COURSE ACTIVITIES IN ORDINARY DIFFERENTIAL EQUATIONS DURING THE COVID-19 PANDEMIC

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ABSTRACT

This study describes the implementation of a remote learning solution for the course Ordinary Differential Equations I during the Summer of 2020 at University of Central Florida. Pedagogical methods based on active learning strategies were implemented in all coordinated sections. We shall present the activities designed, as well as the class management protocols and student's performance.

INTRODUCTION

The COVID-19 pandemic has imposed a been major teaching and learning challenges for all education institutions worldwide. Due to imperative lockdowns, instructors were compelled to find online solutions to their ongoing in-person courses. As a consequence, in addition all the personal and psychological stresses of a pandemic, instructors had to swiftly answer many difficult questions, viz. how to convey materials in an engaging and effective way through online platforms, how to implement meaningful teaching and learning strategies online, etc. (Alsoufi et al., 2020; Hodges et al., 2020, Mailizar et al., 2020; O'Sullivan et al., 2020).

In the Summer of 2020, all courses offered at the University Central of Florida (UCF) were conducted by remote. The course MAP 2302, Ordinary Differential Equations I, hereafter refereed as ODE, were delivered remotely through Zoom sessions. ODE is the last course in the Calculus Sequence. The goal is to introduce basic methods for solving ordinary differential equations, and it is considered a difficult discipline by many students (Rasmussen, 1998; Habre, 2000; Rasmussen, 2001; Rowland and Jovanoski, 2004; Selahattin, 2010).

In this paper, we describe and analyze the teaching activities implemented in ODE course in Summer 2020. Based on the analytics, we identify the strategies that can be implemented in face-to-face course.

METHOD

Course Description

ODEs class at our institution typically enrolls about 80 students per section. Before the pandemic, lectures were delivered face-to-face and the course was managed by a course coordinator. All sections used the same syllabus, same assessments including online homework posted on MyLabPlus (MLP) platform, quizzes and tests in class. During the lockdown terms (Summer 2020 - Spring 2021), the lecturers were converted to synchronously teaching remote modality using the platform Zoom Meetings.

In Summer 2020, 398 students enrolled in the course dividing in 7 sections. For the first time, the course used a new integrated version of MLP, called MyLab Math (MLL). This new platform eases the communication between the system and Canvas. This system is easy and convenient for student use and provides an affordable option. Furthermore, students can easy electronic access through the modules tab in Canvas to e-textbook and MyLab Math.

All the sections were coordinated, the instructors used the same syllabus, assessments, and platform. The course coordinator was also teaching one of the sections. Interactive slides, evidence-based learning strategies, and others teaching lecture materials were shared with all instructors in advance. The goal was to facilitate their task of increasing student engagement in lectures; however, the instructor had the freedom to use any other material they deem appropriate.

Course Activities

The course implemented pedagogical methods based on active learning strategies, in which students take major role in their own learning process (Bonwell and Eison, 1991; Mazur, 1997). As such the course's active learning approaches were based on Just-in-Time Teaching method (JiTT) developed by Gregor Novak and colleagues (Novak et al., 1999). JiTT structures students' reading before classes, provides valuable and prompt feedback, and focuses class time on more complex problems and activities in cooperative groups.

Following the JiTT method, students were expected to read material before class, watch instructional videos, attempt extra questions from the e-book, attend Zoom lectures, and ask questions. The course activities were comprised of weekly study assignments (SA), weekly homework, and four midterm exams. Students' class grade was determined by four midterm exams (15% each), study assignments (20%), and online homework assignments (20%).

The weekly study assignments, posted on MLM, were typically comprised of: reading activities, videos, simple warm-up questions, and conceptual assessments (See Table 1 for an example of instructor edit view). The SA questions were short and due before corresponding lecture, yielding pre-knowledge of the concepts for improved understanding during lectures (See Table 2 for an example of SA question).

