

A Quantitative Analysis of Online Student Engagement and Lecture Formats

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ABSTRACT

This quantitative, causal-comparative study examines low levels of student engagement in online undergraduate courses. Through the theoretical lens of connectivism, the study examined lecture formats to understand their role in online engagement, given their interactivity and communication between instructors and peers. To examine the role of lecture formats in student engagement, ANOVA compared engagement rates among students who attended live lectures, viewed recordings, or did not access either option. Study participants were United States citizens who attended eight-week, U.S.-based online undergraduate courses. The data were collected through Prolific.com, and the Online Student Engagement (OSE) questionnaire served as the study instrument. The results showed a statistically significant difference in engagement rates between students in the live lecture group and those in the no-lecture group. Students in the live lecture group reported higher levels of engagement; however, the effect size is small. The results highlight the complexity of student engagement and the need for further research.

Keywords: student engagement, live lectures, recorded lectures, online learning

Introduction/Background

Student engagement plays a key role in the student experience within virtual learning environments. Students who actively participate in their learning experience have a greater sense of belonging, which is vital to building an effective online learning community. Without interactivity, virtual learning can be isolating, leading to a loss of motivation and interest in learning (Singh et al., 2022). Furthermore, reduced student engagement is linked to lower student performance and success (Jones, 2022; Rioch & Tharp, 2022). Various factors contribute to student engagement within online courses, and their significance must be evaluated independently.

Live and recorded lectures are significant elements in online courses because they replace traditional in-person lectures (Dhawan, 2020). Research indicates that effective instructor communication is correlated with increased student engagement (Hopwood et al., 2023; Singh et al., 2022). For this study, live lectures are defined as a synchronous instructional tool used in online courses in which the instructor and students meet through an online platform for a live class session (Islam et al., 2020). Through live sessions, instructors can answer questions, explain complex content, and foster critical thinking. Instructors can also use live sessions to assess students' mastery of the course learning outcomes and identify potential learning gaps.

Recorded lectures also have numerous benefits, including flexibility and accessibility (Al-Qudah, 2024). Students who choose online learning may do so in part because of the flexibility it offers. Therefore, attending scheduled, live lectures may not be ideal. Students may not have the ability or desire to attend scheduled lectures (Jiang & Koo, 2020). Furthermore, recorded lectures benefit student learning. Because students are watching at their own pace, they can pause and rewatch segments to gain clarity (Angrave et al., 2020). Recorded lectures also have accompanying closed captions and transcripts for accessibility.

Understanding how lecture formats affect student engagement can help educators make informed decisions (de Verneil & Berge, 2020). To examine this phenomenon, this study will determine whether engagement levels among U.S. online undergraduate university students differ depending on whether they attend live lectures, recorded lectures, or no lectures. This study used an analysis of variance (ANOVA) causal-comparison model to assess the effect of lectures on students' engagement in their course. The study may help online universities decide between live lectures, recorded lectures, or no lectures at all.

Theoretical Foundations

Although relatively new, connectivism has become a significant learning theory due to the prevalence of online learning (Downes, 2008; Dziubaniuk et al., 2023; Siemens, 2005). The online learning environment differs vastly from in-person learning and presents unique considerations that cognitive, humanistic, and constructivist theories cannot address (Dziubaniuk et al., 2023; Kotzee & Palermos, 2021). While learning remains a social process, online

education requires connection to the digital world and exploration of various media (Downes, 2008; Mukhlis et al., 2024; Siemens, 2005).

George Siemens (2005) and Stephen Downes (2008) developed connectivism in response to the shift toward online learning (Mukhlis et al., 2024). Connectivism differs from previous learning theories because they do not account for technology's role in knowledge acquisition. Since technology is relatively new in modern society, it is understandable that virtual learning is not yet fully accounted for. However, a theoretical framework that acknowledges technology's role in learning helps conceptualize the online environment.

While connectivism emphasizes technology, students cannot learn solely through online media. Students also learn through dialogue and community formation (Downes, 2008; Siemens, 2005). Whether students communicate in person or remotely, learning communities play a crucial role in shaping knowledge and fostering deeper understanding. Connectivism encourages exchanging ideas to deepen learning (Dziubaniuk et al., 2023). Conversations with others expose students to different perspectives and experiences that can challenge previously held assumptions. Through group work, peer review, and discussion, students gain insight into others' experiences and develop stronger critical thinking skills. For these strategies to be successful, students must listen and share lessons learned (Dziubaniuk et al., 2023; Downes, 2008; Siemens, 2005). Within connectivism, educators should use technology to promote social presence.

