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Research Article

Examining Student Access in Online Courses: Two Courses Over the Years

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Abstract

Studies on how college/university students approach online education and courses have been conducted. The purposes of such studies, including the current paper, is to assess the students' use of online resources to identify patterns and any room for improvement of their online experience. The author has used the Canvas Learning Management System (LMS) to deliver asynchronous instruction in an undergraduate course and to facilitate communication and course organization in a face-to-face graduate course. This paper analyzes student access and usage data from both courses to identify meaningful patterns and insights. The collected data are examined in relation to course enrollment and major course milestones. Information obtained directly from Canvas is supplemented with basic statistical analyses, including descriptive measures such as averages. The findings are then discussed to provide insights into the advantages and limitations of online teaching and learning. Findings include reduced student engagement with online content over time. Graduate students are more likely to stay engaged online versus undergraduate students. Lastly, online group work shows the free-rider effect where some students rely on other group members to finish assigned tasks.

Keywords

Online Education, Online Access, Free-rider Phenomenon, Paired-sample T-test, Correlation Between Online Time and Grades

1. Introduction and Background

The shift toward online course delivery is not a recent phenomenon. Rather, it has evolved over several decades, with continuous advancements in its features, functionality, and instructional capabilities. The earliest documented example of online learning dates back to 1982 [1]. The advent of the Internet significantly expanded access to information, making it widely available at little or no cost. As technology matured, educators and developers sought to move beyond the unstructured nature of information on the World Wide Web by creating organized, purpose-built online learning environments. This effort led to the adaptation of traditional face-to-face teaching practices into structured virtual learning platforms [1].

As interest in online education has grown, so too has the debate regarding its effectiveness and its equivalency to traditional face-to-face instruction. Numerous studies have examined the strengths and limitations of both instructional modalities. According to Drexel University [2], online education offers several notable advantages: *"There are many advantages to virtual learning that can help you sharpen your skills and advance your career. Online courses allow students the flexibility to learn according to their own schedules, rather than*

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adhering to fixed class times. They also tend to be more affordable, as online courses—including those offered at Drexel—generally cost less than traditional on-campus classes. In addition, virtual learning provides a wider range of course options. In face-to-face settings, students often have to choose between courses that are offered simultaneously. Finally, online learning connects students with peers from around the world, offering unique networking opportunities not typically available in on-campus programs.".

In recent years, online education has become increasingly widespread and is now actively promoted by many educational institutions. While some institutions have reduced the number of traditional face-to-face courses, they have simultaneously expanded their online course offerings. Many universities now offer fully online degree programs, including graduate-level degrees, and some secondary schools have also introduced programs that allow students to earn high school diplomas entirely online.

LaMeres and Plumb [3] reported that converting undergraduate digital circuits courses to an online format was as effective as delivering them through traditional face-to-face instruction. They also found comparable learning outcomes for an undergraduate digital systems laboratory offered using a remote laboratory format.

In contrast, Bir [4] compared an online version of a Mechanics of Materials (MoM) course with its traditional face-to-face equivalent and found that students enrolled in the online course achieved significantly lower academic performance than those in the conventional classroom. These findings suggest that the online instructional approach had a negative effect on student achievement. Bir also reported that online delivery adversely affected students' performance in group work, with the exception of those who had earned high grades in the prerequisite Statics course.

Easton [5] conducted a comparative study of online and traditional instruction in both an undergraduate and a graduate engineering course. For the junior-level industrial engineering course, students in the face-to-face section performed significantly better than those enrolled online. However, no significant differences in learning outcomes were observed between the online and in-person sections of the graduate course. Based on these findings, Easton concluded that online instruction can be as effective as traditional classroom teaching, provided that students possess the motivation and commitment required for this mode of learning.

In the Fall 2020 semester, Hamrick [6] offered a non-technical general education course, *History of Engineering*, in two formats: a fully asynchronous online section and a hybrid section consisting of online lectures supplemented by optional face-to-face meetings. The study found that a significantly higher proportion of students in the fully online section earned grades of A compared with those in the hybrid section. However, approximately 10% of the online students failed the course, whereas no students in the hybrid section did so. These findings suggest that while online learning can be highly beneficial for some students, it may be less effective for others.

Reid [7], from the Department of Electrical and Computer Engineering Technology at IUPUI, investigated the transition of two courses—*Digital Fundamentals* and *C++ Programming*—from traditional lecture and laboratory formats to online delivery. The study found that student performance, as measured by self-assessments and final examination scores, was comparable to that of students in traditional classroom settings. However, the online courses experienced significantly lower student retention and satisfaction.

Pisupati and Mathews [8] reported that "the average quiz scores for online and face-to-face sections were identical." Comparable results were also observed on the midterm and final examinations. Despite these similar academic outcomes, students perceived the online format to be more difficult and demanding than the traditional classroom experience.

Similarly, Douglas [9], in a study of an Engineering Statics course, found "little to no difference in content mastery between students who completed the online and face-to-face sections of the class," based on performance on identical proctored examination problems. However, the online sections exhibited higher rates of student withdrawal and course noncompletion than the face-to-face sections.

Khraishi [10] and Khraishi and Denman [11] examined a fully online offering of the sophomore-level engineering course *Energy, Environment, and Society* and compared student performance with that of previous face-to-face offerings. Their findings indicated that "it appears that the online classes result, in general, in lowered grade letter and course component attainment." However, they also reported that students' performance on the midterm and final examinations was not significantly influenced by the mode of course delivery. The primary differences were observed in homework assignments and group presentations, both of which were completed collaboratively.

In 2021, Khraishi [12, 13] also offered the graduate course Introduction to Continuum Mechanics fully online in a synchronous format for the first time as a result of the COVID-19 pandemic. Before this transition, the course had been delivered in a hybrid format, with approximately half of the students attending in person and the remainder participating remotely. The study concluded that the instructional format had no significant effect on students' final course grades. In addition, course and instructor evaluations for the fully online offering were either comparable to or higher than those received for the hybrid format.

The studies reviewed above do not constitute a comprehensive survey of the extensive body of research on the benefits and limitations of online education. Nevertheless, they provide an appropriate foundation for the present study, which applies data analytics to Learning Management System (LMS) usage in online courses. In particular, this work investigates LMS usage patterns in undergraduate and graduate courses to identify similarities and differences in student engagement.

This study examines student interaction with online course materials by analyzing LMS usage data. It focuses primarily on student access to course content during periods surrounding examinations, while also considering access patterns throughout the semester. In addition, the study investigates whether the use of learning reinforcement techniques is reflected in improved student performance on reinforced material. Finally, it explores the relationship between students' engagement with online course content, as measured by time spent on the LMS, and their final course grades.

