

## Effects of the 2020 COVID Quarantine on Machine Design Course Performance

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### Abstract

While there are few good things to say about 2020 COVID-19 Quarantine, student interest and performance improvements were observed in my Machine Design course. The grade levels and distribution of my Spring 2020 course were not notably different from previous years before the 2020 COVID Quarantine. Based on grade averages, the students were performing near or below the usual course norms. However, after the mid-March 2020 campus closing and transitioning to an all online/virtual format student performance improved.

The Machine Design course begins with 3-dimensional stress states/static and fatigue failure theories then follows with applications of these theories to the design and selection of components. Component design usually begins with shafts, followed by gears, flexible drives, fasteners, bearings, etc. Two projects were used to drive home the concepts of the classroom. A large portion of this course grade was project-based learning that commenced about midway through the semester near the time of the switch to virtual coursework.

Discussion of the projects, faculty interaction, and student performance highlight the changes in after beginning the quarantine and all online coursework. Several observations and hypotheses are drawn. Changes in future course offerings as a result are discussed.

### Keywords

COVID, machine design, project-based learning.

### Introduction and Background

The educational community is still learning how to effectively teach with distance learning. One study<sup>1</sup> has found a significant statistical difference in final course grades of the face-to-face (F2F) and distance learning (DL) students. In that limited study F2F students outperformed DL cohorts with statistical, significance. However, the final grades received were similar for both DL and F2F sections in that study<sup>1</sup>.

Prior to COVID-19 quarantine the push for distance learning by higher educational institutions was driven by other pressures<sup>2</sup>. Many universities saw DL as means to control costs by cutting overhead, meeting student (customer) demands, addressing competitor pressures, expanding classroom sizes allowing for growing enrollments, while using less university resources (faculty and real estate).

## **Preparation for Distance Learning under COVID Quarantine**

There are many important differences with a normal planned distance learning (DL) course and the COVID transitioned F2F to DL course discussed here. My approach as the instructor was to try to make the DL course as close the F2F class as possible. Actually, I wanted to make the DL course better, despite the fact I had never done a DL or video class. I was hoping to retire in a few short years missing the DL trend. So, with help from our University, all faculty members prepared to deliver some sort of DL course within a week of COVID Quarantine announcement.

In preparation for the shift to a virtual classroom, an appropriate classroom/meeting platform was needed. Fortunately, technological advances in modern video-conferencing/meeting software were at the ready to help make the transition to virtual classrooms fairly easy. Zoom was the software of choice for most faculty, including the author of this paper. After deciding that Zoom seemed like the best format to keep the DL classroom close to normal without much production preparation, a little more computer hardware was needed.

Aside from a computer and good internet connection, only the addition of a webcam with audio mic was required. Most recent laptop computers have this hardware as standard. Desktop computers without webcams were easily upgraded with USB plug and play devices. Some variation in video/audio hardware was preferred by faculty. Some preferred headsets with mics. Most listened via computer speakers, while many preferred earbuds or ear phones for noisier environments. The author preferred a recording quality condenser microphone for high fidelity sound using a laptop with camera and speaker. Poor audio can easily cause audience disinterest. Luckily, I already owned a decent USB recording condenser microphone (Blue Yeti)<sup>3</sup>. The sound was excellent. Lastly, I improved the lighting on my face so the camera shot of my face was clear. Extra face lighting helped. Thus, I was ready for a Zoom production in the allotted time.

### **Course Particulars**

The Machine Design course discussed here was taught live via Zoom video conferencing, using the previously discussed laptop with built-in web camera and an external USB 2.0 condenser mic. Fortunately, the majority of the course lecture material was already developed using PowerPoint presentation media. This greatly eased the transition to Zoom and on-line instruction. Updates to include other white-board material were necessary. Additional presentation materials were prepared for instruction for using engineering design and analysis software.

Class was conducted at the normal class hours and for the normal 50-minute lecture periods. It should be noted that there was significant increase in the office hours via Zoom for help and individual instruction. Class presentation materials were also placed in the Canvas LMS Course folders for students to refer.

The course assessment included 2 exams, 2 projects, a final exam, homework/quizzes. The first exam was completed and the first project was given before the shift from face-to-face classes. Completion of both projects, the 2nd exam as well as the final exam were completed virtually. Homework was scanned by students using the smart phone apps to create pdfs. Canvas was effective in collecting and displaying the pdf files from the students.

## What I learned

For best attendance at the normal scheduled class meeting times, email reminders with zoom links were helpful. Students preferred to have lecture materials prior to the lecture or at the start. Slack and time were helpful for students.

It became apparent that students were focusing more time to their coursework, as much of their social and work place activity was shutdown. It was also a confusing and stressful time for the students as coursework and interactions were being redefined in real time.

The requests for tutorials and additional office hours increased substantially in comparison with prior years. This may be in part the impact of students not receiving as much help and support from their cohorts in past F2F years. Students appreciated my availability for individual help via Zoom. Students seemed to feel more isolated and stressed. It was apparent students believed that course work load was being increased in the transition to this distance learning approach. I do not believe this was the case.

