

# A personal account of teaching chemistry courses in the epicenter of the COVID-19 pandemic

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## ABSTRACT

The COVID-19 pandemic has impacted every aspect of life around the world. Colleges and universities were forced to close and shift to remote/distant/online learning. This event resulted in classes being delivered online, prompting faculty in different chemistry departments to ponder on several questions. How can we maintain the same engagement we have in a face-to-face environment once we go online? Are we ready for this mode of teaching? How are we going to do the laboratory class? This same set of questions posed a challenge to me when the institutions I am teaching decided to shift on remote/distance learning. In this paper, I share my experiences on how we transition to this new teaching mode. Among these experiences include the preparations in classes (both lecture and laboratory) and the resources that I used. I will also discuss the preparation I made for my students and the reactions I got from them as we went on transition and by the end of the semester. I hope that this paper will be helpful to the readers (college and high school faculty) as they prepare for flexible learning once classes resume in the Philippines.

**Keywords:** *COVID-19; remote learning; laboratory classes; synchronous; asynchronous*

## INTRODUCTION

For twenty-two years, I have taught at different institutions, first in the Philippines (Cavite State University and University of the Philippines Los Baños) and then in the United States. The bulk of the courses that I taught are the General Chemistry I and II, Analytical Chemistry (both lecture and laboratory), and Instrumental Analysis (laboratory) classes. For the Spring 2020 semester, which started in the last week of January, I was teaching in two institutions, namely Pace University, where I am a tenured Associate Professor and at York College of CUNY (City University of New

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York) where I am an Adjunct Associate Professor. The courses I taught cover both lecture and laboratory classes (Table 1).

**Table 1. Courses being taught in two institutions during the pandemic**

Institutions	Courses	Day and Time
Pace University	CHE 111 General Chemistry I lecture (44) <sup>1</sup>	Tues/Thurs. 12-1:30 PM
	CHE 112 General Chemistry II laboratory (22)	Wed 1:30-4:30 PM
	CHE 331 Instrumental Methods laboratory (10)	Mon 5:30-9:30 PM
York College	CHEM 111 <sup>2</sup> General Chemistry II lecture (44)	Saturday 12-4 PM
	CHEM 241 <sup>3</sup> Instrumental Methods of Analysis (16)	Friday 1-6 PM

<sup>1</sup> The number of students in a class

<sup>2</sup> The course is stand-alone

<sup>3</sup> The course is stand-alone and mostly laboratory

A week before the semester started, the first case of COVID-19 (coronavirus disease 2019) was reported in Washington state from a patient who had traveled from China (Holshue et al., 2020). The first nontravel related case in the United States was confirmed on February 26 in California (Heinzerling et al., 2020). In New York City (NYC), the first case was confirmed on March 1 by one who traveled from Iran (Intarasuwan et al., 2020). The anxiety level in the surrounding city is now increasing. A week after, some of the private universities in the city such as New York University and Columbia University canceled classes and switched to remote learning. By March 10, Pace University announced its shift to remote learning starting the next day with the intention to resume face-to-face classes by the week of March 30 (which did not happen). On the other hand, the CUNY system announces the suspension of face-to-face instructional activities by March 12 and be in instructional recess till March 18. By March 19, all CUNY campuses transition their instructional activities to distance learning throughout the rest of the semester.

Since then, the COVID-19 case increased, and by the last week of March 2020, New York City became the epicenter with at least 5,000 cases and 500 deaths reported daily until the second week of April (Intarasuwan et al., 2020). At present (July 25, 2020), NYC has flattened the curve with no reported death on July 11, the first time it happened since March. However, the cases in other parts of the United States worsened with a new high record of cases being reported daily. As of this writing, there have been 220,172 cases and 18,849 confirmed deaths in New York City (NYC Health 2020) and 4,024,492 cases and 143, 868 deaths in the United States (July 25) (CDC 2020). The epicenter of the pandemic has already shifted from New York City to the state of Florida.