Three hypotheses are evaluated in this study. First, student engagement with online course materials is expected to increase in the period immediately preceding examinations. Second, learning reinforcement is anticipated to produce measurable improvements in student performance on reinforced content. Third, the relationship between the amount of time students spend accessing online course materials and their final course grades is expected to be weak or statistically insignificant.

2. Methods and Materials

This study examines two courses: *ME217 - Energy, Environment, and Society*, a required undergraduate course for all Mechanical Engineering (ME) students at the University of New Mexico (UNM), and *ME512 - Introduction to Continuum Mechanics,* a graduate-level course offered by the same department and typically taken by students during the early stages of their graduate studies.

ME217 was delivered by the author in a fully asynchronous online format using the Canvas Learning Management System (LMS). Although the course is also taught by other instructors during the academic year, those offerings typically enroll substantially larger numbers of students. For the summer offering analyzed in this study, all lectures were pre-recorded as narrated PowerPoint presentations and provided to students as MP4 video files. The complete set of lecture materials was made available through Canvas on the first day of the course. A required textbook supplemented the online lectures, with its chapters assigned and covered according to the course schedule throughout the semester.

ME512 was also delivered in an asynchronous online format; however, Canvas was used primarily as a platform for distributing course information and instructional materials rather than for delivering lectures. The LMS hosted the course syllabus, handouts, instructor-prepared notes, supplementary resources not included in the required textbook, and homework instructions. In both courses, the Canvas *Announcements* feature was used to post weekly updates, which were automatically sent to students via email. Textbook ordering information was made available through Canvas for both courses, although in the 2022 and 2023 offerings of ME512, this information was also communicated by email, during class meetings, or through both methods.

ME217 included several additional graded components, including weekly multiple-choice quizzes and two examinations (a midterm and a final), all of which were completed within designated time windows during the eight-week summer session. Each instructional week included two quizzes: a pre-quiz administered after students completed the assigned textbook reading and a post-quiz administered after they had both read the assigned material and viewed the pre-recorded lectures. Each quiz consisted of fewer than ten multiple-choice questions scored on a binary basis (1 point for a correct response and 0 points for an incorrect response). The post-quiz contained the same questions as the corresponding pre-quiz administered two days earlier, although the order of the questions was randomized for each student. This design was intended to reinforce learning by allowing students to revisit the same concepts after engaging with the lecture material. Scores from both the pre- and post-quizzes contributed to the final course grade, with no quiz scores dropped. Over the duration of the summer session, students completed a total of eight pre-quizzes and eight post-quizzes.

For ME512, all lectures were delivered in person, and the course examinations (two midterm examinations and a final examination) were administered on campus in accordance with the face-to-face instructional format. At the same time, every lecture was recorded using Zoom, stored in the cloud, and uploaded to the Canvas course site, providing students with a convenient resource for review and allowing those who were unable to attend class to access the recorded lectures.

In addition to quizzes and examinations, ME217 required students to complete seven group homework assignments, all of which were submitted electronically through Canvas. Students also prepared and delivered a group presentation on a topic assigned by the instructor (the author of this paper). Each presentation was evaluated by students outside the presenting group through a peer-review process, and the resulting peer evaluations were used directly to determine the group's presentation grade.

Both ME217 and ME512 have been offered annually through the Canvas Learning Management System since 2022, when the University of New Mexico (UNM) adopted Canvas as its institutional LMS. The data analyzed in this study include course offerings through 2026. Enrollment in ME217 was 11 students in 2022, 20 in 2023, 15 in 2024, 15 in 2025, and 25 in 2026, for a total of 86 students. Enrollment in ME512 was 11 students in 2022, 6 in 2023, 9 in 2024, and 5 in 2025, for a total of 31 students.

In ME217, students were organized into five or six groups each year, with a target average group size of three students based on recommendations from previous research [14]. Across all course offerings included in this study, the average group size was 3.09 students. In ME512, group sizes ranged from two to three students, with an overall average of 2.17 students per group. The 2025 offering of ME512 did not include group work because of the small class enrollment. In both courses, collaboration was limited primarily to homework assignments. ME217 required one group homework submission each week, whereas ME512 required one group submission for each of its four homework assignments, corresponding approximately to one assignment per textbook chapter after Chapter 1.

All quizzes and examinations were completed individually. In ME217, quizzes and examinations were administered online during designated time windows without remote proctoring. In contrast, all examinations in ME512 were conducted in person under the supervision of the instructor.

As noted in the *Abstract,* the methodology employed in this study is quantitative and statistical in nature. The analysis includes the calculation of percentages, rates, normalized (relative) measures, and descriptive statistics such as averages. In addition, paired-sample t-tests are used to compare mean values obtained from the same group under different conditions or at different points in time. Statistical significance is evaluated using the corresponding p-values, with $p < 0.05$ adopted as the criterion for significance.

3. Results and Discussion

The Results and Discussion section is organized into two parts: the first presents the findings for ME217, and the second focuses on ME512. Comparisons and relationships between the two courses are discussed in the concluding portion of the paper.

3.1. ME217

For ME217, Figure 1 compares the average pre-quiz and post-quiz scores across all eight weekly quizzes. As illustrated in the five graphs, post-quiz scores were consistently higher than pre-quiz scores, with only three exceptions in which the pre-quiz average already exceeded 90%. These results are consistent with the expectations outlined in the *Materials and Methods* section, indicating that students were better able to answer the same questions after completing the instructional activities, despite the randomized ordering of the questions.

Another noteworthy trend evident in Figure 1 is that the first two pre-quizzes produced the lowest average scores of the semester. Beginning in the second week, quiz performance improved steadily, reaching a plateau by approximately the fourth week and remaining relatively stable for the rest of the course. This pattern suggests that students became increasingly familiar and comfortable with the weekly quiz format. The sustained improvement in performance over successive quizzes further supports the effectiveness of learning reinforcement in promoting student achievement.

To further analyze the paired column chart presented in Figure 1, a paired-sample t-test was performed on the 40 pairs of pre-quiz and post-quiz mean scores (degrees of freedom, $df = 39$). Figure 2 presents a raincloud plot of the data distribution. A raincloud plot combines individual data points ("rain"), a half-violin plot representing the probability density ("cloud"), and a box plot summarizing the data distribution.

The box plot provides a graphical summary of the data using the five-number summary: the minimum, first quartile (Q1), median (Q2), third quartile (Q3), and maximum. The box represents the interquartile range (IQR), which contains the middle 50% of the observations, while the line within the box denotes the median. The whiskers extend to the minimum and maximum values, facilitating visualization of the data's central tendency, variability, and potential outliers. Figure 3 presents the same results as a bar chart with 95% confidence intervals.

The paired-sample t-test, performed using the JASP statistical software package, produced a p-value of less than 0.001, indicating a statistically significant difference between the pre-quiz and post-quiz mean scores. The Cohen’s d for effect sizes here is -0.9011 which indicates a large effect (a very clear, substantial difference). For the assumptions of the paired t-test, the data is continuous and the Shapiro-Wilk test W value is 0.8469. A value of W close to 1 means the data are normal.