Table 1. Study assignment structure – instructor edit view

My Selections (10) ▸ View Assignment Details Questions: 7

	#	Question ID / Media	Section / Book Association	Estimated time: 17m 48s+	Points: 10
☐		2.4 Exact Equations 2.4: Exact Equations			1
☐		Example: Solve a differential equation that is exact (05:30) 2.4: Exact Equations			1
☐		Example: Solve a differential equation that is not exact (05:43) 2.4: Exact Equations			1
☐	1	2.4.3	Classify differential equations as separable, li...	37s	1
☐	2	2.4.5	Classify differential equations as separable, li...	43s	1
☐	3	2.4.9	Test differential equations for exactness, then...	1m 52s	1
☐	4	2.4.12	Test differential equations for exactness, then...	6m 8s	1
☐	5	2.4.17	Test differential equations for exactness, then...	1m 58s	1
☐	6	2.4.21	Solve initial value problems using the method ...	2m 31s	1
☐	7	2.4.26	Solve initial value problems using the method ...	3m 59s	1

Table 2. Example of study assignment

Determine whether the given differential equation is separable.

$$\frac{dy}{dx} - 5\tan(x+y) = 0$$

Is the differential equation separable?

- A. Yes; because $\frac{dy}{dx} = g(x)p(y)$ where $g(x) = 5\tan(x)$ and $p(y) = -5\tan(y)$.
- B. Yes; because $\frac{dy}{dx} = g(x)p(y)$ where $g(x) = 5$ and $p(y) = \tan(x+y)$.
- C. Yes; because $\frac{dy}{dx} = g(x)p(y)$ where $g(x) = 5\tan(x+y)$ and $p(y) = 1$.
- D. No

Students were also required to complete one homework post-class assignment per week posted on MyLab Math. The four midterm exams were administrated online via MyLab Math.

With the content-transfer aspect of the course delegated to pre-class preparation, instructors could focus on the class time on higher order thinking skills (HOT) problems and hands-on activities in cooperative groups (See Table 3 and 4 for examples). The sequence depicted in Figure 1 was suggested to manage class time more efficiently.

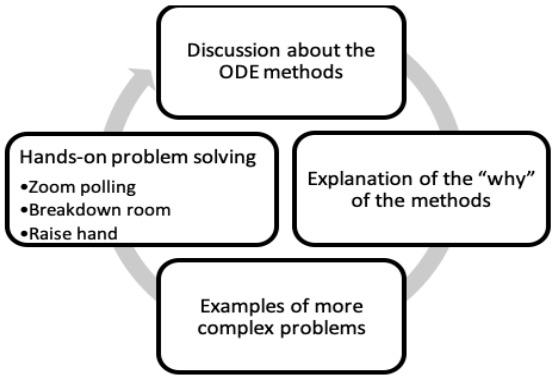

Figure 1. Suggested lecture structure

Table 3. Example of higher order thinking question

Let $f, g: \mathbb{R} \to \mathbb{R}$ be continuous functions and assume $g(z) = 0$, for some $z \in \mathbb{R}$. Solve the IVP: $y' = f(x)g(y), \quad y(x_0) = z$. *Hint: Think before calculate*

Table 4. Example of hands-on problem

1. Choose your favorite (smooth) function of two variables, $F(x, y)$. 2. Apply Chain rule to compute $\frac{d}{dx}F(x, y(x))$. 3. Choose an initial condition. 4. Your calculation in 2 yields an ODE, $\frac{d}{dx}F(x, y(x)) = 0$. Combine with your choice in 3 and *challenge* your colleague to solve your Exact Equation.

RESULTS/DISCUSSIONS

In total, 19 study assignments were assigned during the semester with unlimited attempts and time. Overall students scored very high on those assignments in all sections (see Figure 3). There was no difference in average score across all sections. The amount of time spent to complete the assignments were similar among sections (Figure 4).

