Do the Prerecorded Lecture Videos Help Students' Learning During COVID-19 Pandemic? A Case Study

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Abstract

Online synchronous/asynchronous delivery of courses with lecture videos is a time-demanding approach to web-based teaching and learning systems that is designed to engage students in investigations of authentic concepts/problems without coming to the pre-set classrooms two or three times a week. This paper presents perceptions and attitudes of students that have participated in online synchronous/asynchronous and hybrid courses in environmental engineering due to COVID-19 intervention in Spring 2020. Three courses in Environmental Engineering were offered either in online synchronous/asynchronous and hybrid delivery mode with prerecorded lecture videos in Spring and Summer 2021. At the very end of the semesters, an online anonymous survey was conducted with three questions to understand the students' perceptions and attitudes towards the use of prerecorded lecture videos in their learning environment. The data analysis revealed that overall, 26% of the students did not view the prerecorded lecture videos. Although students' perceptions and attitudes about the course materials covered and agreements between the course outline and the course content were very in the range of 78-100%, the performance was in the range of 77-80%. However, performance did not perceive any correlation with the students' perceptions and attitudes.

Keywords

Environmental engineering, COVID-19 adjustment, prerecorded lecture videos, students' perception and attitude.

Introduction

Online and/or internet-based teaching and learning is becoming popular and was a dire need during pandemic. The relatively recent advancement of Learning Management Systems (LMS), such as blackboard, eCollege, Moodle, and WebCT, offer lectures via MS Teams, Zoom and other platforms in the undergraduate setting in educational institutions have made it easy to provide online user education, that is, web-based augmentation to traditional (face-to-face) classroom instruction[1]. This on-line, hybrid or mixed delivery approach lets instructors combine the advantages of online class learning with the benefits of face-to-face interaction with relatively limited technological sophistication on their part[2]. The addition of a hybrid/on-line approach to the existing in-class lecture-centric environmental engineering course would not reduce the quality of

teaching and learning as well as would be welcomed and well received by students[3,4]. Preliminary reports suggest that the hybrid approach holds significant benefits for students and instructors, regardless of their level of technological expertise[4,5] and regardless of whether the classroom is hard-wired for live Internet access[6]. Despite frequent use of an LMS for course administration purposes (content and lecture delivery), the faculty do not appear to be harnessing the full pedagogical potential of web-based augmentation via LMSs. The possible potential of LMS tools along with other on-line and mobile technology flatforms to increase course administration/lecture delivery efficiency and enhance learning in traditional settings is an important educational issue that must be fully explored from both faculty and student perspectives[7,8]. However, combining multiple modalities of on-line content with a *pot pouri* of in-class learning exercises that appeal to several learning styles may precipitate higher overall learning outcomes[9].

A study[10] conducted using four different approaches such as (1) traditional, face-to-face lectures, (2) completely replaced the face-to-face lectures with videos recorded by the instructor outside of the classroom, but covering the same topics as the classroom lectures, then posted to a class web site, (3) combined face-to-face lectures with videos, and (4) was an inverted format where students watched videos at home and worked on homework during class and using common final exam scores as a quantitative measure of effectiveness, the results showed that overall student performance was maintained as class sizes and instructor workloads increased and also found that the inverted approach was better suited for higher-ability students. Another study[11] using Learning Management System (LMS) as a natural part of study together with face-to-face learning and all face-to-face education is offered to students both in the form of real-time videos and as on-demand videos found that the learning environment when studying with the help of videos is different from that in face-to-face teaching and the student can control the progress of the lecture when using a video.