Figure 4 illustrates student access to the fourteen pre-recorded lectures in ME217. The x-axis represents the individual lectures (typically two per week, except during Weeks 5 and 8), while the left y-axis indicates the percentage of unique students who accessed each lecture. With the exception of the first lecture in the 2023 offering, no lecture was viewed by the entire class. The highest access rates occurred during the first week, generally ranging from 80% to 90%, indicating that approximately 10%-20% of students did not view even the initial lecture.

Following the first week, lecture access declined steadily as the semester progressed, reflecting a gradual reduction in student engagement with the recorded lectures. This downward trend continued until approximately Week 6, after which access rates stabilized at a relatively constant level. The lowest access rate was observed for Lecture 13, which was not viewed by any students. One possible explanation is that students relied primarily on the assigned textbook readings and therefore perceived less need to watch the corresponding recorded lectures. However, because textbook usage could not be monitored, this interpretation remains speculative (see the *Materials and Methods* section).

The right y-axis in Figure 4 shows the normalized number of lecture views per student, computed by dividing the total number of views for each lecture by the course enrollment. A value of 1 indicates that, on average, each student viewed the lecture once. During the first few weeks of the semester, this ratio consistently exceeds 1, suggesting that students either revisited the lectures or exhibited greater enthusiasm while becoming familiar with the course material. By approximately the third to fifth lecture, however, the average number of views per student declined to around 1 or slightly below. Consistent with the trend observed for the percentage of unique students accessing the lectures, the normalized view count gradually decreased as the semester progressed, indicating a reduction in student engagement with the recorded lectures. Similar declines in online lecture participation have been reported in previous studies [15].

Both curves in Figure 4 exhibit noticeable increases in activity around Lecture 9 and the immediately preceding lectures, indicating a period of intensified review of course materials. This pattern likely reflects students' preparation for the first examination, which is administered after Lecture 8. A second increase in lecture access is evident near the end of the semester, with the final lecture experiencing elevated viewing activity during the week preceding the final examination. These periods of increased engagement, or "study spikes," are consistent with findings reported in the literature. For example, one study [16] found that students who devoted more time to course modules before major assessment deadlines tended to earn higher course grades. Similarly, another investigation [15] reported that increased engagement immediately before examinations, as well as sustained engagement following the midterm, was associated with improved academic performance.

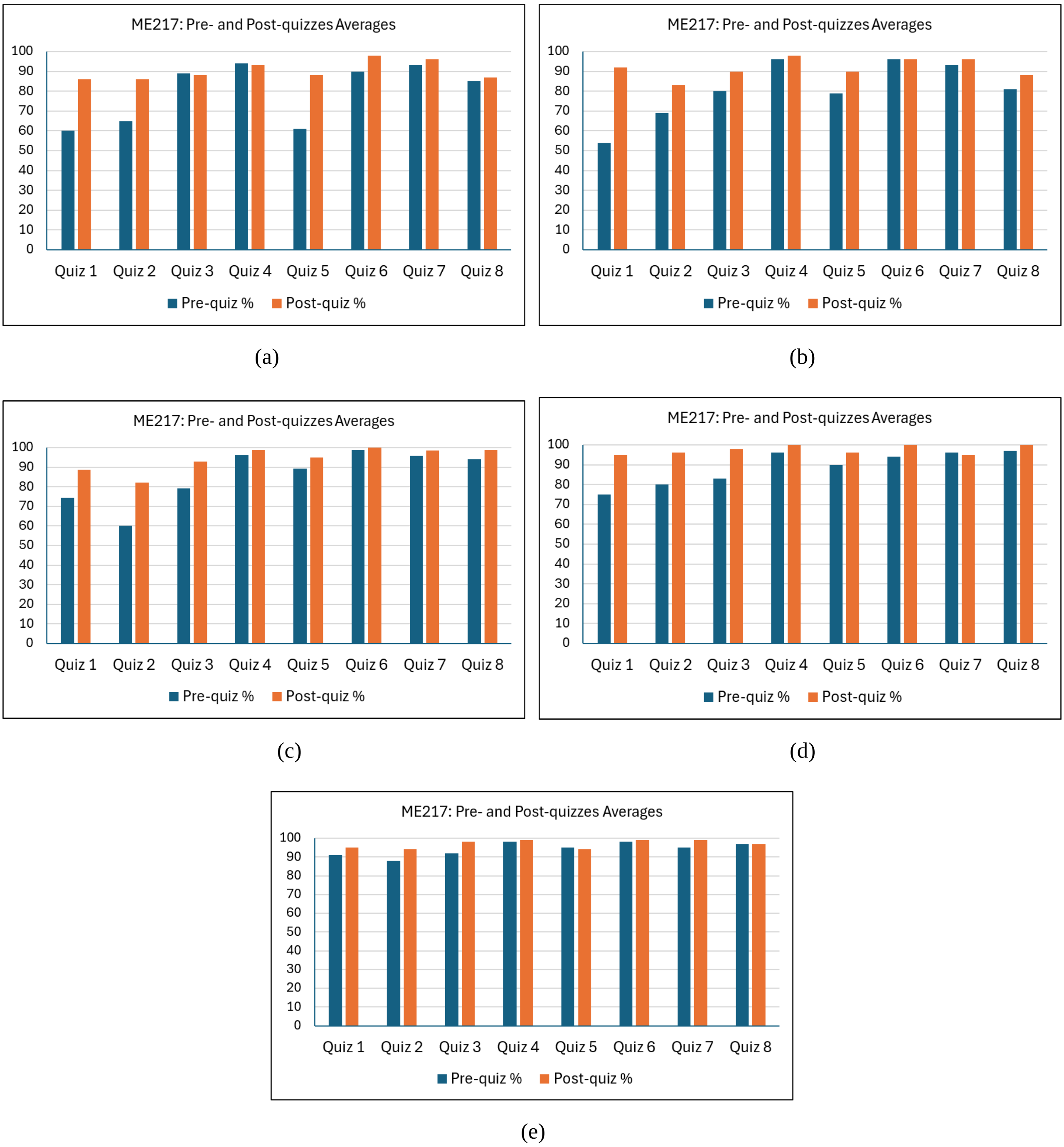


Figure 1. Pre-quiz and post-quiz comparison for ME217 over 8 weeks. (a) 2022 (b) 2023 (c) 2024 (d) 2025 (e) 2026.