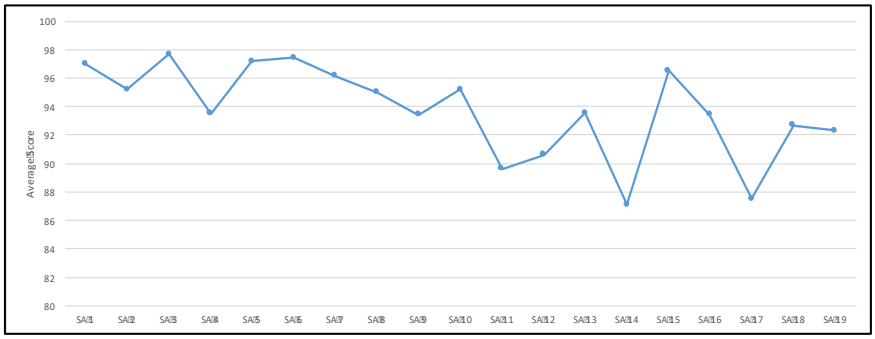

Figure 3. Average score for all sections on study assignments

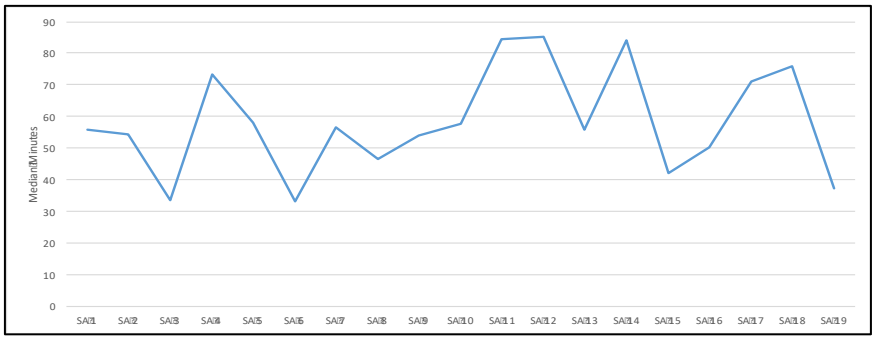

Figure 4. Median time spent on study assignments for all sections

Eleven homework assignments were administered during the semester with unlimited attempts and time. As similar to study assignments, both average score and time spent to complete the homework assignment were about the same among sections (Figure 5 and Figure 6).