This study was designed mainly to answer a question: What are the students' perceptions and attitudes about the prerecorded lecture videos during COVID-19 course offerings? To answer this question, an objective was formulated to understand the students' perceptions and attitudes about the prerecorded lecture videos for online synchronous/asynchronous and hybrid course deliver modes. The objective was accomplished via an anonymous online survey and with statistical analyses of the data collected from the survey and class performance that are the final grades. Although teaching hybrid or online courses may increase time demands and, in some cases, result in a loss of control, many faculties enjoy this approach because it allows for significant flexibility and benefits in instruction. Due to COVID-19 in March 2020 the course delivery options had to change to on-line synchronous and all the exams had to administer online, and the prerecorded lecture videos were required for most of the courses. The overall goal of this study was to understand the overall effect of prerecorded lecture videos during COVID-19 pandemic on students' perceptions and attitude about an online synchronous/asynchronous and hybrid course delivery modes.

The terms Face-to-Face, Hybrid, HyFlex (Hybrid-flex), Online synchronous/asynchronous have been used throughout the manuscript and the definitions of all these terms are provided in a study by the author[12].

Study Methodology

The instrument used to conduct this study was an online survey and the class grades at the end of the semesters. To understand the effect of prerecorded lecture videos on the perceptions and attitudes of students an on-line anonymous survey was conducted at the end of the semester with three questions to compare the students' learning environment in the environmental engineering course, with 50% in-class lecture (hybrid) with 100% online synchronous/asynchronous offering along with online midterm and final exams. The survey questions are presented in Figure 1. The first two questions were asked to understand the students' perceptions and attitudes about the course content and alignment delivered with online approach although no changes were made in the course content and other alignment. The third question was asked to find effect of prerecorded lecture videos.

Q.1. Did tests reflect material covered in the class? □ Yes □ No

Q.2. Is there a good agreement between the course outline and the course content?
□ Yes □ No

Q.3. Did you review the pre-recorded lecture videos before taking the quiz, exam, and doing the homework? If "YES" do you think that these lecture videos helped you learn and understand the materials (5 being the highest)? If "NO" choose "N/A"
O 1 O 2 O 3 O 4 O 5

Figure 1: Survey questionnaire for online offerings of Environmental Engineering Courses

The data collected through the online survey was analyzed to understand students' perceptions and attitudes about the course content and alignment, prerecorded lecture videos, and the degree of learning. The data was collected for Spring and Summer 2021 semesters that represent the data during COVID-19 pandemic with prerecorded lecture videos and compared it with Spring and Summer 2019 semesters that represent the data before COVID-19 pandemic without prerecorded lecture videos for first two questions. Three different undergraduate courses were used in this study, and these are: CE 3702 – Introduction to Environmental Engineering, CE 4343 – Solid Waste Engineering, and CE 4708 – Hazardous Waste Engineering. Table 1 below lists course enrollment and participation in the survey by course and semester.

Table 1: Course enrollment and participation in the survey by course and semester

Course No. and Semester	Enrollment	Participated in the Survey (%)		Course No. and Semester	Enrollment	Participated in the Survey (%)
CE4708-Sp19	27	18 (67%)		CE4708-Sp21	27	26 (96%)

CE3702-Sp19	37	24 (65%)		CE3702-Sp21	49	32 (65%)
CE3702-Sum19	34	9 (26%)		CE3702-Sum21	28	13(46%)
CE4343-Sum19	10	4 (40%)		CE4343-Sum21	15	2 (13%)

As shown in Table 1, there was a total of 64 students enrolled in Spring 2019 (CE 4708 & CE 3702), 44 in Summer 2019 (for CE 3702 and CE 4343), 76 in Spring 2021 (CE 3702 & CE 4708) and 43 in Summer 2021 (CE 3702 and CE 4343). Out of 108 enrolled students in spring and summer 2019 overall, only 55 (about 51%) students participated on the online survey. Overall, 53 students (about 49%) did not participated in the survey for spring and summer 2019 because the survey was not mandatory, and no incentive/grade points was given to participate in the survey. Out of 119 enrolled students in spring and summer 2019 overall, only 73 (about 61%) students participated on the online survey. Overall, 46 students (about 39%) did not participated in the survey for spring and summer 2021 due to the same reason. The analysis of data was performed with simple statistics and with excel for Goodness-of-fit tests such as ANOVA, χ^2-tests, student *t*-Tests, or *F*-Tests, as necessary. The results of the data analysis are illustrated in the following sections and in the Figure 2 through Figure 6. Please note that some of the responses to questions/options/choices, as seen in the Figures, might not sum up to 100% as few students did not respond to all questions or selected all options or choices.

