they were surveyed after the midterm exam and asked if they would like an oral part after the final exam, all of them answered positively. In addition, their recommendation was to use oral exams in further classes. For me – it was the most enjoyable part of the class. Discussing math and getting to know my students better and in a more informal and less stressed environment was priceless. The downside was the amount of time it took me to do all oral exams. With a small class it is much more manageable but having 10 or more students became very time consuming and not practical. I have not tried oral exams since then. I am trying to figure out a better way to offer and manage oral exams with bigger classes.

Conclusion

All these diverse active learning activities (new or modified during the pandemic) foster student communication and engage them in math conversations and the exchange of ideas and force them to discover the problem solutions on their own. Based on students' feedback and my personal observations, I believe that those active strategies greatly improve the student learning experience, prepare them better for in-class work, and provide them with confidence in their math skills and abilities. In addition, they benefit me – by enhancing my teaching practices. Moreover, enhancing the class with technology allows students more flexibility and better engagement with the concepts covered.

Overall, I have enjoyed seeing my students transforming into engaged and responsible learners that are not afraid to speak up in-class, engage in discussions, and work with peers. I constantly work on redesigning and improving my active learning approaches I have been using in my classes with the goal to better align them with the Bloom's

taxonomy levels of educational objectives [1], and hence improve my students' success. My goal is to continue doing so, and hence the strategies become more meaningful and hopefully increase the positive impact on students.

Appendix A

Final (Reflective) Exam[1]: Calculus II (Fall 2021)
(*Due December 15, 11am*)

1. **(60 pts – 10 for each problem)**
   Choose 6 problems that illustrate the variety of (diverse) ideas from this course that you might put on a final exam for this class if you were teaching this course. Make sure that each problem comes from a different chapter.
   Then for each problem do the following:
   - (5 pts) solve the problem
   - (1.5 pt) explain why you chose that particular problem from that particular chapter
   - (1.5 pt) describe what that problem is assessing.

   (2 pts) will be awarded based on how difficult the problem was chosen, whether it represents diverse and good ideas to be tested on a final exam, etc. Student must choose the problems solely based on their opinion of the problem.

   Note: Do not use questions/problems given on exams/homework (for this class) or solved in class or in the textbook.

2. **(10 pts) Illustrate the virtue of persistence:**
   [15] "Take one homework problem you have worked on this semester that you struggled to understand and solve, and explain how the struggle itself was valuable.
   In the context of this question, describe the struggle and how you overcame the struggle. You might also discuss whether struggling built aspects of character in you (e.g., endurance, self-confidence, competence to solve new problems) and how these virtues might benefit you in later ventures."

3. **(10 pts) [15] Illustrate the virtue of curiosity:**
   [15] "What mathematical ideas are you curious to know more about as a result of taking this class?
   Give one example of a question about the material that you'd like to explore further, and describe why this is an interesting question to you."

[1] Part of the exam is based on Dr. Francis Su's exam questions [15].

4. **(10 pts) Illustrate the virtue of disposition toward beauty:**
   [15] "Consider one mathematical idea from the course that you have found beautiful, and explain why it is beautiful to you.
   Your answer should:
   (1) explain the idea in a way that could be understood by a classmate who has not yet taken this class and
   (2) address how this beauty is similar to or different from other kinds of beauty that human beings encounter."

5. **(10 pts) Illustrate the virtue of creativity:**
   [15] "Give one example of a mathematical idea from this class that you found creative, and explain what you find creative about it.
   For example, you can choose an instance of creativity you experienced in your own problem-solving, or something you witnessed in another person's definition or reasoning."

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