The virus responsible for COVID-19 is SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2). Since the first cases were reported in Wuhan, China, in December 2019, the COVID-19 has affected 213 countries and territories with a total of 16,111,411 cases around the world (as of July 25, 2020) (Worldometer, 2020). The clinical features of COVID-19 varied from asymptomatic state to acute respiratory distress syndrome and multi-organ dysfunction. The common clinical features include fever (not in all), cough, sore throat, headache, fatigue, myalgia, and breathlessness. Some have developed various fatal complications, including organ failure, septic shock, pulmonary edema, severe pneumonia, and Acute Respiratory Distress Syndrome (ARDS) (Sohrabi et al., 2020).

**Traditional Classes (Pre COVID-19).** Before the pandemic, a Learning Management System (LMS) in the form of Blackboard Collaborate is available in both institutions. This LMS serves as a depository of teaching and learning materials that include lecture PowerPoint slides, assignments, reviewers, laboratory manuals, experiments, videos, and other materials. Lecture classes are being

held in a big lecture room with a capacity of at least 50 students and equipped with a computer and a board (chalkboard or whiteboard). Although PowerPoint slides are used for my lecture discussions, I prefer the traditional chalk/pen and board method, especially in problem-solving sessions. During classes, I normally incorporate a CHEMTERTAINMENT segment where videos and clips from movies and TV series are shown as a motivation/break especially in long lecture sessions (Mojica, 2019). From time to time, I engage students to do board works to solve problems. Exams are done during the class sessions utilizing one whole 1.5-hour meeting. For the 4-hour class, exams are held for the first hour and the class resumes after a 30-minute break. Also, both lecture classes have an online component that students need to accomplish. Pace University uses Cengage Online Web Learning (OWL), which constitutes 10% of their final grade, while York College utilizes McGraw-Hill Assessment and Learning in Knowledge Spaces (ALEKS) making up 25% of their final grade.

Typically, classes start with the collection of assignments or lab reports (laboratory). Quizzes are given at the start unless it is a long lecture class where quizzes are given after a one and a half-hour lecture. To prevent students' tardiness, deductions are given for any late submission of assignments during class. For the laboratory classes (CHEM 241, CHE 112), a one-hour lecture/discussion on the principles related to the experiment and a pre-lab discussion is usually conducted. Students are paired in doing an experiment but each student submits a lab report a week after completing the experiment. For the Instrumental Methods Laboratory class (CHE 331), students perform experiments simultaneously on 3 different instruments and proceed on rotation to use the other instruments on a three-week cycle. The prelab discussion is very challenging during the first meeting because 3 experiments have to be discussed. The monitoring is also complicated especially if the 3 instruments to be used in a meeting are housed in different rooms. In the second and third weeks of the 3-week cycle, the situation becomes manageable as students tend to help each other. Three lab reports are submitted after the 3-experiment cycle.

***Online Learning vs. Remote and Distance Learning.*** After the announcement of the shift in the mode of teaching due to the pandemic, faculty on both institutions were given a week to prepare for the transition period. During this time, both institutions issue clarifications on the mode of teaching that will be done, and webinars were held to help prepare the faculty for the transition. The remote or distance learning mode was explained as essentially moving the course contents online. Sasha Thackaberry of Louisiana State University explains that since the shift results in teams and offices "working remotely" then the students are "learning remotely." This definition clarifies the approach as clearly not an "online learning" method, but rather a "remote learning" process. Thus, in using remote learning the following messages should clearly be communicated to the faculty and students: 1) We know you didn't sign up for this, 2) This is a temporary solution to an extraordinary circumstance, and 3) Hopefully you won't judge an entire modality based on an experience with a pandemic (Thackaberry, 2020).