Results and Discussions

Overall, about 96% of the participants agreed with Q.1 that is the test materials reflected what was covered in the class and about 8% did not agree on that (Figure 2a) during spring and summer 2019. Whereas overall, about 88% of the participants agreed with Q.1 and about 12% did not agree on that (Figure 2b) during spring and summer 2021. The participants were well represented by the fact the before and during COVID-19 situation. Among the individual semester/course about 100% agreed that tests materials reflected what was covered in the class in CE 4343 - Summer 2021, followed by CE 4708 – Spring 2021 (96%), CE 3702 – Summer 2021 (92%), and CE 3702 – Spring 2021 (78%) during spring and summer 2021. During spring and summer 2019, the agreement was little higher for individual semester/course.

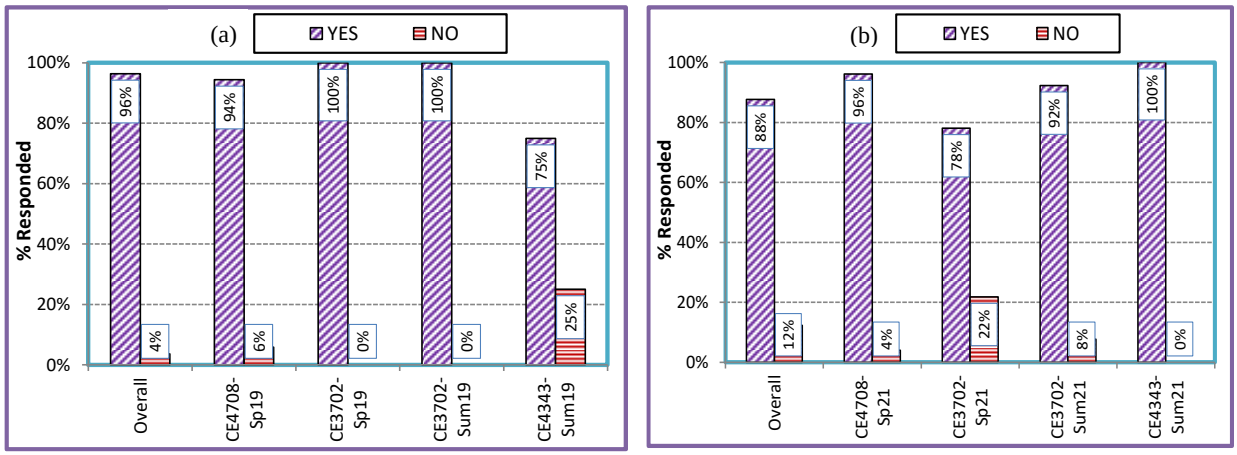

Figure 2: Distributions of responses for Q.1

As shown in Figure 3, overall, about 96% of the students, participating in the survey, agreed with Q.2 that is there is a good agreement between the course outline and the course content. Among the individual semester 100% participants agreed that there was a good agreement between the course outline and the course content for all three courses for CE 4708 – Spring 2021, CE 3702 – Summer 2021, and CE 4343 – Summer 2021 and followed by CE 3702 – Spring 2021 (91%) as shown in Figure 3(b). It appeared that very similar trends were observed every semester as well as the combined for all semesters (overall) for both pre-COVID (spring and summer 2019) and during-COVID (spring and summer 2021). Therefore, students' perception and attitude about the course content and the alignment were consistent and similar to some extent for both the scenarios.