Unlike traditional pedagogy, in which the teacher is the center of the class, connectivism positions the instructor as a facilitator of idea exchange (Ayalon & Aharony, 2024; Downes, 2008; Sidik et al., 2021; Siemens, 2005). Connectivism does not employ a teacher-centered approach; instead, it views instructors as one of the many resources available to students. The instructor's role is to foster a learning environment where students feel safe expressing their creativity and applying their knowledge in meaningful ways (Alam, 2023; Dziubaniuk et al., 2023). Despite the learner-centric approach, instructors are essential in connectivism because students require critical scaffolding and guidance in problem-solving (Alam, 2023; Dziubaniuk et al., 2023; Sidik et al., 2021). Furthermore, instructors improve student engagement by providing activities that foster higher-order thinking.

Literature Review

Online learning offers flexibility and anonymity. Students have more freedom regarding when and where they complete coursework. Due to the anonymity of online learning, student engagement is often lower than in traditional, in-person courses (Heilporn et al., 2024). However, since the COVID-19 pandemic of 2020, more courses have been presented online than ever before. Unfortunately, this shift has made it harder for university students to form connections with instructors and peers (Martin & Borup, 2022). Before the pandemic, many educators overlooked online learning's potential to foster meaningful student engagement (Mehall, 2020). However, online learning's ability to engage students during stay-at-home orders challenged these misconceptions (Dhawan, 2020). As online learning becomes more widespread, addressing engagement challenges is essential to give students the best chance of success.

Online student engagement can be categorized into three types: cognitive, behavioral, and emotional engagement (Teng & Wang, 2021; Turk et al., 2024; Yarmand et al., 2021). Some online students find cognitive benefits in the online environment; however, other students find the autonomous nature of online classes challenging (Heilporn et al., 2024). For example, they may show lower levels of behavioral engagement and fail to complete assignments on time or participate in discussion boards (Heilporn et al., 2024). Emotional engagement refers to a student's feelings about their courses, including physical and emotional safety and relationships with peers and instructors (Jiang & Koo, 2020; Suen & Hung, 2025). All three types of engagement are related to motivation and academic achievement (Teng & Wang, 2021; Turk et al., 2024; Yarmand et al., 2021).

Furthermore, students' engagement levels can decrease throughout the course. Discussion boards posted near the beginning of a term typically elicit more engagement and student responses than those at the end of a term (Hopwood et al., 2023). Students who struggle to maintain online engagement are more likely to experience greater frustration and increased mental load (Yarmand et al., 2021). Lack of engagement also affects student achievement. Students who regularly interact and communicate with their instructors and peers report higher grade point averages than those who do not (Rioch & Tharp, 2022). Sustained engagement in an online course is therefore essential to support student achievement and reduce frustration in online environments.

This quantitative causal-comparative study examined the generally low level of engagement in online universities and the limited understanding of how lecture formats affect student engagement. To address challenges in online student engagement, educators benefit from understanding whether live or recorded lectures enhance teacher presence, connectivity, and cognitive learning opportunities compared with courses without lecture options. This research focused on lecture offerings because previous researchers established a correlation between teacher presence and student engagement (Hopwood et al., 2023; Sadaf et al., 2021; Singh et al., 2022). In a lecture setting, instructors can connect with students, provide valuable feedback, and motivate them to persevere in their coursework.

Comparing engagement rates among students who attend lectures live, view recordings, and have no lecture opportunities within an eight-week term provides research-based guidance to university leadership. Previous studies, such as Heilporn et al. (2024), have established a relationship between course design and student engagement. Student engagement can also fluctuate as the term progresses (Hopwood et al., 2023). As courses progress, students complete several discussion boards and assignments, and repetition can reduce engagement. This study examined whether the lecture format can mitigate the monotony students may experience in online courses. By interpreting quantitative data, the researcher provided actionable insights and recommendations for university instructors and leadership to design online courses that optimize student engagement.