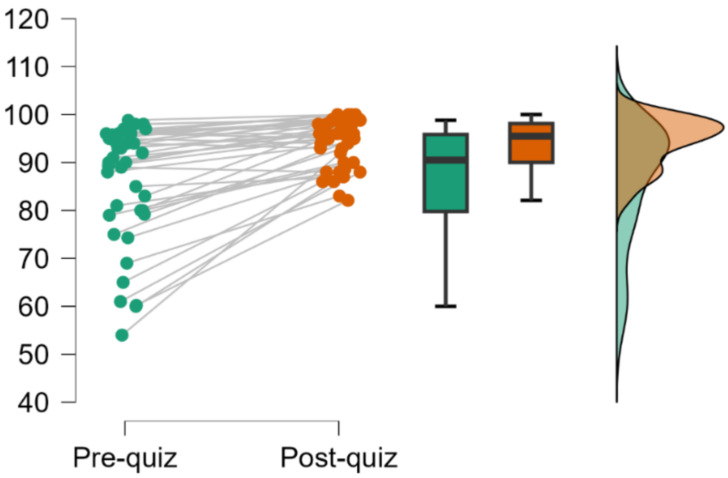


Figure 2. *Raincloud plot (providing a maximum of statistical information while allowing for 'inference at a glance' from key summary statistics) for ME217 showing pre-quiz versus post-quiz data and distribution. The data shown here is for five years.*

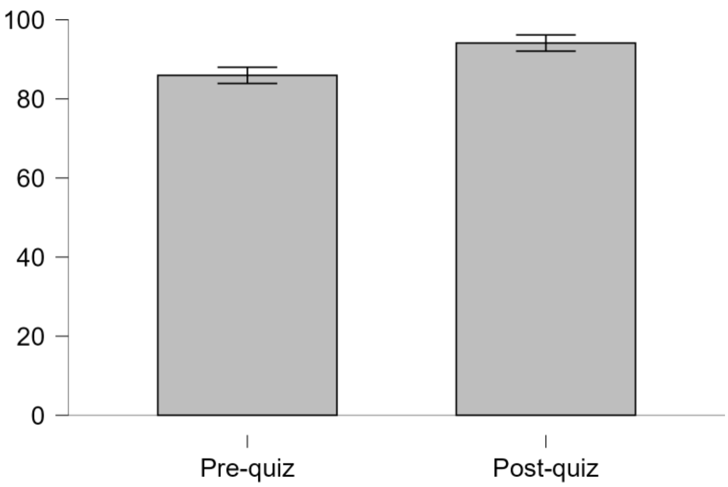
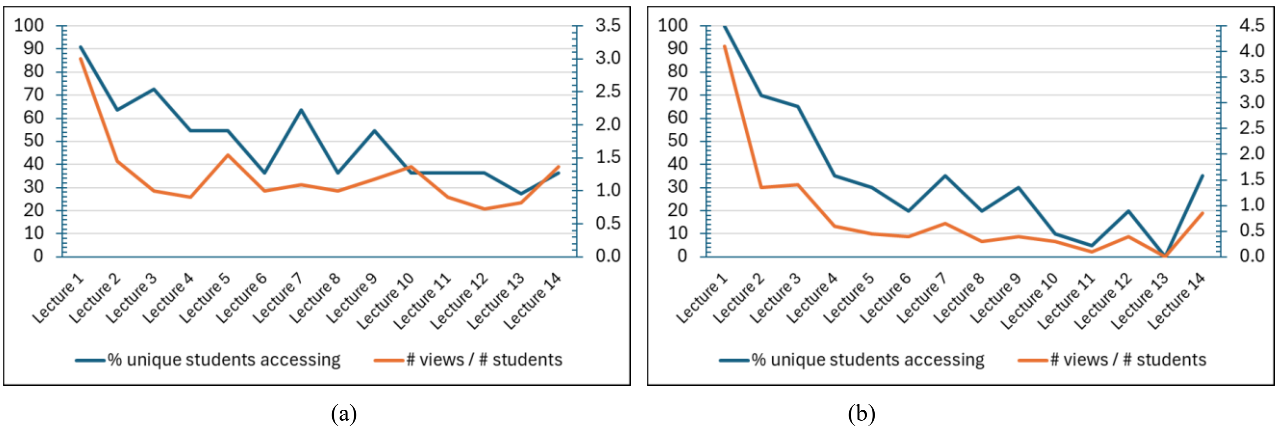
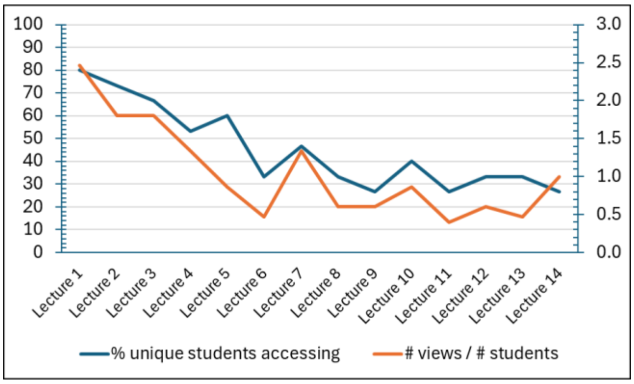


Figure 3. *Vertical bar chart/plot, with 95% confidence interval, for ME217 showing pre-quiz versus post-quiz mean data (across all years considered) and distribution.*





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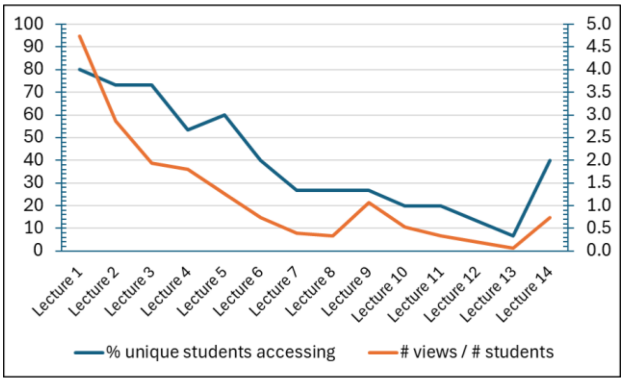

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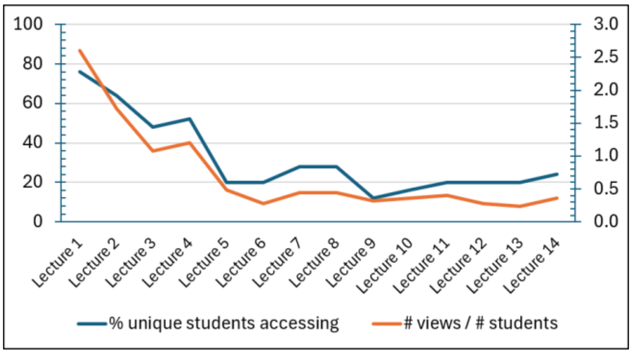


(e)

Figure 4. *Access to course lectures by ME217 students including the normalized view numbers for the online lectures. (a) 2022 (b) 2023 (c) 2024 (d) 2025 (e) 2026.*

To determine whether the increases in lecture access observed before examinations in Figure 4 are statistically significant, a paired-sample t-test was performed on 10 pairs of normalized lecture-view data collected before and after exams (degrees of freedom, df = 9). The analysis combined data from both major assessments by comparing Lecture 8 with Lecture 9 (in the lead up to the midterm examination) and Lecture 13 with Lecture 14 (in the lead up to the final examination).