Jason Wrench of SUNY Paltz further explained the difference between remote learning and online learning. Online learning is well-planned involving a 1-2 year development timeline before being offered. Moreover, it is intentional and guided in terms of instructional development. In contrast, remote learning is emergent, developed immediately as a response to a crisis, and haphazard in terms of instructional development. The learner's focus for both modes of teaching is attainment, but engagement is included in online learning (Wrench 2020). This clarification in terminologies was very helpful for the faculty to buy-in to the new mode of teaching because the connotation to online learning was module creation, which is impossible to do given the one-week preparation time.

The terms synchronous and asynchronous sessions were also introduced during the faculty orientation. Synchronous learning is online or distance education that happens in real-time, while

asynchronous learning occurs through online channels without real-time interaction (The Best Schools, 2018). Since the class schedules are to be maintained, synchronous classes have to be done, which further clarifies the difference between remote learning from online learning. Online learning typically is more asynchronous, while the synchronous session is like a face-to-face class but done remotely. This means that the mid-semester transition due to the pandemic maintains the synchronous nature of the face-to-face environment, which can be very helpful to the students.

***Connecting with Students and other Chemistry Faculty and other Preparations.*** Before the disruption of the face-to-face classes due to the COVID-19 situation, I was able to inform the students of the possible shift to online teaching either using the Zoom or Blackboard platforms. When the transition was officially announced, the first thing I did was to survey my students asking them about their possessions of a laptop or a personal computer and the conditions of their internet connection. I also asked them about any issues or concerns they may have about the remote or online teaching mode that we will be implementing.

I learned that not all of them have their own devices and a stable internet connection. I informed those with these concerns to contact the office in charge of this kind of problem. In one way or another, they will be provided with means to meet these needs. I also learned the concerns and worries that they would have during the transition. Most of them have a bad impression of online learning, and they are concerned about the set-up that we will use. They are also concerned about how to provide solutions to any problems on the slides and that they have no one to ask if they do not understand the material. Some are worried about being able to ask questions, the organization factor, and not being able to learn as well as it was in the classroom settings. I incorporated all the inputs in my preparation for the transition. Once the remote teaching mode was officially clarified for implementation, I emailed the students that the teaching mode is not the typical online learning session but rather it will be the same as the classroom session but done remotely via an online connection. I think this was the most important part of the transition. I have to convince the students that the mode of teaching that we had and this new remote set-up that we will be doing is the only way to have continuity in education. For this set-up to work, the students have to buy-in to the mode of teaching that we will be using.

To determine the acceptability of the students to the new remote learning set-up that we just had, I surveyed them after the exams. I asked them about the difficulty level of the online exam, the sufficiency of the time given for the exam, and the perception of their performance if the exam was done in the classroom setting. I also solicited comments and suggestions to improve the present set-up. Most of them have no comments and suggestions. Some answered that this is the best set-up that we have at this present time, which could only mean that they have learned to accept this as the only way to move forward.

It was also very helpful for my preparations that I was able to connect with former Filipino colleagues who are now teaching in the US through a Facebook group called “Strategies for teaching chemistry online”. In this group, the sharing of problems, plans, and strategies from different institutions were helpful as we learn from each other.

Taking into consideration the inputs from the students, I invested in a writing pad and a microphone. I wanted to maintain the chalk/pen and (white)board method that we are used to before we shift to remote learning. This practice is much better than just clicking the mouse and having all numbers come out in the slide. Similar to the face-to-face class, slides that contain only problems were also prepared, and the slide show was recorded with the solution being written step-by-step while at the same time explaining how to solve the given problem. As much as possible, the slide show being recorded is at most 8 minutes and posted at the Blackboard platform for the students to review during their free time. Going over the posted slide recording is one of

the asynchronous activities being done by the students in addition to the OWL and ALEKS activities.

## TRANSITION OF CLASSES DURING PANDEMIC

The transition to the remote lecture was easily managed where classes were held synchronously using Zoom (Pace University) or Blackboard (York College). However, when students started not to show their faces in Zoom, we shifted to Blackboard because it has an additional feature allowing students to participate by writing in the canvass during class. The class sessions were recorded and made available on Blackboard to accommodate students who cannot attend for whatever reasons.

