Assessment of Course Materials Developed for Remote Instruction

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Abstract

Due to the COVID-19 outbreak, our electromagnetics course, like other courses on campus in spring 2020, was transitioned rapidly from in-person modality to remote instruction, which lasted for five weeks till the end of the semester. The learning objectives and the management of the course were revised to match the remote instruction modality. New instructional video lectures were prepared for the delivery of education in those five weeks. This pedagogical approach for remote instruction was assessed through a survey and an end-of-term examination. The findings were that majority of the students continued to learn the course materials through remote instruction and that their performance in the examination met our departmental expectation.

Keywords

Remote instruction, face-to-face instruction, video lectures, distance learning, assessment

Introduction

The delivery of education in the in-person modality in our university was interrupted in the spring semester 2020 due to the nationwide COVID-19 outbreak. The in-person modality was transitioned rapidly to remote instruction for the remainder of the semester after spring break. Accordingly, our electromagnetics course (EEL3472) in the electrical engineering department was taught in remote instruction for five weeks. The course was taught in the in-person modality in the first ten weeks of the same semester.

The electromagnetics course is a junior level core course that covers transmission line theory, vector calculus, electrostatics, magnetostatics, and time-varying electromagnetic fields. The course contents are organized into seven modules. The topics in the modules are summarized as follows:

- Module 1: Review of traveling waves, complex numbers and phasors
- Module 2: Transmission lines: lumped-element model, transmission-line equation, wave propagation, reflection coefficients, standing waves, wave impedance, and Smith chart.
- Module 3: Vector calculus: orthogonal coordinate systems and their transformations; algebraic vector operations; gradient, divergence, curl, and Laplacian operators; divergence and Stokes theorems
- Module 4: Electrostatics: Coulomb’s law and its applications, Gauss’s law and its applications, computation of electric field, electric scalar potential, and current density

- Module 5: Magnetostatics: magnetic force and torque, Biot-Savart law and Ampere's law and their applications

- Module 6: Time-varying electromagnetic fields: Faraday's law, moving conductor/loop in static and time-varying magnetic fields, displacement current, and Maxwell equations in time and phasor domains

- Module 7: Uniform plane-wave equations and their solutions. Relationship between electric and magnetic fields in uniform plane waves

Students were informed of the learning objectives, reading assignments, and other course requirements for each of the modules in the start of the semester. After covering the first four and a half modules face-to-face for ten weeks, the course was transitioned to remote instruction and the remaining two and a half modules were covered in remote instruction for five weeks. The remote instruction approach is described in the next section.

Remote instruction approach

Various options for the delivery of education in the remote instruction modality were considered. The options included asynchronous delivery online or synchronous delivery at the regular class schedule remotely. The tools for asynchronous delivery were immediately available to the instructor. These tools will be described below. The tools for synchronous delivery at that time were obscure to the instructor. So asynchronous delivery was chosen. In this asynchronous mode, our delivery of education was through video lectures that were uploaded into Studios of the learning management system Canvas and that could be streamed to the students for viewing at their own schedules.

The course learning objectives for the in-person modality were re-visited. This was necessary because a few of the original objectives, e.g., hands-on experimental assignments, were not applicable for remote instruction due to the lack of access to the laboratory on campus. The revised objectives for the remaining two and a half modules were relevant to the understanding of the concepts specified in those modules, the derivation of the theory, computer simulation, and applications.

The method of course assessment was re-visited also. This was necessary in the remote instruction period because the original plan of examination in the classroom was no longer feasible for remote instruction. Various options were considered. The options included written examination with online proctoring services such as Honorlock, group projects, and individual research papers. The final choice was a take-home written examination with emphasis on honesty.

The management of the course in the five weeks of remote instruction is described as follows: weekly announcements were sent to the students informing them of the particular lecture videos to view for the week, the reading assignments, the homework problems, and the different ways to get help from the instructor. The lecture videos were prepared weekly and were recorded in mp4 format. These lecture videos were uploaded into Canvas Studio. Canvas is a popular learning management system. Studio is an integrated video sharing platform that allows instructors and students to share video contents. Students streamed the lecture videos from Canvas Studio to

themselves for learning at either the regular class time or at other times fitting their schedules. The reading assignments matched the contents of the lecture videos and offered extra materials for those students interested in learning more about the topics discussed in the videos. The videos also taught problem solving skills by examples. That helped the students solving the homework problems. An examination was given at the end of the five weeks of remote instruction. The examination was for the assessment of learning through the video lectures. The development of the video lectures is described in the next section.

Remote Instruction Materials

One of the challenges in the delivery of education to students in the remote instruction period was limited time to prepare quality materials for students to learn the course contents in an effective way. Teaching materials in the form of lecture videos were produced within the limited timeframe by using tools immediately available to the instructor. Those tools included a Samsung tablet with a stylus (S-Pen), a versatile notetaking app S Note, and a screen recording app xRecorder. The instructor was familiar with these tools but had not put them together to produce lecture videos before. Other options were Microsoft OneNote and Surface tablets. The Surface tablets were not immediately available. The Microsoft products were not considered.