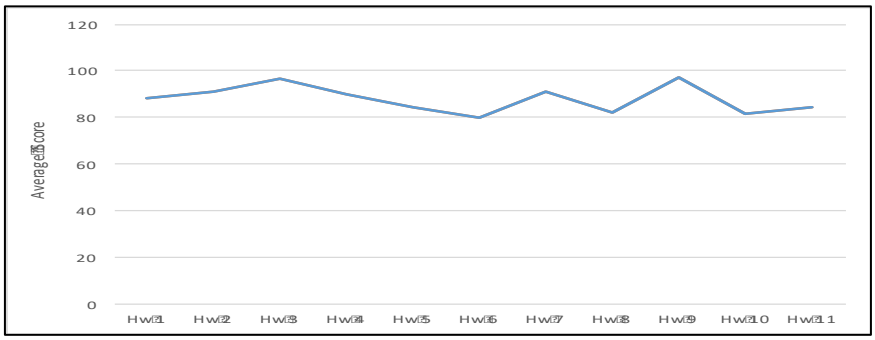

Figure 5. Average score on homework assignments for all sections

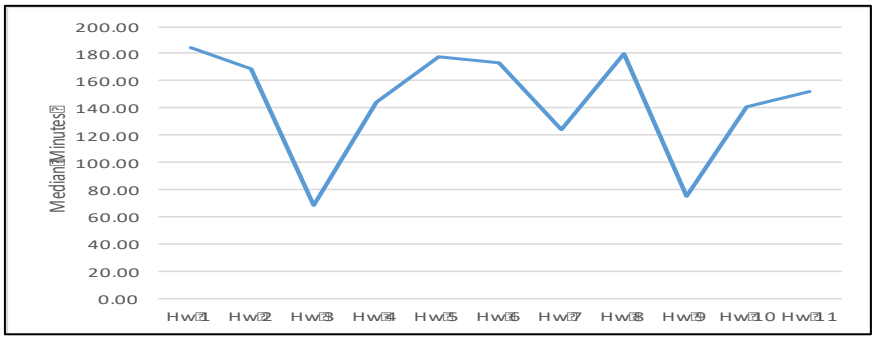

Figure 6. Median time spent on study assignments for all sections

There were four midterm exams posted on MLL with one attempt and 120-minutes time. The exams were monitored using either ProctorHub or Zoom recorded meeting. No partial credit was given for incomplete solutions on midterms; however, a more flexible policy was implemented as to adjust for obvious glitches of Pearson's MyLab Math. Typical issues found include: use of a different variable, obvious typos, students going beyond what the problem asked, among others. For all those cases, the course coordinator tried to implemented a unified protocol among all instructors for resolving these issues manually.

The average score of the midterm exams were high and similar in all sections (Figure 7). The amount of time spent to complete the tests were about the same among the sections, except for one class on midterm 1. While students completed the midterm 1 in approximately 60 minutes in all other sections, that specific class students spent only 19 minutes to complete it (average score: 94).

The overall passing rate, when combined all seven sections reached the 94%. Indeed, 374 of the 398 students who enrolled in the course achieved a passing grade; only 4 students withdrew.

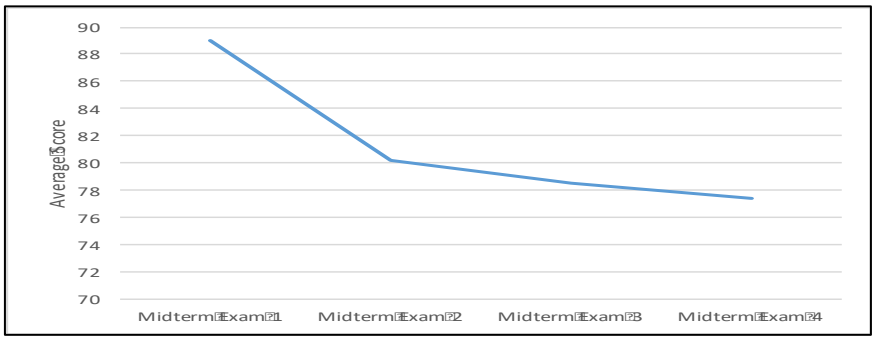

Figure 7. Average score on midterm exams for all sections

While there might be reasons pertaining to the new dynamics of remote teaching which influenced this result, it is reasonable to assume the way the course was planned and executed had a positive impact on the final outcome. Even though the tests were monitored using ProctorHub or Zoom recorded meeting, there were uncontrolled variables such as the use of websites, internet resources, and technology for graded work. Students easy access to calculators and other online tools may also have impacted the overall success rate. While it certainly becomes harder to prevent cheating, making a clear policy regarding the usage of calculators and other math software is not necessarily a negative aspect of the solution put forward in the Summer. Indeed, if well planned, such policies allow for assignments to focus more on the theory of ODEs — the principle learning objective of the course.

CONCLUSION

The pedagogical methods implemented on the ODE course in Summer 2020 had a positive effective on the final outcome. Study assignments helped students to stay on time-on-task, be more prepared for class, and connect their out-of-class effort and in-class instruction. Moreover, the study assignments allowed instructors more flexibility to develop in-class activities targeting higher order thinking skills and use a variety of innovative student-centered teaching practices.

The results suggest that the active learning strategies implemented may play a key role in improvement on students' performance, success rate, and course perception. In particular, the study assignments by maintaining a students' studying flow throughout the modules.

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