Advancing Theoretical Knowledge

Through the lens of connectivism, knowledge acquisition goes beyond understanding and defining course material. Learners must also understand the content's significance and apply their

skills to make informed decisions (Connolly & Wicks, 2023). In an online environment, students will apply their decision-making skills to their interactions and use of technology to support their learning. Society and technology are ever-changing, and connectivism encourages educators to prepare students for evolving knowledge and theories of understanding, thereby improving the world around them (Omodan et al., 2023). For example, social norms, societal challenges, and technological tools are continuously changing. Therefore, students must understand how to apply information in dynamic contexts. Connectivism facilitates this process by encouraging the use of various learning materials, including textbook readings, articles, and videos, which allows students to critically analyze and engage with the content.

Connectivism is closely linked to online learning, as students utilize technology as a primary learning avenue (Liu et al., 2024). Technology and online learning platforms create a collaborative learning network, enabling students to connect and engage with course materials through the learning management system (LMS) (Liu et al., 2024). Students interact with LMS tools through both live and recorded lectures. Students attending live lectures experience many aspects of connectivism, including social connections and discussions; however, the value of recorded lectures should not be overlooked. Recorded lectures let students engage with course content and the LMS in flexible ways (Al-Qudah, 2024). Students can critically question and deepen their knowledge without being tied to an instructor's schedule. In this way, both live and recorded lectures play crucial roles in fostering a connectivism environment that provides students with diverse learning opportunities to engage with the content and enhance their learning experience.

Methods

This quantitative causal-comparative study examined differences in engagement scores among online undergraduate students in US-based colleges and universities who attended live lectures, watched recordings, or did not view any live or recorded lecture material during an eight-week term. Causal-comparative research was used to identify the differences between variables without manipulation (Alverson, 2022). Causal-comparative research design comprises several key components: it must be non-experimental, involve group comparisons, and employ retrospective designs (Alverson, 2022; McBee, 2021).

The study was non-experimental because no variables were manipulated (Engsted & Schneider, 2024). The participants' institution or instructor set the course models and, therefore, they could not be altered. Non-experimental research allows for observations in authentic settings, thus providing real-world context (Engsted & Schneider, 2024).

Because the study aimed to compare engagement rates among students in the live lecture, recorded lecture, and neither lecture groups, an ANOVA was conducted. The lecture format served as the independent variable, and engagement rates served as the dependent variable. Participants included undergraduate students enrolled in an eight-week fully online course in the United States. The results provided evidence to inform instructional strategies and course design in online education.

Research Questions and Hypotheses

RQ1: What is the difference in student engagement scores between undergraduate online students enrolled in US-based colleges and universities who attend live lectures, those who view recorded lectures, and those who do not participate in lectures?

H1₀: There is no difference in student engagement scores between US undergraduate online students enrolled in US-based colleges and universities who attend live lectures, those who view recorded lectures, and those who do not participate in lectures.

H1_A: There is a statistically significant difference in student engagement scores between undergraduate online students enrolled in US-based colleges and universities who attend live lectures, those who view recorded lectures, and those who do not participate in lectures.

The researcher investigated the effect of the lecture format on student engagement among online students. To test the hypotheses, study participants completed the Online Student Engagement Scale (OSE) developed by Dixon (2015), in which participants ranked their responses on a five-point Likert scale. Participants indicated their responses as follows:

- *not at all characteristic of me*
- *not really characteristic of me*
- *moderately characteristic of me*
- *characteristic of me*
- *very characteristic of me*

The OSE served as a valuable tool in examining how the lecture format (independent variable) affects online student engagement (dependent variable). The 19-item survey measures various aspects of engagement behavior, including conversing with peers and applying knowledge to their daily lives. Additionally, participants answered demographic questions and indicated the lecture format they use most frequently (live, recorded, or neither) within an eight-week term.

Data Collection

This study used a survey instrument that included demographic questions and a validated measure to assess the rate of online student engagement. Prolific hosted the survey and recruited participants. Interested participants registered through Prolific's website. If Prolific determined that the study aligned with the registered user's profile, it made it available to potential participants (Prolific, 2025b). To meet the study's criteria, potential participants had to be adults aged 18 and above who resided in the United States and were enrolled in an eight-week, fully online undergraduate course. To ensure accurate results, G*Power analysis required 159 participants across the three groups. Prolific's robust recruitment practices helped ensure a diverse sample.

Participation in the study on student engagement was voluntary, anonymous, and participants could withdraw at any time. Participants were also informed about the data retrieval process and provided with the researcher's contact information. To ensure anonymity, Prolific generates unique participant identification numbers. The researcher did not have access to participants'

names or contact information and could not communicate with participants outside Prolific's website (Prolific, 2025a).