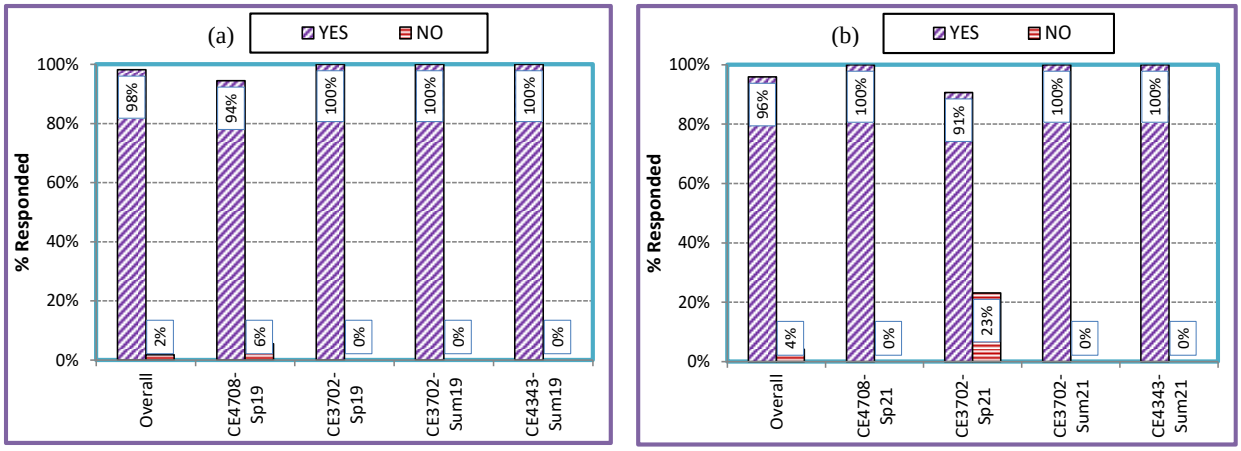

Figure 3: Distributions of responses for Q.2

Based on the responses to Q.3 as to how the participants liked prerecorded videos for learning and understanding the course materials, overall, about 8% of the participants chose "5" and "4" scales, 12% chose "3" scale, 27% chose "2" scale, and 18% chose "1" scale. About 26% of the participants did not even view the videos and chose "N/A" (Figure 4). The weighted average of the choice was about 2.83 for overall, no values for spring and summer 2019 (as this question was not part of

these semesters). Based on the choice distributions, it was seen that about 50% of the participants liked the prerecorded lecture videos for CE 3702-Summer 2021 and CE 4343-Summer 2021.