Figure 5 presents these data as a vertical bar chart with 95% confidence intervals. The paired t-test, conducted using the JASP statistical software package, produced a p-value of 0.009, indicating a statistically significant difference between lecture access leading up to the examinations. Therefore, the null hypothesis—that no true difference exists between the paired groups—was rejected. The Cohen's d for effect sizes here is -1.052 which indicates a large effect (a very clear, substantial difference). For the assumptions of the paired t-test, the data is continuous with independent pairs and the Shapiro-Wilk test W value is 0.9221. A value of W close to 1 means the data are normal.

It should be noted, however, that the sample size for this analysis is relatively small. Although a sample size of 30 or more paired observations ($N > 30$) is commonly recommended for achieving more reliable statistical inferences, particularly when data may not follow a normal distribution, larger sample sizes (e.g., 50-100 pairs) generally provide greater statistical power for detecting meaningful differences. Consequently, the results presented here should be interpreted with consideration of the limited sample size.

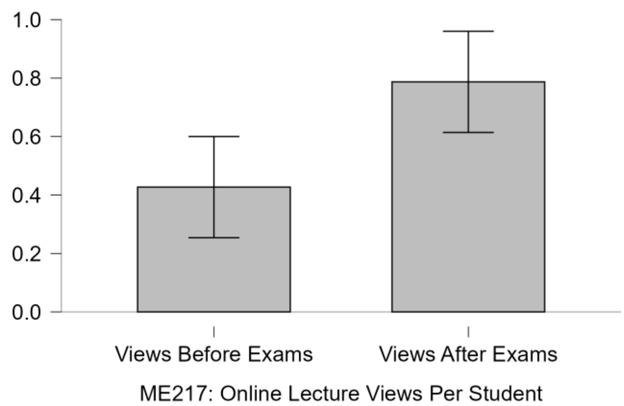


Figure 5. *Vertical bar chart/plot, with 95% confidence interval, for ME217 showing normalized online access by students for pre-recorded lectures (saved on Canvas) right before and right after the exams (both midterm and final exams). The data is for five years.*

Figure 6 shows an overall declining trend, with occasional minor increases, in the percentage of unique students accessing homework (HW) assignments online. It should be noted that students were required to access these pages before completing the assignments, as the posted links contained the necessary homework instructions and details. Homework 1 (HW1) consistently exhibited the highest access rate, whereas subsequent assignments generally showed lower engagement levels, with one instance reaching a minimum access rate of 67%.

As discussed in the *Materials and Methods* section, homework assignments in ME217 were completed as group activities, with an intended group size of three students and only one submission accepted per group. Consequently, each group received a single grade based on its submitted solution. This structure may contribute to reduced individual participation among some students, commonly referred to as "free-riding," in which less active members depend on more engaged group members to access assignment information and coordinate submissions. Although students were encouraged to complete the assignments individually before collaborating with their groups to determine the final solutions, some variation in participation was expected. The challenges associated with free-riding in group-based learning environments have also been documented in previous studies [17].

A further observation from Figure 6 is the increase in homework access following HW4, which is assigned immediately before the midterm examination. This pattern is consistent with the previously observed increase in lecture engagement near examination periods and suggests that upcoming assessments may motivate students to increase their interaction with course materials. However, this increase in participation appears to be temporary, as engagement decreases again for the final homework assignment prior to the final examination. One possible explanation is that students face increased time constraints near the end of the semester, resulting in greater reliance on group members to complete or coordinate the final assignment.

The final analysis for ME217 is presented in Figure 7, which plots the total time each student spent accessing course materials online against the student's overall course score (percentage). It might be expected that greater engagement with online materials would correspond to higher academic performance. However, the data do not demonstrate a strong relationship between online activity and final grades. Several students achieved comparable course scores despite substantial differences in the amount of time spent online, suggesting that time spent accessing course materials alone is not a reliable predictor of performance in this course.

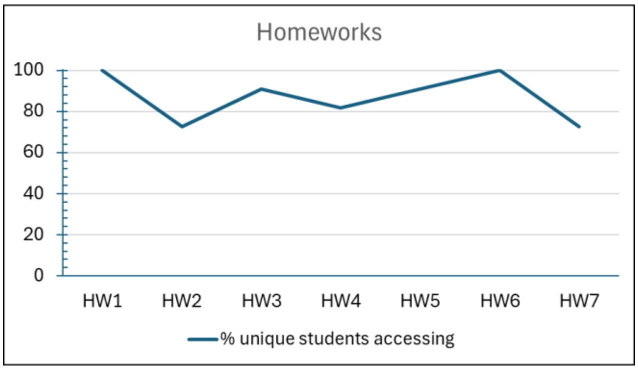
Although the present data do not reveal a clear correlation, previous studies have identified relationships between online engagement and academic outcomes in other contexts. For example, a study of a large third-year university business forecasting course [18] found that students who spent more time accessing course websites tended to achieve higher assessment scores. Similarly, research involving online economics and finance courses [19] reported that students with higher GPAs and greater online study time generally earned higher course grades. In addition, a multi-disciplinary study involving diverse student populations [20] found that improved academic performance was associated with increased out-of-class study time.

Table 1. *Access to several pages or documents online on Canvas for ME217.*

% unique students accessing, ME217	2022	2023	2024	2025	2026
"Welcome" page	90.91	85.00	66.67	60.00	84.0
"Introduction" page	100.00	70.0	80.00	73.33	80.0
"Syllabus" (PDF online)	100.00	N/A	93.33	100.00	96.0
"Rules for Presentations" document	27.27	20.00	20.00	46.67	36.0

Table 1 summarizes the percentage of unique students who accessed various online pages and documents during each course offering. Ideally, all students would access these resources, resulting in a 100% access rate. However, the observed access percentages were consistently below this expected level, with the page containing information about upcoming student group presentations receiving access from as few as 20% of students. Even the course syllabus, which included essential information such as examination schedules and grading policies, was not accessed by all students in all years. Similarly, the “Welcome” and “Introduction” pages, which were designed to serve as the initial entry points to the Canvas course site, frequently showed access rates below 100%.

When considered together with the trends presented in the previous figures, these results suggest that some students maintained limited engagement with available online course resources throughout the semester.