The main challenge in the transition to a new mode of teaching in the middle of the semester is the laboratory classes. Four options were available during the transition. First, we can just cancel and stop doing any laboratory experiments, but this is not acceptable to the school administration. Second, we can shift on using virtual laboratories and simulations. The next option is to let the students do home experiments, and the last option is to use videos similar to the experiments.

The first option is out of the question since we are already in the middle of the semester. Although some companies offer for free the use of their virtual laboratories through the duration of the spring semester, we decided not to shift to this mode since that would involve additional adjustment and training for the students. However, this coming Fall semester, the department will adapt CHEM101 (<https://www.101edu.co/>), a commercially available classroom engagement app to supplement the lecture and laboratory class. The use of home experiments, which is done in some online classes (e.g. Consumer Chemistry and Forensic Chemistry) in the department, was also considered because these classes have corresponding laboratory kits that can be sent to the students for home experiments. However, this set-up will mean additional expenses and adjustments to the students. Moreover, the safety aspect was taken into consideration because unlike some companies that offer legal liabilities to any purchaser (Carrigan, 2012) for any untoward accident, the company that offers us the laboratory kits do not include this kind of safety net.

We have chosen the last option of using videos related to lab experiments in General Chemistry courses. In my opinion, this is the least disruptive option for the students during the transition. I have been using videos in both my lectures and laboratory classes. Having to handle off-semester General Chemistry courses and evening schedules, the use of video clips from movies, TV shows, and YouTube videos were helpful in engaging students during this 3-hour long lecture class (Mojica, 2019). Videos related to Analytical Chemistry experiments were also developed to allow students to watch beforehand the laboratory procedures to be performed (Mojica and Upmacis, 2019). This practice would cut the prelab discussion time on how to perform the experiment giving more time to focus on developing the laboratory skills needed by the students. Videos related to the remaining experiments that need to be performed to complete the laboratory requirements were searched on YouTube. Links for videos were posted at Blackboard, and students were asked to watch it before meeting in class.

Since the original laboratory schedule was maintained for synchronous class, one hour was allotted for students to watch the videos. An online quiz related to the videos and the experiment to be performed was then given just before the online class meets. During the synchronous meeting, the typical prelab discussion is being reenacted online, discussing the experimental procedure, principles behind the experiment to be performed, procedure outline, and calculations needed in the given experiment. A set of data is given and used for sample calculations. The online session ends with the class being given another set of data that they will use for their lab report. The

students are asked to watch videos for portions where they need to make observations in the procedure. The students were asked to utilize the remaining time to finish their lab reports for submission. During this time, students can send an email or schedule a meeting in Zoom for any help needed to finish their lab reports. Only a few students sought help and met with me in Zoom. Although incentives (+10 in each lab report) are given to those who submit their lab reports by the end of the session, most students still utilize the one-week grace period before they submit their report just like the face-to-face session.

For the Instrumental Analysis courses in both institutions, the same set-up was utilized: meeting synchronously, use of videos, and utilizing the remaining class schedule to finish their lab report. In addition, simulations were used for some instrumentation: the IR and HPLC portion utilized the free simulation sites ([http://www.cheminfo.org/Spectra/IR/Exercises/Browse\\_Spectra/index.html](http://www.cheminfo.org/Spectra/IR/Exercises/Browse_Spectra/index.html) and <http://www.multidlc.org/hplcsim/hplcsim.html>). To force students to visit these sites, they were given graded activities comparing the IR spectra of isomers and getting the optimized conditions for a given set of compounds in HPLC. Lastly, since developing hands-on skills in using instruments is not possible in the remote set-up, there is a shift in the learning outcomes of the course to focus more on how the students process and interpret the data and to develop their writing skills especially on how the lab reports are written. This shift in the learning outcomes was emphasized to the students during the first meeting after the transition.