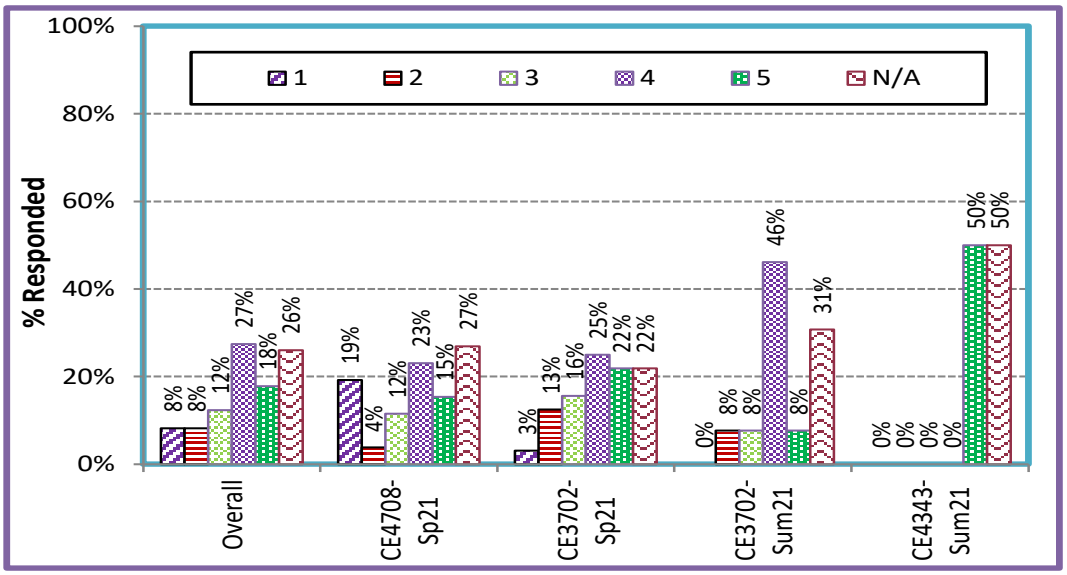

Figure 4: Distributions of choices of the participants for Q.3

The final grades for Spring and Summer 2019 (Pre-COVID) and Spring and summer 2021 (During-COVID) are presented in Table 2. These grades are used to calculate the weighted average GPA using A=4, B=3, C=2, D=1, and F=0. Weighted Average GPAs were used for Chi-square and other statistical tests to assess the performance and see the effect of prerecorded lecture videos.

Table 2: Distribution of final grades for Pre-COVID and During-COVID scenarios

Option	**Semester**	**Observed Grades**					
		A	**B**	**C**	**D**	**F**	**Total**
Without Prerecorded Lecture Videos ((Pre-COVID)	CE4708-Sp19	15	7	5	0	0	**27**
	CE3702-Sp19	7	17	8	3	2	**37**
	CE3702-Sum19	10	14	7	3	0	**34**
	CE4343-Sum19	3	5	2	0	0	**10**
With Prerecorded Lecture Videos (During-COVID)	CE4708-Sp21	6	14	7	0	0	**27**
	CE3702-Sp21	10	25	8	0	6	**49**
	CE3702-Sum21	4	15	9	0	0	**28**
	CE4343-Sum21	4	8	1	1	1	**15**
	Total	**59**	**105**	**47**	**7**	**9**	**227**

An assessment was performed based on the weighted average GPA for Pre-COVID and During-COVID situation and the data is presented in Table 3. From the chi-square test, for Pre-COVID scenario a *p*-value of ***1.0000*** was obtained which is greater than both 0.05 (α = 5%) and 0.01 (α = 1%). A χ^2-value of ***0.0925*** was also obtained. For a degree of freedom of 3, the critical values for χ^2 are 7.81 (for α = 5%) and 11.3 (for α = 1%). The chi-square (χ^2) value obtained from the test is

less than the critical values of both for α = 5% and α = 1%. Therefore, from both the χ^2-value and *p*-value point of views, the null hypothesis cannot be rejected and concluded that "no significant differences in the semester to semester and between the courses and semesters". This means, statistically similar trends were observed in the semester to semester for all the Pre-COVID Scenarios. A similar conclusion can be made for During-COVID scenarios. The weighted average grades are estimated based on the number of A, B, C, D, and F grates with GPAs of A=4.0, B=3.0, C=2.0, D=1.0, and F=0. For example, weighted score for CE4708-Sp19 = (15x4+7x3+5x2+0x1+0x0)/(15+7+5+0+0) = 3.3704. The expected GPA is estimated as total GPA for all semester divided by number of semester (12.0308/4 = 3.0077).

Table 3: Assessment based on weighted average GPA using Chi-square Goodness-of-fit test for two scenarios

Option	Semester	Observed GPAs	Expected GPAs	Statistics
Without Prerecorded Lecture Videos (Pre-COVID)	CE4708-Sp19	3.3704	3.0077	***p-value*** *= 0.99272 ≈ 1.00* ***DF*** *= 3* χ^2***-value*** *= 0.0925*
	CE3702-Sp19	2.6486	3.0077	
	CE3702-Sum19	2.9118	3.0077	
	CE4343-Sum19	3.1000	3.0077	
	Total	**12.0308**	**12.0308**	
With Prerecorded Lecture Videos (During-COVID)	CE4708-Sp21	2.9630	2.8464	***p-value*** *= 0.99975≈ 1.00* ***DF*** *= 3* χ^2***-value*** *= 0.0095*
	CE3702-Sp21	2.7374	2.8464	
	CE3702-Sum21	2.8214	2.8464	
	CE4343-Sum21	2.8667	2.8464	
	Total	**11.3858**	**11.3858**	