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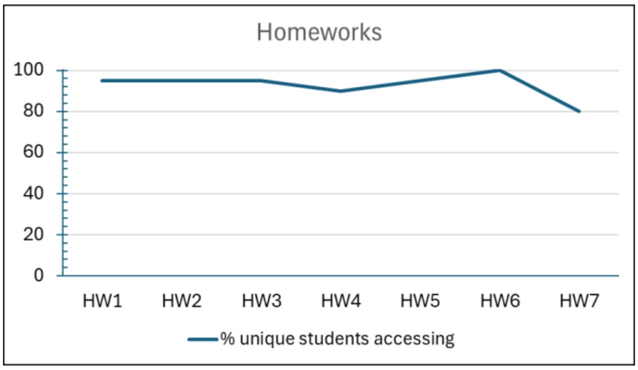

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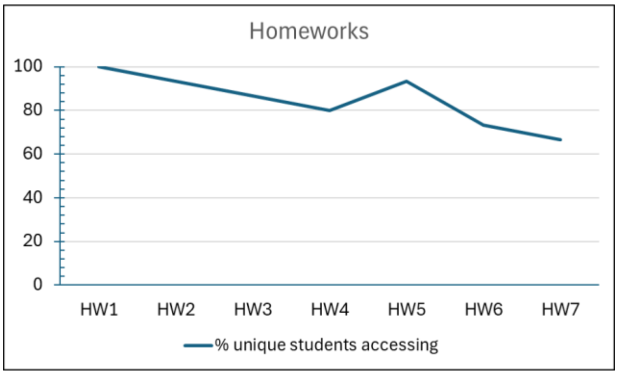

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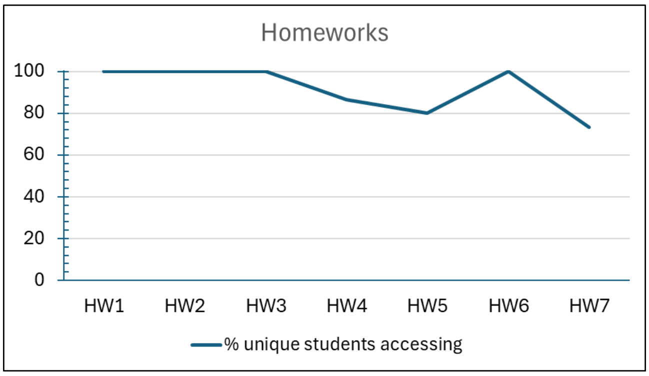

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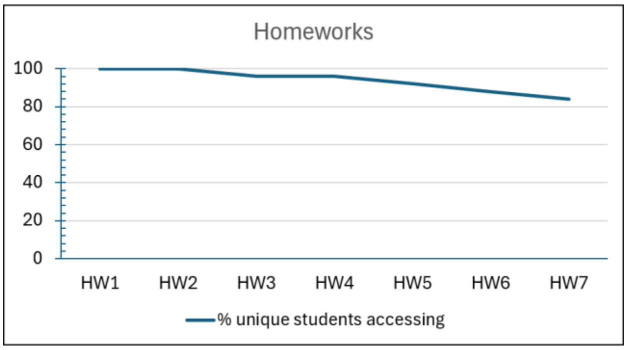

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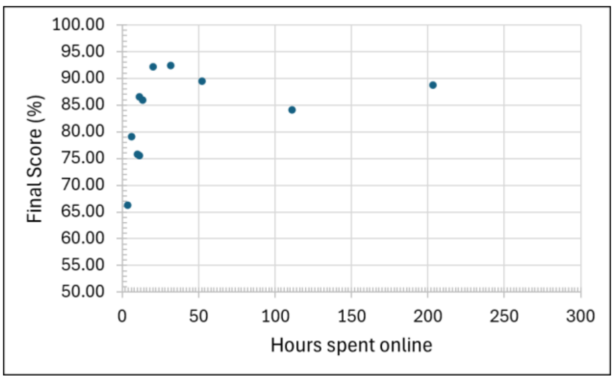
Figure 6. *Percentage of individual students accessing homework (HW) assignments online in ME217. (a) 2022 (b) 2023 (c) 2024 (d) 2025 (e) 2026.*



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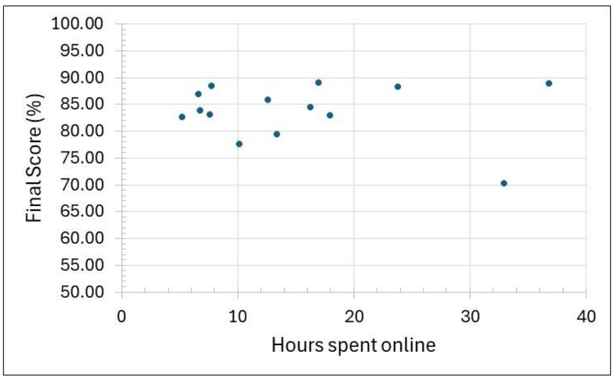

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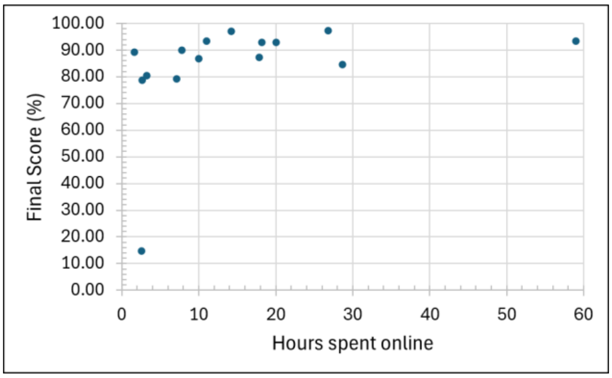

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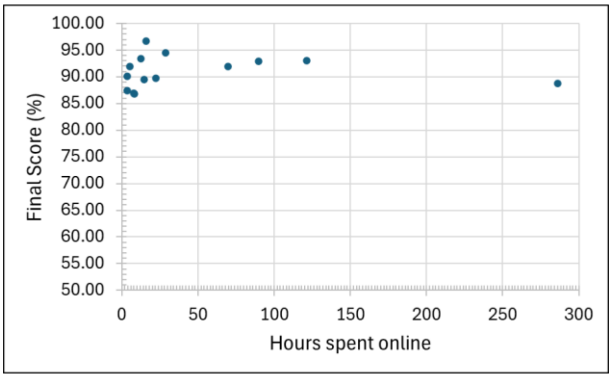

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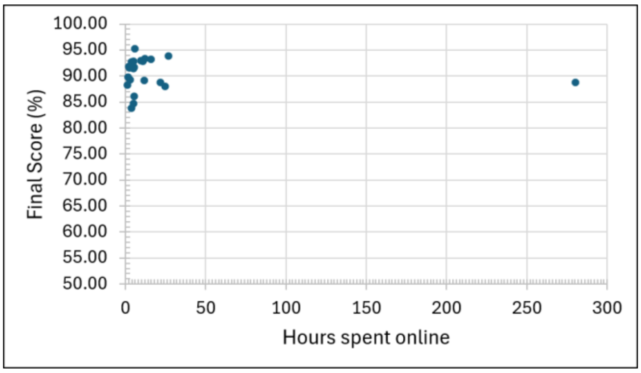