## PROBLEMS ENCOUNTERED

The transition to remote/distance learning was not smooth as some problems were encountered. Foremost of this is the initial low turnout of students in the synchronous classes. To offset this problem, I emailed each student to ask if they have any problem. Unfortunately, the news I heard from some of the students are not good news. Some of them have family members affected by COVID-19, and they have to take care of them; hence they were not able to attend some sessions. One of them has a relative who passed away due to COVID-19.

Effective engagement with the students was initially experienced. To counter this, I gave additional online quizzes before, during, and after our synchronous meeting. Instead of the required ten quizzes they have to take, the additional quizzes allow them to do well since the ten highest scores for the quizzes are now the ones being considered. I also included multiple-choice questions related to topics being discussed during the class since I have a notion that students usually just log-in and hide behind their camera and not participating during class. This suspicion was confirmed since I get no reply from these students for the questions posted during class and observing that they are still logged-in even though all students have logged-out already.

The main problem encountered was the conduct of the assessment. Since the exam is done online, students can have access to notes, books, and the internet. Although Pace University has purchased the Respondus Lockdown Browser, a custom browser that locks down the testing environment within a learning management system, I opted not to use it due to privacy concerns. In addition, using it may cause additional stress and burden to the students. However, I will use this software in the coming Fall semester.

With the new remote teaching set-up, there was an observed increase in the exam score average in one of my General Chemistry classes. From an average score of 57% in the first exam, which was taken in a face-to-face environment, the average score for the second exam jumped to 82%. I was hoping that the students abide by the honor system that I preached before the exam. Upon using the Internet to find the answers to the questions I made in the second exam, I was able to finish it in less than 10 minutes. I discovered during this time that the questions in all test banks of

General Chemistry books are available online with the correct answers. Upon the advice of the Department Chair, I used the calculated formula for problem-solving, where all I need to input is the formula for the given problem and the minimum and maximum values to be used in the formula. Since random numbers will be given to each student, they will have to work with different values resulting in different answers. Besides, each item is given with multiple questions about a particular topic so students will receive a different set of questions. I also paraphrased and swapped values for questions taken directly from test banks. With these modifications, the third and fourth exams have average scores of 60% and 62%, respectively.

The problem of rampant cheating during the shift to remote learning has been reported in the Facebook group. One concern is how sure are we, as faculty, that our students are the one taking the exam and not someone they paid for to take it on their behalf. Another concern is the posting of an exam and asking for experts to answer it. This practice has become known as chegging since most of these incidences involved Chegg.com, an education technology company that provides digital and physical textbook rentals, online tutoring, and other student services. Although I did not experience any of this, a friend of mine teaching in another university learned that her exam was posted in Chegg.com by her student. High stakes assessments such as online exams have become the breeding ground for academic dishonesty, and this is the main reason that I will be using the Respondus Lockdown Browser this coming Fall semester.

## **INSTITUTIONAL SUPPORTS**

The shift to remote or distance learning was made easier by the support initiated by the administration of both institutions I am teaching. Both Pace University and York College provided online webinars to train and prepare the faculty in the shift to remote learning. As the semester continues and ends, both administrations emphasized two important keys to success: communication and empathy. Faculty are reminded to have an open line of communication and how to interact with students in terms of finding out the time zone, well-being, and working conditions (such as internet connectivity or family obligations). Both students and faculty should understand how the class will operate (synchronous meeting and office hours) for the rest of the semester.

Faculty are reminded to have empathy for each other, reminding everyone (faculty, staff, and students) is doing their best under an extraordinary set of circumstances and support each other by being patient and kind. The faculty are asked to view themselves in the students' condition.

But I think the most important support that both administrations had is the pass/fail option (Pace University) or credit/no credit option (York College) for the students. In this policy, a student is given several days to apply for this option once he/she gets her letter grade. The student will be credited for the course taken, and the original grade is not included in the calculated GWA. This policy is helpful, especially to those students who are directly affected by COVID-19. For instance, I have a student who topped the first exam but started to miss the class upon transition and did not do well in the succeeding exams. After reaching out to him, I learned that his relative passed away due to COVID-19, and I advised him to apply for this option.