Another assessment was performed based on the weighted average GPA combinedly for both the Pre-COVID and During-COVID scenarios. From this chi-square test, a *p*-value of ***1.000*** was obtained (Table 4) which is greater than both 0.05 (α = 5%) and 0.01 (α = 1%). A χ^2-value of ***0.1221*** was also obtained. For a degree of freedom of 7, the critical values for χ^2 are 14.11 (for α = 5%) and 18.5 (for α = 1%). The chi-square (χ^2) value obtained from the test is less than the critical values of both the significance levels. Therefore, from both the χ^2-value and *p*-value point of views, the null hypothesis cannot be rejected and concluded that "no significant differences in the semester to semester and between the with and without prerecorded lecture videos". This means, statistically similar trends were observed in the semester to semester for both the scenarios.

Table 4: Assessment based on weighted average GPA using Chi-square Goodness-of-fit test for combined scenario

Option	Semester	Observed GPAs	Expected GPAs	Statistics
Pre-COVID and During-COVID Combined	CE4708-Sp19	3.3704	2.9271	***p-value*** *= 1.00* ***DF*** *= 7* χ^2***-value*** *= 0.1221*
	CE3702-Sp19	2.6486	2.9271	
	CE3702-Sum19	2.9118	2.9271	
	CE4343-Sum19	3.1000	2.9271	
	CE4708-Sp21	2.9630	2.9271	
	CE3702-Sp21	2.7374	2.9271	
	CE3702-Sum21	2.8214	2.9271	
	CE4343-Sum21	2.8667	2.9271	
	Total	**23.4165**	**23.4165**	

Although statistical analyses above showed that student performances did not differ significantly between the without (Pre-COVID) and with (During-COVID) prerecorded lecture videos, the direct calculations showed a little different (Total = 12.0308 for Pre-COVID and 11.3858 for During-COVID).

For further confirmation, single factor ANOVA, t-Test, and F-Test were performed for two groups (Pre-COVID and During-COVID) based on the data shown in Table 3. The ANOVA test data is shown in Table 5.

Table 5: ANOVA Analysis for Table 3 data

Group	Sum	Count	Average	Variance	*Source*	*SS*	*DF*	*MS*	*F*	*p-value*	F_{crit}
Pre-COVID	12.030	4	3.008	0.0927	*Between group*	*0.0623*	*1*	*0.0623*	*1.162*	*0.322*	*5.987*
During-COVID	11.324	4	2.831	0.0145	*Within group*	*0.3217*	*6*	*0.0536*	---	---	---

Since $F<F_{critical}$ in ANOVA ($p=0.322$, $F=1.162$, $F_{critical}=5.987$), the null hypothesis cannot be rejected and concluded that "no significant differences in the semester to semester and between the Pre-COVID and During-COVID situations". Similarly, both two-tailed t-Test ($p=0.342$, $t=1.078$, $t_{critical}=2.776$) and F-Test ($p=0.081$, $F=6.381$, $F_{critical}=9.276$) agreed with ANOVA and concluded that no significant difference of student performances exist between Pre-COVID and During-COVID course offering.

Students' perception was compared with the performance (weighted average GPA converted into percentage) as shown in Figure 5. As mentioned earlier, the students' perceptions were collected via an online survey with two questions: Q1 - Did tests reflect material covered in the class? and Q2 - Is there a good agreement between the course outline (syllabus) and the course content? There

is no clear correlation among students' perceptions and the performances in terms of GPA. However, a trend analysis (Figure 6) of students' performances and the performances further proved that no clear trend of increasing of performance with increased perceptions. Although Q3 trend shows a decrease of performance with increase perceptions, but it should be a valid observation as the correlation coefficient is less than 1% for all three relationships.