Findings

Data were collected through survey responses in Google Forms and analyzed in R. Before conducting the ANOVA to evaluate differences in online student engagement rates across lecture formats, descriptive statistics were reviewed. Although descriptive statistics did not support inferences, they summarized the dataset and concisely categorized the data (Kaliyadan & Kulkarni, 2019). A total of 163 participants completed the survey.

Participants indicated the lecture type they use most frequently. This response was necessary to address the study's purpose statement and research question; therefore, all participants were required to respond. Most participants utilized recorded lectures (66.87%). Live lectures accounted for the second-largest group (26.38%), while using neither live nor recorded lectures accounted for 6.75%. Unfortunately, this left the groups unbalanced, which can occur in ANOVA studies and is why a post-hoc test is needed (Juarros Basterretxea et al., 2024).

Table 1 presents additional descriptive statistics for the dependent variable, student engagement, as measured by the OSE, including measures of central tendency (mean and median), minimum and maximum, and first and third quartiles. To score the dependent variable, we summed the scores for each survey question and divided by the number of questions (19). Higher scores indicate greater online student engagement.

Table 1

Online Student Engagement Score Descriptive Statistics from the Dataset

	<i>Min.</i>	<i>1st Qu</i>	<i>Median</i>	<i>Mean</i>	<i>3rd Qu</i>	<i>Max.</i>
Online Student Engagement Score	1.58	3.19	3.58	3.58	4.05	5

Note. Where applicable, each numerical value is rounded to two decimal places.

Numerical Summaries for Student Engagement Variable Based on Lecture Type

To answer the research question, the numerical statistics were reviewed by group. The numerical statistics included the mean, standard deviation, skewness, and kurtosis. Live lectures had the highest mean (3.75), followed by recorded lectures (3.55). Those who indicated they did not use either lecture option had the lowest mean of 3.18. The standard deviation scores followed the same pattern. The live lecture group had the highest standard deviation (0.73), indicating the greatest spread in scores. Recorded lecture scores were moderately spread with a standard deviation of 0.68, while the *neither* option had the least spread with a standard deviation of 0.57. However, all groups demonstrated a moderate standard deviation, indicating that scores were neither extremely close together nor widely spread (Hattem et al., 2022).

Skewness and kurtosis followed a similar pattern to that of the mean and standard deviation. All groups demonstrated slight negative skew, indicating that participants rated their engagement at the higher end of the OSE scale. Because participants recorded the highest scores for live lectures, the skewness was -0.53, followed by recorded lectures with -0.24, and the *neither* option with -0.21. However, the skewness values were low. The live lecture group was between small and moderate, while the recorded lecture group and *neither* were very close to symmetrical (Hatem et al., 2022). Additionally, kurtosis was very small in all groups. Table 2 presents the mean, standard deviation, skewness, and kurtosis for the engagement scores (as measured by the OSE), grouped by selected lecture type.

Table 2

Numerical Summaries of Lecture Type and Online Student Engagement Variables

Lecture Type	<i>Mean</i>	<i>SD</i>	<i>Skew</i>	<i>Kurt</i>	<i>Student Engagement: n</i>
	N	N	N	N	N
Live	3.75	0.73	-0.51	0.36	43
Recorded	3.55	0.68	-0.24	-0.008	109
Neither	3.18	0.57	-0.21	-0.35	11