After the semester ends, both institutions issued a memo requiring faculty to attend an online teaching training before being allowed to teach during summer. This requirement is very helpful for faculty like me with no background in online teaching. Attending these workshops gave a broader and deeper understanding of online teaching/learning and will help me improve my teaching delivery for the coming Fall semester.

**AFTERMATH**

As I look back at what happened during the transition to remote or distance learning, I have to say the 2020 Spring semester is the most stressful semester I had so far in my whole teaching career. The work from home is hard, especially if all family members are doing remote teaching or remote learning at the same time. My wife is a public school teacher specializing in Special Education teaching Grades 1 to 3 while my son is a high school student, and my daughter is a PreK student. There are days when some of us have the same schedule in class, which results in chaos at home. Also, our residence location at 3<sup>rd</sup> Avenue adds anxiety to our household, especially during the peak of the pandemic. There was a time that almost every minute, there is an ambulance that passed through. The sound of the siren is so deafening. It is hard to record some materials without including those sounds. They also served as a distraction during my class. I became used to it to the point that when I heard a siren, I just hum the Queen's song, "Another one bites the dust". During April and May, I only went out of the house twice to stock up our supplies as it takes days before delivery can be done if we order perishable items online. We felt helpless during this time, as we were unsure of the coming days. During this time, our mental health was challenged. But the experiences we had as we flattened the curve made us stronger and gave us hope for the coming new normal. One of the good aftermath results in the shift to remote learning is the comments given in the students' evaluations. All the worries and problems encountered during the transition are worth it as the students appreciated and were grateful for all the stuff that I have done based on their evaluations. They were able to accept the concept that we are all in this together, and this is the only option that we have at this time of the pandemic.

**THE COMING FALL SEMESTER AND BEYOND**

As of this writing less than a month as we resume the fall semester on August 24, Pace University will be on hybrid flexible or hylflex mode with in-person, online, and hybrid mode options. The mode of teaching depends on the approval of the Governor of New York State, Andrew Cuomo. Should an in-person mode be allowed, we have to follow federal and state guidelines such as six feet physical distancing and 25% room capacity. In this scenario, we will adopt a rotation system depending on the number of persons allowed in a given room. For instance, a laboratory room can accommodate at most 24 students. Following the guidelines, only six students can be accommodated at one time, and they will be rotated in each experiment (which will be supplemented with online materials). For the Analytical Chemistry lab course that I am teaching, the 12 students will be divided into two groups, with one group doing the experiment during the first half of the schedule while the other group is doing it during the latter half. It may mean additional work with no additional compensation on my part, but since this is a major course, I see a need for students to do the experiments to help them develop hands-on skills that they will need once they graduate. To ensure that they are ready to do the experiments, they are required to watch videos of the experiments beforehand. In all courses that I will be teaching, I will be implementing a contactless policy where all quizzes, assignments, and exams are done online.

Based on positive feedbacks from the previous semester, we will continue to implement the use of videos related to experiments and simulations. A virtual lab CHEM101 will also be used. Once we are comfortable going back to the university before the start of the semester, we will perform the experiments ourselves in General Chemistry courses, record it and make it available to the students once the semester resumes. These videos can help students if the rotation system is adopted as each student will not perform all experiments.

Even though the difficult part of the transition has been behind us, we are still preparing ourselves for the unknown future as we move to the new normal. In this new setting, things that we found useful during the transition period will be adapted. Constant communication with our students will be practiced. We have an informal online meeting with our incoming students this month, and another one will be held by August to prepare our students. We will have synchronous meetings should remote learning be done once again. The use of the Respondus Lockdown Browser is a new thing that I need to adopt. I am preparing myself on how to tell my students why there is a need to use this software during exams. Although the quality of teaching is compromised, during this pandemic, there is no one-size-fits-all solution for this situation. At this present time, this is the best thing that we can do to have continuity in education.

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