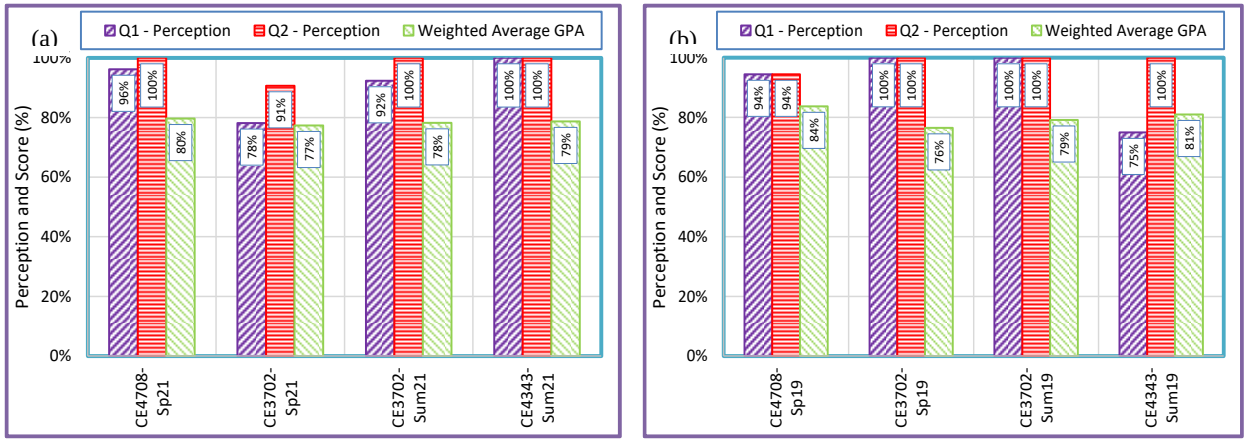

Figure 5: Students' perception and performance

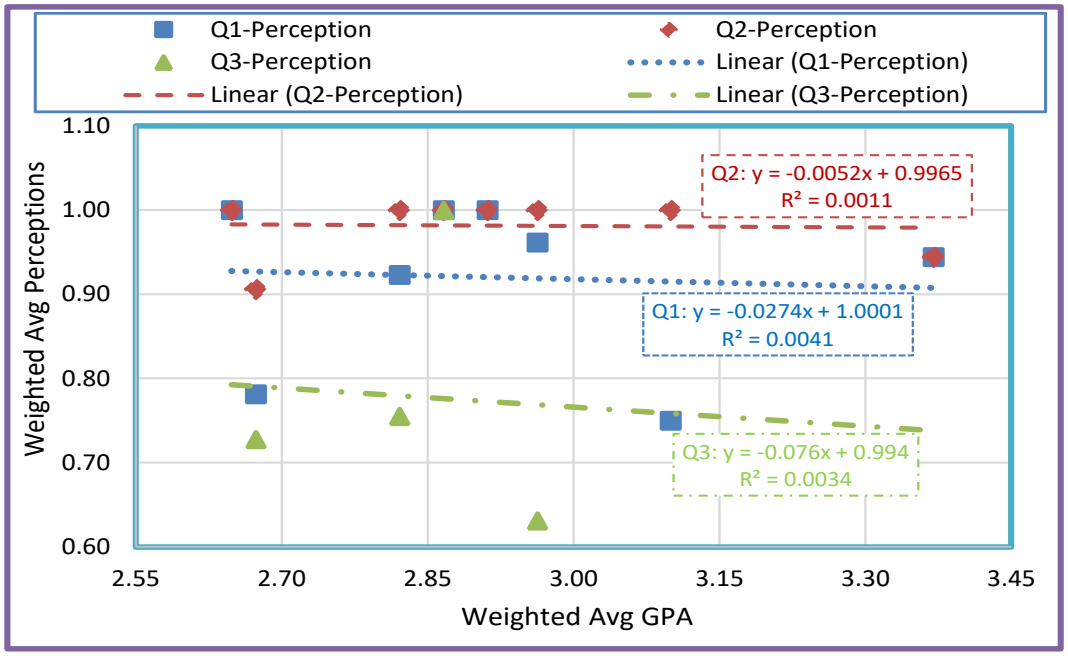

Figure 6: Trends of students' performance and perception

Study Limitations

The main source of bias for this study could be the fact that the author was the only person who designed this study, conducted the survey, collected the semester end data, and analyze the data. The evident conflict of interests and potential unconscious bias could genuinely affect the validity

of this study. Several other subjects in engineering field along with other faculty collaboration could make the study more reliable and conclusive.

Summary and Conclusions

In this paper, an effort was made to assess the perceptions and attitudes of students about the effect of prerecorded lecture videos during COVID-19 course offerings, which influence the learning environment as well as the quality of teaching and learning in environmental engineering for the changes in the course offerings due to COVID-19 pandemic at the middle of Spring 2020. Three courses in Environmental Engineering were offered either in online synchronous/asynchronous and hybrid delivery mode with prerecorded videos in Spring and Summer 2021. At the very end of the semesters, an online anonymous survey was conducted with three questions to understand the students' perceptions and attitudes towards the use of prerecorded lecture videos in their learning environment. Although students' overall perceptions and attitudes about the course materials covered and agreements between the course outline and the course content were around 95%, the performance was in the range of 77-80% and the performance did not perceive any correlation with the students' perceptions and attitudes. The study should not discourage creating and using prerecorded lecture videos in teaching engineering courses. It is the author's opinion and reflection that creating proper lecture videos with animation and other attractive features may increase the use of prerecorded lecture videos and benefit the students.