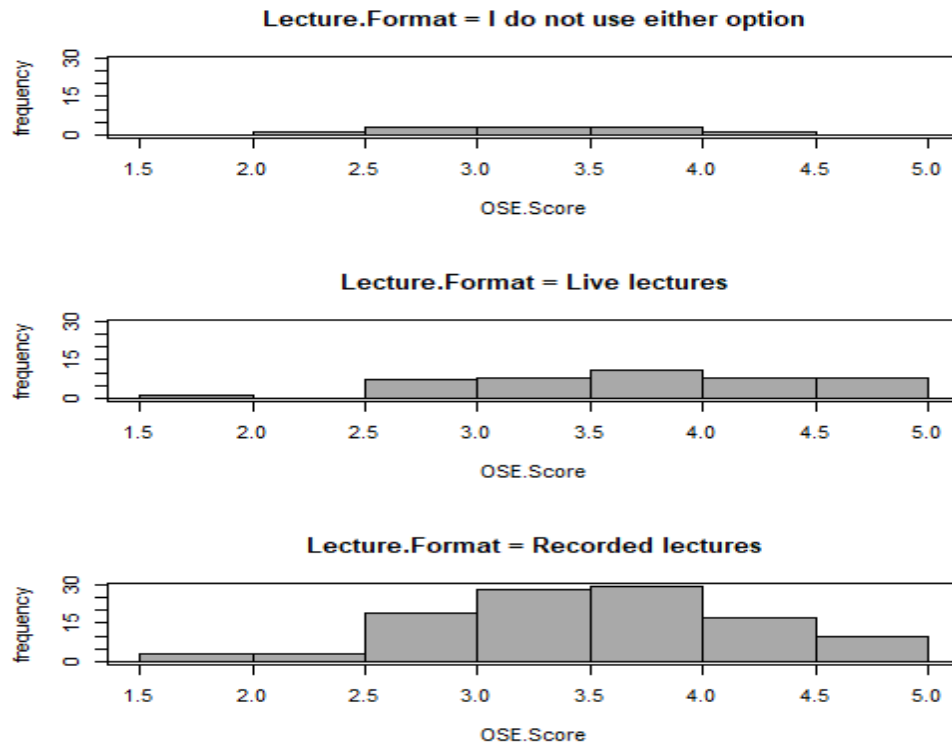
Assumptions and Data

Before conducting the ANOVA test, the researcher ensured that the data met the necessary assumptions, which include normality, homogeneity of variances, and the absence of significant outliers (Alverson, 2022; Yu et al., 2021).

The normal distribution was demonstrated using a histogram, a boxplot, and a quantile-quantile plot (QQ plot). The histogram was a useful, visual tool for determining the distribution and shape of the data (Guzik & Więckowska, 2022). Like the numerical skewness and kurtosis values calculated above, histograms can highlight potential data issues (Guzik & Więckowska, 2022). Figure 1 below illustrates the histogram for engagement score by selected lecture type.

Figure 1

Histogram Frequency Scores for Lecture Type and Online Student Engagement



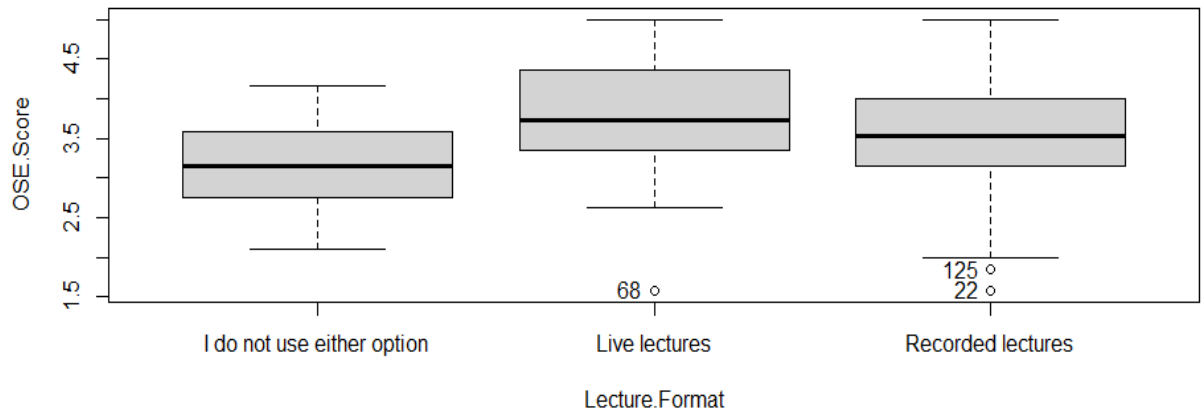
Note. This figure represents the frequency scores for lecture type and student engagement.

The data for each lecture type followed a bell-shaped pattern. The highest values were in the middle, and the lowest values were at the ends. The largest differences between the graphs were in the amount of data collected for each group. Recorded lectures received the most responses, while the *neither* lecture option had the fewest. Additionally, recorded lectures and the *neither* lecture option showed the strongest bell shape. Live lectures showed a small leftward tail, which may indicate an outlier (Guzik & Więckowska, 2022).