To reduce student stress I found it effective to give 50% more test time to all students taking the online tests, thus allowing for accommodations, printing, scanning emailing.

It was fortunate that a good percentage of the course was two small individual projects. Two smaller projects tend to work better than a single larger project. As many students work on projects close to the due date, the work was more manageable and less stressful to the students. During the class meeting more time was spent on discussing the project and approaches compared to previous years. It was also helpful and efficient to including additional presentation-based tutorials on key steps in the project design and analysis software usage.

With good class attendance and many out-of-class sessions with students, I believe that the COVID quarantine might have caused students to take a greater interest in the course and the projects than previous years.

## Assessment of Student Work

Figure 1 plots the average scoring by grade component for the past 3 years (F2F 2018, 2019, DL 2020). For the grading component (Exam 1) before the Pandemic, student average was lower than in the two prior years. In the course elements given after the pandemic lockdown, student performance improved. It is unclear exactly why.

In all grading components after the quarantine, students had higher average scores. This included the exam 2, final exam, and both projects. Clearly, after the mid-March 2020 campus closing and transitioning to an all online/virtual format student performance improved. My conjecture as to reasons include 1) less distractions, 2) no outside employment, 3) more exam time, 4) more work time to focus on their school work with little else to do under quarantine.

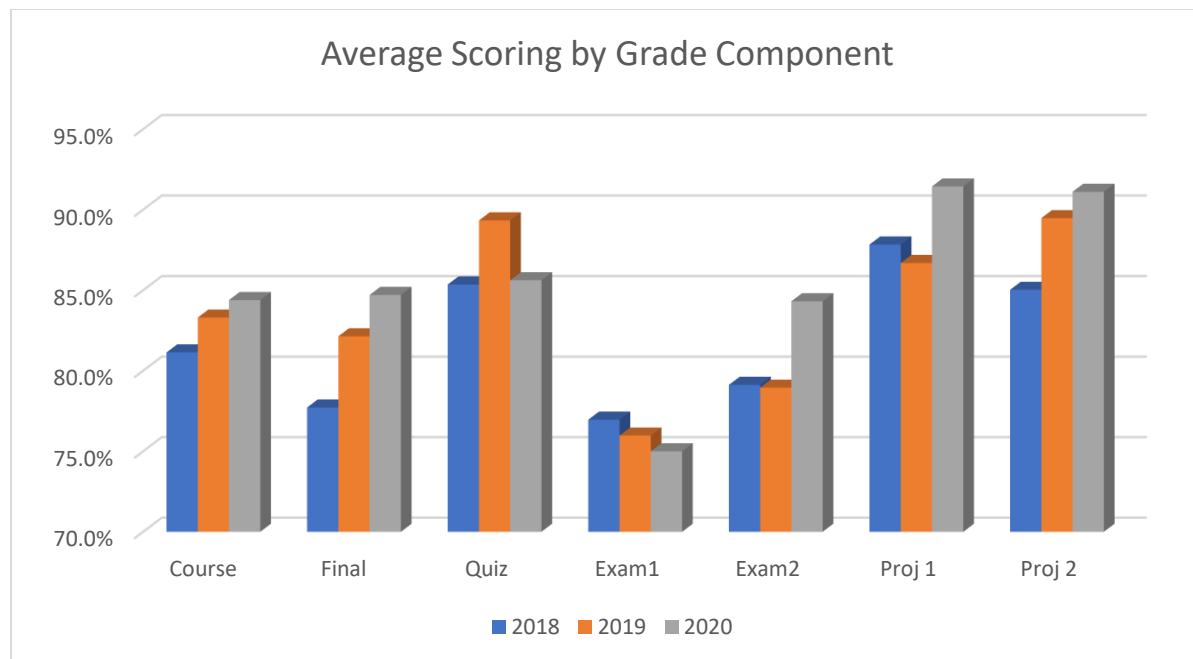


Figure 1. Average Scoring by Grade Component for the past 3 years (F2F 2018, 2019, DL 2020).

While the student course feedback evaluation results may not be statistically significant, the results are worth discussing. First, the student survey completion rate was higher in 2020. And interestingly “instructor satisfaction” was higher in 2020 than in the the previous two years. “Course satisfaction” had similar scores to the results for the 2-years prior.

Student comment: “I like the two project assignments as they allow us to apply our class knowledge and integrate it into our modeling experience. That is a great experience for someone who learns through doing.”

## Summary

Despite some previous studies to the contrary, my machine design students had improved performance with distance learning during the COVID pandemic quarantine. Functionally the DL class appeared to be very much similar to the F2F class. Possibly the course initially meeting F2F, before the transition to DL, may be an important factor in the success of transition to DL. Being responsive the student needs was also a big factor to student success, or at least to their perceived instructor satisfaction. It could be that the project-based learning components were well suited to the DL environment.

## References

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