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Dr. Karim spent about six years as a full-time faculty at Bangladesh University of Engineering and Technology (BUET) after his graduation from the same university in 1989. He came to USA in 1995 and finished his Ph.D. in Civil/Environmental Engineering from Cleveland State University in 2000. He worked about three years for ALLTEL Information Services in Twinsburg, Ohio as an Applications Programmer. Then he worked about eight years (in two different times) for the Virginia Department of Environmental Quality (VDEQ) as a Senior Environmental Engineer and taught at Virginia Commonwealth University (VCU) as an Affiliate Professor before he went to Trine University in January 2008, as a full-time faculty of Civil & Environmental Engineering. He taught part-time at Indiana University-Purdue University Fort Wayne (IPFW) while employed at Trine University. During his time at Trine University, he taught an online course for VCU. He also taught at Stratford University, Richmond, Virginia campus as an adjunct faculty while working for VDEQ. Since fall of 2011, Dr. Karim has been working for Kennesaw State University (KSU), Marietta Campus, Georgia as a full-time faculty in Civil and Environmental Engineering. Currently he is a full professor of Civil Engineering. He served as an Assistant Department Chair and an Interim Department Chair of Civil and Environmental Engineering Department at KSU. He is a registered professional engineer for the State of the Commonwealth of Virginia and the state of Georgia. He has more than forty journal and proceeding publications and several professional reports in the area of soil and sediment remediation, environmental management, waste treatment and management, wastewater treatment, statistical hydrology, project-based learning (PBL), and engineering education. He is a fellow of American Society of Civil Engineers (F.ASCE), American Society for Engineering Education (M.ASEE), and a Board-Certified Environmental Engineer **(**BCEE) from American Academy of Environmental Engineers and Scientists **(**AAEES**).** He is also an ABET EAC Program Evaluation Volunteer (ABET EAC PEV) both for Civil Engineering (through ASCE) and Environmental Engineering (through AAEES) Programs.