(e)

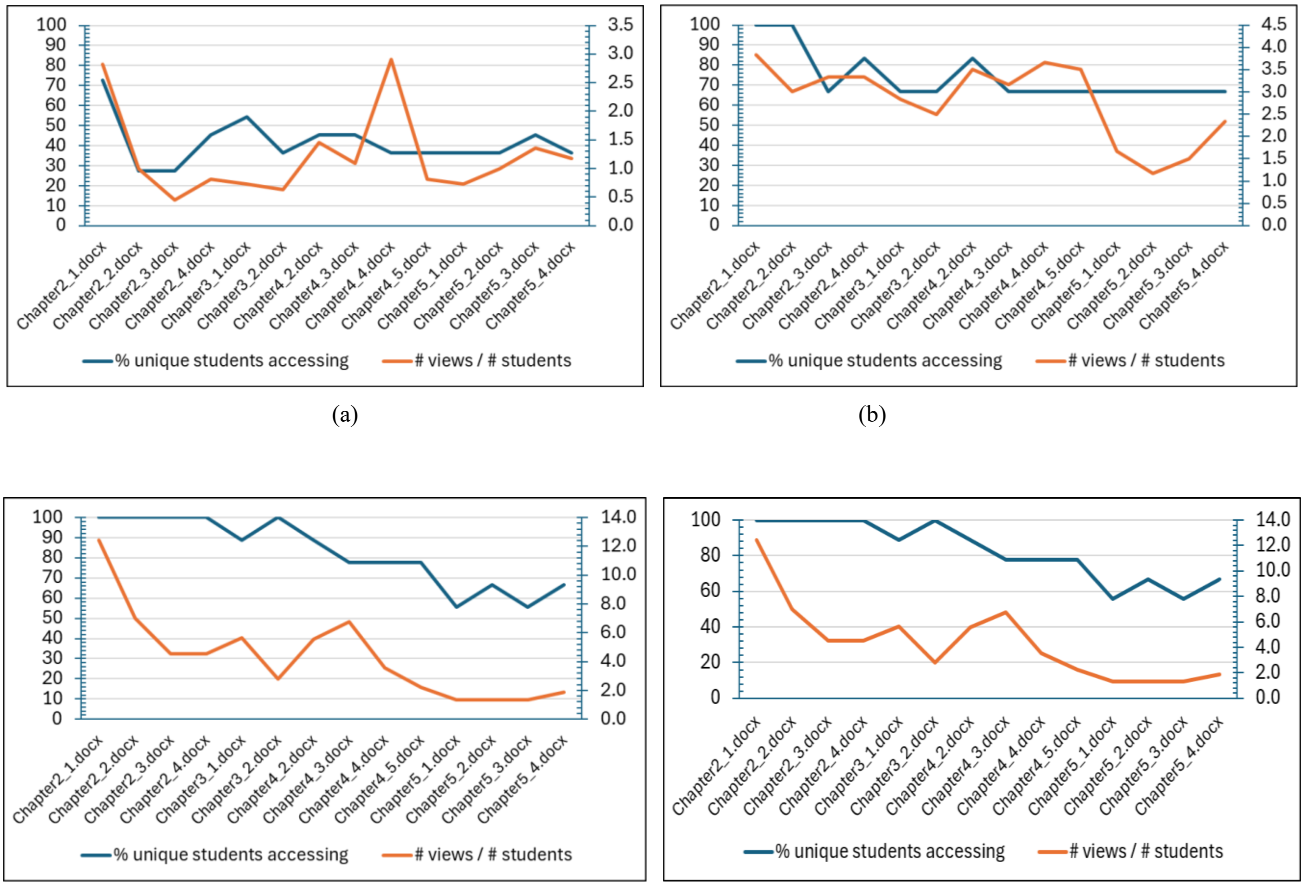
Figure 7. *Final ME217 course accumulation or score in percentage versus the total number of hours each student, represented by a dot, spent on the online content of the course. (a) 2022 (b) 2023 (c) 2024 (d) 2025 (e) 2026*

3.2. ME512

As noted in the *Materials and Methods* section, the scope of online content in ME512 was more limited than in ME217 because ME512 was not a fully online course and had a smaller enrollment. Nevertheless, the course included several online resources that provide opportunities for analysis and comparison with the undergraduate ME217 course.

Figure 8, which is analogous to Figure 4, illustrates student access patterns for ME512. In this case, the x-axis represents Word documents containing optional or supplementary problems associated with each chapter. These problems were typically completed during class meetings to encourage active learning and allow students to receive immediate feedback from the instructor. The same additional problems were also uploaded to Canvas so that students could review them outside of class at their own convenience.

The access patterns shown in Figure 8 exhibit trends similar to those observed in Figure 4. However, unlike ME217, where student access to required course materials occasionally declined to zero, ME512 students maintained consistent engagement even with optional resources. This behavior is likely attributable to differences in student population, as ME512 students are graduate-level learners who are generally more academically mature, professionally focused, and motivated to engage with course materials. Furthermore, because the ME512 midterm examination occurred after Chapter 3, the access curves show increases both before and after the examination, reflecting the same type of examination-driven engagement or "study bumps" observed in the ME217 results.



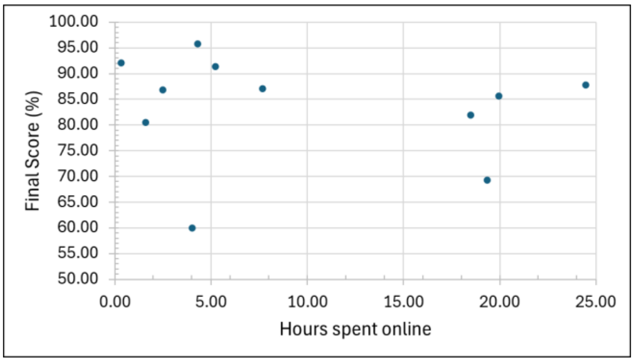
(a) (b) (c) (d)

Figure 8. *Access to course materials (extra chapter problems) by ME512 students including the normalized view numbers for these course materials. (a) 2022 (b) 2023 (c) 2024 (d) 2025.*

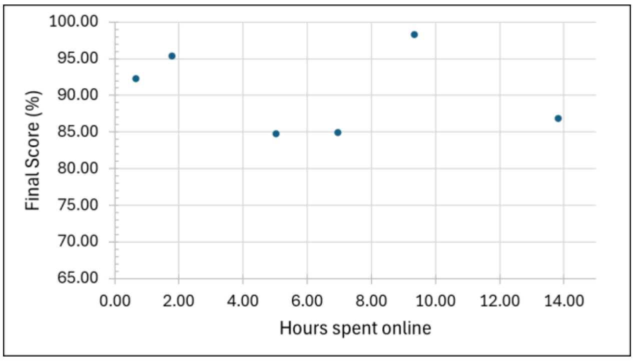
Figure 9 presents the relationship between students' final course scores and total time spent accessing online materials in ME512, allowing comparison with the corresponding analysis for ME217 shown in Figure 7. Similar to the ME217 results, Figure 9 does not reveal a strong or consistent correlation between online engagement time and final course performance.