A box-and-whisker plot, also known as a boxplot, is another distribution visualization that helps identify outliers (Jones, 2022). Boxplots were created by lecture type, and the boxes within the box-and-whisker plot represent the interquartile range (Jones, 2022). The whiskers show the highest and lowest values, and outliers are shown outside the whiskers. Figure 2 below represents a boxplot for lecture type and rates of student engagement.

Figure 2

Boxplot for Lecture Type and Online Student Engagement

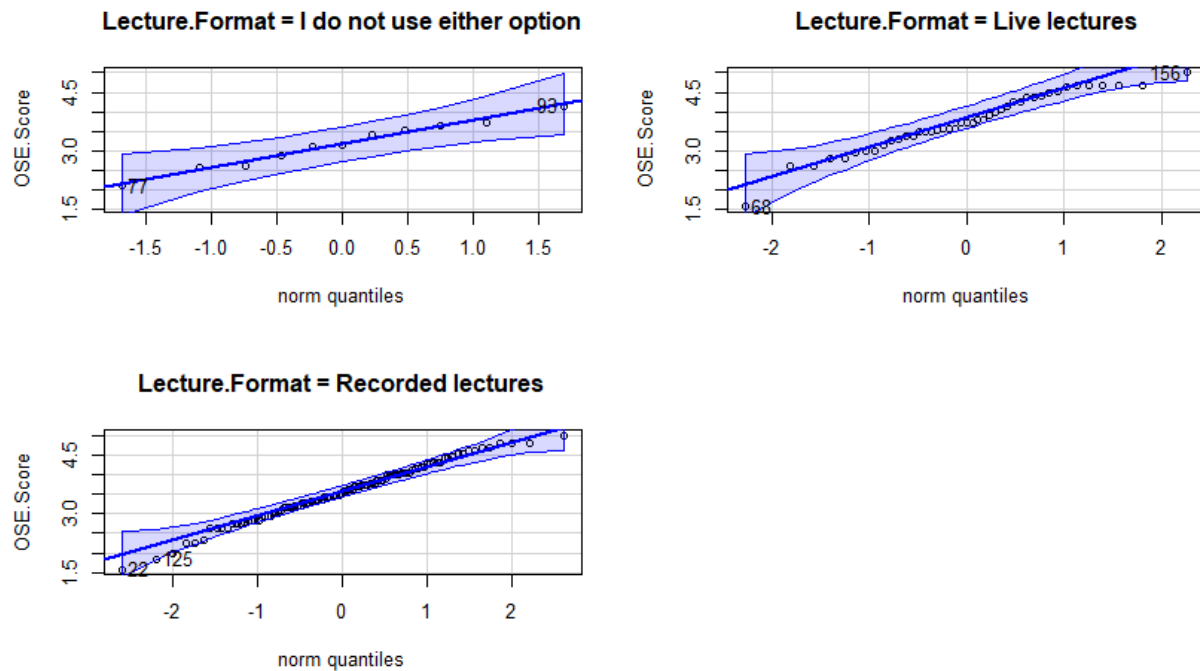


Note. This boxplot shows one outlier for live lectures (Participant 68) and two for recorded lectures Participant 22 and 125).

The boxplots identify three outliers. Participant 68 in the live lecture group had an unusually low score of 1.578947368. Within the recorded lecture group, Participant 22 also had a score of 1.578947368, and Participant 125 had a score of 1.842105263. It was interesting to note that none of the scores in the *neither* lecture option group were outliers, and no scores were extremely high.

To test this assumption further, a quantile-quantile (QQ) plot was created to visually represent data distribution by lecture type. In the figure below, the y-axis represents the OSE data from the sample population, and the x-axis represents the theoretical distribution. To interpret the QQ plots, the researcher examined whether the OSE data aligned with the theoretical line, indicating a normal distribution, and that the assumption was met (Jiang et al., 2024). However, significant variations might indicate problems within the data, such as Type I and Type II errors, or the data being a poor fit for the research model. Figure 3 is the Q-Q plot for lecture type and OSE score, with possible outliers indicated.

Figure 3
QQ Plot for Lecture Type and Online Student Engagement



Note. Frequency scores for lecture format and online student engagement variable data within the shaded area are within the 95% confidence interval ($p > 0.05$) and are considered normal. Possible outliers noted.