S Note is a versatile and easy-to-use electronic notepad that runs on a Samsung tablet. It was chosen mainly because of the following features. First, it supports paginations that the contents can be organized into pages. This was helpful in the flow of the presentation of the lectures and the random access of the contents in different pages. Second, the app permits layers. The users can overlay layers of drawings, graphics, photos, text and handwriting on the same page. Third, S Note supports various photo, audio and video multimedia files. These multimedia files can be embedded into the pages. These features were helpful in the delineation and clarification of concepts. S Note supports tags that permits search of contents. It supports S-pen that a user can use it like a piece of chalk on an electronic blackboard, which is a Samsung tablet.

The lectures and the procedures for solving problems were clearly presented step by step in writing in S Note alongside with verbal explanation. These activities were recorded as mp4 videos by xRecorder. The app xRecorder is a popular app for recording the screen of Android devices and their microphone inputs. The app is equipped with its own video editor that can be used for video cropping and for frame rate changing.

Our experience was that the tablet and S Note facilitated a smooth process of presenting the lecture materials and the step-by-step problem solving procedures to the students. It was also that the xRecorder was a convenient screen capture tool for recording lectures in mp4 format. Video lectures are one of the popular methods for the delivery of education online. Some of the studies[1,2,3] reflected the benefits of that method.

In the five weeks of remote instruction we produced 24 videos on the topics specified in the last two and a half modules of this electromagnetics course. The videos for magnetostatics covered Biot-Savart law, Ampere's law, and force on a moving conductor and torque on a loop induced by static magnetic field. The videos for time-varying electromagnetic fields covered Faraday's law, calculation of electromotive forces induced along a conductor and inside a loop in time-varying magnetic field, displacement current in time-varying electric field, and Maxwell

equations. The videos for electromagnetic waves covered Maxwell's equations in the phasor domain, wave equations, and plane-wave propagation. The average length of the videos was approximately 30 minutes. The total size was approximately 12 GB.

Assessments

At the end of the semester the instructor designed and conducted a survey on the five weeks of remote learning for this course. There were 38 students in the course. They were requested to complete the survey. No extra credit, no bonus point and no other incentives offered to students for completing the survey. Twenty-one students voluntarily participated in the survey. Their submissions were anonymous. The survey and the results are summarized as follows:

1. Evaluation of the remote learning approach for this course. There were two questions about that in the survey. The first question: "How comfortable are you learning remotely in this course (EEL3472)?" The second question: "How easy is it for you to gain access to the remote learning tools (computer, internet, bandwidth, etc)?" The responses are shown in Tables 1 and 2 with our remarks in the below.

Table 1: Student response to the first question

How comfortable are you learning remotely in this course (EEL3472)?	Number of Respondents	Percent of respondents selecting this answer
Not comfortable at all	0	0 %
Slightly comfortable	7	33 %
Somewhat comfortable	4	19 %
Quite comfortable	7	33 %
Extremely comfortable	3	14 %

If approximately half of the students indicated quite comfortable or better about the remote learning approach for this course, we considered that the approach would be worthy for future consideration and improvement. Due to the sudden transition from the in-person modality to remote learning, we did not anticipate a large percentage of students to embrace remote learning the first time. The result was that 10 students out of 21 (47%) indicated quite comfortable or better. That was close to our goal.

Table 2: Student response to the second question

How easy is it for you to gain access to the remote learning tools (computer, internet, bandwidth, etc)?	Number of Respondents	Percent of respondents selecting this answer
Not easy at all	0	0 %
Slightly easy	1	5 %
Somewhat easy	4	19 %
Quite easy	7	33 %
Extremely easy	8	38 %
No Answer	1	5 %

The intent of this question was to find out if the students had the tools necessary for remote learning. The availability of the tools can affect the result in the first question. There were 15 out of 21 indicated that it was quite easy or extremely easy to gain access to the tools. Six students indicated otherwise. Had these students had better access to the tools, the result in the first question might have been better. Based on the above findings, the remote learning approach will be further investigated and improved. The approach will be considered again in future course offerings if remote instruction is required.

2. Evaluation on the effectiveness of learning through video lectures for this course. There were two questions about that in the survey. The first question was "Am I learning new things from watching the video lectures?" The second question was "How easy was it to stay focused long enough to watch the EEL3472 video lectures?" The responses are shown in Tables 3 and 4.

Table 3: Student response to the third question

I am learning new things from watching the video lectures	Number of Respondents	Percent of respondents selecting this answer
Strongly disagree	0	0 %
Disagree	0	0 %
Neutral	4	19 %
Agree	10	48 %
Strongly agree	7	33 %

There were 17 out of 21 students agreed or strongly agreed that they learned the new course materials from the video lectures. This indicated that the videos served 81% of the students in a positive way in their learning. There is room for improvement because 19% of the student were in the neutral category. No written comments were provided for the neutral response. Further study will be conducted to find out the reason.