Most ME512 students spent approximately 10 hours or less accessing online materials, whereas ME217 students typically accumulated up to 20 hours of online activity. This difference is consistent with the distinct instructional formats of the two courses: ME217 was delivered fully online, while ME512 incorporated online resources primarily as a supplement to traditional face-to-face instruction. In ME512, much of the recorded online activity resulted from students accessing Zoom-recorded lectures uploaded to the cloud.

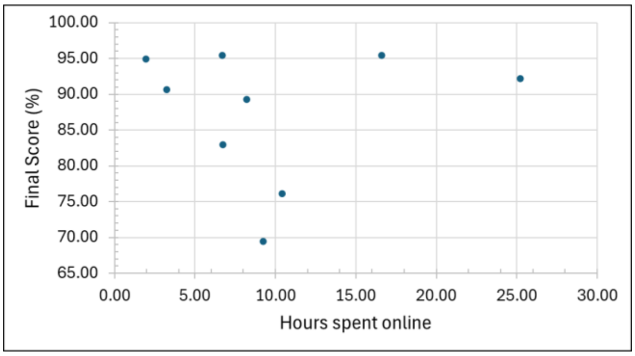
Figure 9 further shows that more than half of the ME512 students achieved final course scores above 80% without spending substantial time online. This outcome is expected because the majority of course content—including lectures, discussions, and in-class activities—was delivered during face-to-face sessions. The online materials served mainly as supplemental resources, such as optional practice problems, recorded lectures, and occasional homework-related announcements. Therefore, consistent attendance and active participation in the in-person class environment were sufficient for many students to achieve strong course outcomes.



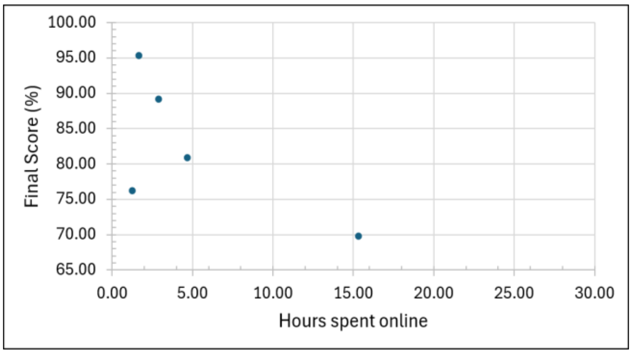
(a)



(b)



(c)



(d)

Figure 9. *Final ME512 course accumulation or score in percentage versus the total number of hours each student, represented by a dot, spent on the online content of the course. (a) 2022 (b) 2023 (c) 2024 (d) 2025.*

No additional figures are presented for ME512 because of the limited amount of available online activity data. However, Tables 2 and 3 provide further analysis of student engagement with specific Canvas resources. Table 2 summarizes the percentage of students who accessed homework-related announcements, with access rates ranging from 36.36% to 100%. This range is somewhat unexpected, as graduate students might be expected to consistently review course announcements to remain informed about assignments and deadlines. Nevertheless, the persistence of the free-rider phenomenon at the graduate level may help explain why access rates did not consistently reach 100%, particularly since homework assignments were completed collaboratively in groups.

Table 3 presents student access data for the course syllabus and textbook ordering information; however, data were only available for the 2024 and 2025 course offerings. In 2024, all students accessed these resources, whereas full access was not observed in 2025. Overall, these results are consistent with expectations and show generally higher engagement than the corresponding undergraduate results presented in Table 1. This difference likely reflects the greater level of maturity, independence, and responsibility typically associated with graduate students.

Table 2. *The data for student accessing of homework (HW) assignments posted online on Canvas for ME512.*

% unique students accessing, ME512	2022	2023	2024	2025
HW1	72.73	100.00	100.00	80.00
HW2	36.36	83.33	100.00	60.00
HW3	63.64	66.67	100.00	60.00
HW4	45.45	66.67	88.89	40.00

Table 3. Online access (absolute and relative) of two documents posted on the Canvas website for ME512 (2024, 2025).

2025, Total no. of students = 5	# unique students accessing	% unique students accessing
"Syllabus" (PDF online)	4	80
"Textbook ordering info" document	4	80
2024, Total no. of students = 9	**# unique students accessing**	**% unique students accessing**
"Syllabus" (PDF online)	9	100.0
"Textbook ordering info" document	9	100.0

4. Conclusions

In conclusion, the analysis of online course usage data from two distinct instructional settings—an undergraduate course and a graduate course—provides valuable insights into student behaviors and engagement patterns. In both courses, access to online resources, including lecture materials and supplementary problems, generally declined as the semester progressed, with the decrease being more substantial in the undergraduate course. Neither course demonstrated a strong relationship between the amount of time spent accessing online materials and students' final grades or course scores.

Both courses showed high levels of engagement during the early weeks of the semester, with students frequently accessing course materials multiple times. However, graduate students maintained higher levels of repeated engagement throughout the semester compared with undergraduate students. The findings also indicate that even important course resources, such as syllabi and instructional documents, were not accessed by every student. Additionally, the results suggest that group-based assignments with a single submission per group may influence individual participation and reduce engagement with related online materials.

The hypotheses proposed earlier in the paper were supported by the results. However, because this investigation is limited to only two courses, additional studies involving a broader range of courses, instructors, and student populations are needed to determine whether these observations can be generalized.

Finally, although this study identified patterns of reduced engagement with online course content among some students, it was not specifically designed to investigate strategies for improving engagement in online learning environments. Nevertheless, the findings provide useful information that can help instructors develop targeted approaches to encourage greater student interaction with course materials and promote more effective use of online resources.

Abbreviations

LMS	Learning Management System
UNM	University of New Mexico
ME	Mechanical Engineering
MoM	Mechanics of Materials
DF	Degrees of Freedom
Q1	First Quartile
Q2	Median
Q3	Third Quartile
IQR	Interquartile Range
HW	Homework
HW1	Homework 1

Author Contributions

Tariq Khraishi: Conceptualization, Data curation, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing

Conflicts of Interest

The author declares no conflicts of interest.

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