Each lecture type had two outliers indicated. The live lectures category shows one low outlier (Participant 68, score 1.578947368) and one abnormally high outlier (Participant 156, score 5). The recorded lectures category shows two low outliers. Participant 22 had a very low score of 1.578947368, and Participant 25 had a score of 3.421052632. In the non-lecture option group, Participant 77 had a low score of 2.105263158, while Participant 93 had a high score of 4.157894737. Because the outliers likely reflect expected variation in the student experience rather than recording or measurement errors, they remained in the results.

Anderson-Darling Normality Test Results

ANOVA statistics also assume a normal distribution (Alverson, 2022; Yu et al., 2021). The Anderson-Darling normality test was used to determine if the data differed from normality. The A-value represents the difference between the observed data and the expected distribution, and the p-value represents the probability that the observed data is normally distributed (Liang & Ahad, 2020). A p-value less than 0.05 indicates that the data are likely not normally distributed (Liang & Ahad, 2020). Table 3 below includes the results for the Anderson-Darling normality test. The test was performed for each lecture type (live, recorded, and neither).

Table 3
Anderson-Darling Normality Test

Normality Test		
	<i>A</i>	<i>p-value</i>

Anderson-Darling		
Live Lectures	0.40	0.35
Recorded Lectures	0.19	0.89
Neither	0.14	0.96

Note. The Anderson-Darling normality test indicated normality across all groups. The results for all three groups are greater than 0.05. Therefore, the normality assumption was met.

Levene's Test for Homogeneity

To test the final ANOVA assumption, Levene's test for homogeneity of mean variance was performed. The test results were insignificant, indicating that participants across the different lecture groups answered roughly the same (Gaciu, 2021). The homogeneity of variance test yielded $F(2, 160) = 0.3302$, $p = 0.7192$. Since the p-value is greater than 0.05, the assumption is met (Gaciu, 2021).

Results

The one-way ANOVA was significant, $F(2, 160) = 3.277$, $p = 0.0403^*$. This result indicates a statistically significant difference among the three groups because the F-statistic is moderate and the p-value is below the 0.05 threshold (Gaciu, 2021). Therefore, the results indicate student engagement differs in at least one lecture type.

Although the results are statistically significant, the effect size is also important. The effect size measures the extent of the difference between the lecture groups. The effect size is 0.04, which is considered very small (Gaciu, 2021). Although the results are statistically significant, the effect size suggests they may not be strong enough to have a practical impact on student engagement.

Post-Hoc Analysis

Table 4 shows the post-hoc analysis using Tukey contrasts. Because the ANOVA test yielded a statistically significant result, a post-hoc test helped determine which groups differed (Nanda et al., 2021). The difference between live lectures and the *neither* group was significant, but there was no statistically significant difference between recorded-*neither* and live-recorded. Table 4 below outlines these results. The results of the post-hoc test support the ANOVA findings, as it showed a statistically significant difference between live lectures and *neither*.

Table 4

Post-Hoc Analysis of Lecture Type and Online Student Engagement

	Estimate	Std. Error	T-Value	Pr(> t)
Live – Neither	0.5708	0.2327	2.453	0.0375
Recorded – Neither	0.3705	0.2179	1.701	0.1986
Live - Recorded	-0.2003	0.1240	-1.615	0.2319