Table 4: Student response to the fourth question

How easy was it to stay focused long enough to watch the EEL3472 video lectures?	Number of Respondents	Percent of respondents selecting this answer
Not easy at all	2	10 %
Slightly easy	7	33 %
Somewhat easy	5	24 %
Quite easy	5	24 %
Extremely easy	2	10 %

The average duration of the video lectures was about 30 minutes. The intent of this question was to obtain preliminary information about such duration could be within the attention span of our students. Only 7 out of 21 students indicated that they were quite easy or extremely easy to stay focused on watching the videos. This is an indication that breaking down the videos into shorter pieces may help more students keeping focused. This could be a way to improve the results of the previous question. Further study on this will be considered.

3. Evaluation was also conducted on the comparison between remote learning and regular face-to-face learning conducted earlier in the same term. The responses are shown in Table 5.

Table 5: Student response to the fifth question

How much are you learning during remote learning compared to regular learning?	Number of Respondents	Percent of respondents selecting this answer
Learning much less	3	14 %
Learning somewhat less	6	29 %
Learning about the same	8	38 %
Learning more	3	14 %
Learning much more	1	5 %

There were 9 out of 21 (43%) indicated that their learning were less or much less in remote instruction than face-to-face. Only four students (19%) indicated that their learning were more or much more in remote learning than the face-to-face instruction. The rest (38%) indicated that the learning about the same. Same amount of materials were covered in remote learning in spring 2020 as in face-to-face instruction in the previous semesters. But the responses indicated that in remote instruction more of our students thought that they learned less than in face-to-face. It will be interesting to find out the rationale behind.

4. Students were asked to provide optional anonymous written comments at the end of the survey. Only five students offered their comments. The comments are provided below verbatim. They were arranged in chronological order.

Optional comments #1: the total amount of the videos in a week seem to be longer than actual class time. It was helpful to be able to pause and rewind videos because professor Choi has a tendency to speak soft in class so if you're not paying attention you could miss crucial details.

Optional comments #2: My learning capability remotely has been hindered greatly from an increased work schedule due to high customer demand from amazon. But whenever I am able to work on homework, I find the textbook intuitive in terms of understanding and it allows myself to learn more in depth about EMF topics that I have barely covered in my previous physics classes. I believe I am much more productive in learning with an in-class lecture along with studying the textbook on my own compared to remote learning; wherein I study by looking over previously written notes and reading the textbook on my own time. In addition, I consider myself a social learner wherein I feel more motivated to work on assignments in person with other peers who strive for high grades. This remote learning and quarantine due to COVID has hindered this completely.

Optional comments #3: Your remote lectures were great. I found it particularly useful to be able to pause mid lecture and read the associated section after you explained it the concept and then pause again after you did an example problem to attempt the books associated example problem and exercise problem. Further, the announcement with a general outline for each week helped me stay on track and set a plan at the beginning of the week to tackle the expected work which was extremely helpful. Each of my courses used different tools and methods for remote learning and this courses tools/methods were definitely my favorite.

Optional comments #4: Dr. Choi has a real gift for teaching. His online lecture prowess is excellent, I understood a lot when I am able to repeat and slow down when I don't understand something.

Optional comments #5: Posting the videos along with worked out problems is really helpful!!

The above written comments indicates that some students preferred face-to-face in classroom and some preferred remote learning. That is also indicated in the responses to the previous question above. Further research will be conducted to find out whether a hybrid mode of instruction would work better for our students.

5. An examination was given to the students on the materials taught in remote instruction covered in the video lectures. Our departmental expectation was that 70% of the students scored above 70 points (out of 100 points) in the exam. There were 35 out of 37 students scored above 70 points. The departmental expectation was met. The average score was 84.86 and the standard deviation was 14.02.

There were two exams on the course materials taught face-to-face in the classroom in the first ten weeks of the course. Their results were as follows: in the first examination there were 26 out of 37 students scored above 70 points. The departmental expectation was met. The average was 78.49 and the standard deviation was 13.95. The first examination was on the materials in Modules 1 and 2. In the second examination there were 31 out of 37 students scored above 70 points. Again the departmental expectation was met. The average was 82.86 and the standard deviation was 12.29. The second examination was on the materials in Modules 3 and 4. Apparently, the students performed in the remote instruction examination a little better than the first two examination. The remote instruction examination was a take-home examination that all the students had to take at a specific two hour period. All the students signed an honesty statement attesting their honesty in the examination.

Concluding Remarks

The pedagogical approach for remote instruction was briefly described and its effectiveness was assessed through a survey and an end-of-term exam. The majority of the students did learn the new course materials from the video lectures during the remote instruction period. That is reflected in the survey and in the examination scores. However, some students seemed to favor a little less in remote instruction modality than face-to-face instruction. Further investigation will be conducted to find out if shorter videos and hybrid instruction will improve our students' responses.

References

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