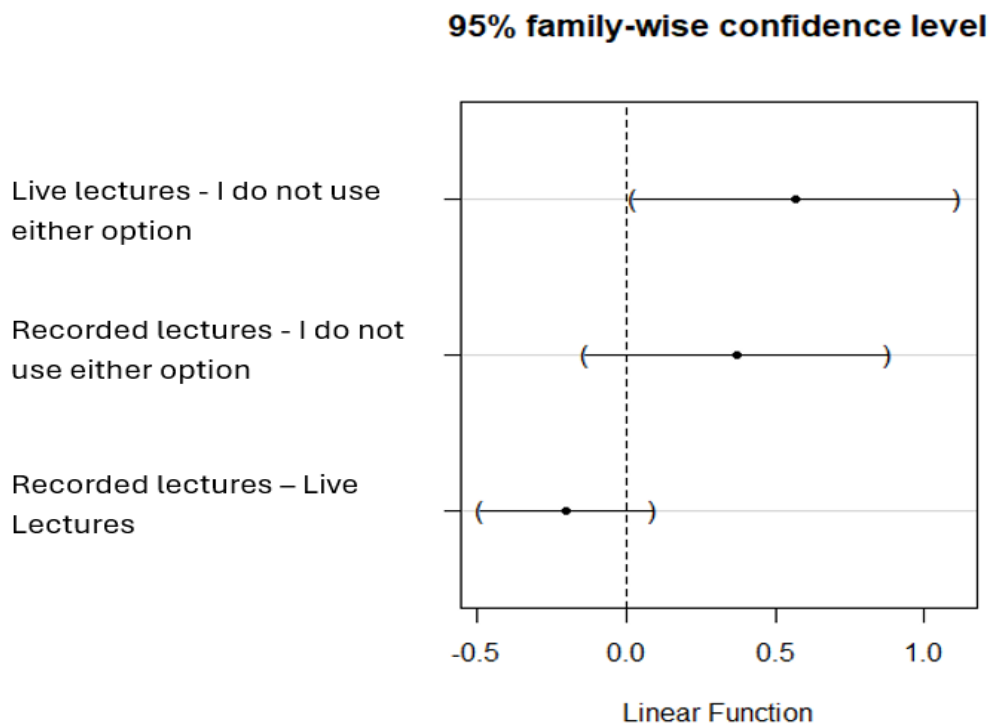
Note. The comparison between live lectures and *neither* was significant.

95% Family-Wise Confidence

Figure 4 below represents the family-wise confidence by groups. The groupings that did not touch the dotted line at the 0.0 linear function are considered statistically significant. Those that intersected with the dotted line were not significant. As with the Tukey contrasts, the groupings for the live lectures and *neither* lecture option were significant.

Figure 4

Linear Function of Family-Wise Groups



Note. The grouping of live lectures and *neither* lecture option was significant.

When deciding to reject or retain the null hypothesis, the combination of the statistically significant test results, small effect size, and family-wise confidence level was considered. The p-value of the ANOVA test and post-hoc test indicates that the results were unlikely to happen by chance; therefore, the null hypothesis is rejected. However, the small effect size and family-wise confidence rates suggest that the results may only have a minimal effect in a real-world setting. In a classroom setting, for example, students may not feel more engaged despite the statistical advantage. Therefore, while the live lecture group had a statistical advantage over no lectures in student engagement rates, the magnitude may not be large enough for instructors to observe these effects in the classroom.

Summary of Findings and Conclusion

Despite the statistically significant results and the rejection of the null hypothesis, these findings may not have practical implications in authentic classroom settings. Students in the live lecture group reported higher engagement than those in the recorded lecture or no lecture groups. However, the difference was only statistically significant between the live lecture group and the no-lecture option group. Furthermore, the effect size was small, and the difference may not be strong enough to affect engagement rates in an online classroom. Therefore, students may not perceive greater engagement in a course with live lectures than in one without lecture options.

The literature helps explain this small effect size. Behavioral engagement centers on students' actions that contribute to their success, such as completing assignments and developing strong study habits (Jones, 2022; Pan, 2023). While behavioral engagement underpins more complex aspects of engagement, attendance and task completion do not necessarily require cognitive or emotional engagement (Pan, 2023). Participation in a live lecture alone may not be enough to promote engagement. Students may be physically present during the live lecture but still fail to ask questions or interact with their peers. Recorded lectures, which did not yield significant results, may also not be enough to fully engage students. Students may watch recordings without taking the necessary steps to engage, such as taking notes and reflecting.

Interaction is necessary for engagement; however, students and instructors may not have taken the steps to connect during a live lecture. Instructors do not always find building relationships with students through live lectures as natural as in-person interactions (Yarmand et al., 2021). Even when using webcams and telling personal stories, instructors feel they are speaking into a void. Study participants may also have felt uncomfortable during their live lectures. For example, participants may have been too embarrassed to join online discussions for fear of making mistakes. Instructors may have used breakout groups to promote student interaction (Harris et al., 2021), but students may have felt more comfortable remaining anonymous (Yarmand et al., 2021).

Students' experiences in their courses were likely varied. Participants attended various institutions, were taught by different instructors, and may have experienced different standards for live lectures across courses. For example, some institutions may have had different lecture frequencies or used different instructional techniques. According to Doherty (2022), students are more engaged when they can see the instructor's face, and Jiang and Koo (2020) indicate that students benefit from immediate feedback during question-and-answer sessions. However, the researcher did not know whether these specific tactics were used in the lectures the participants attended. This variance in instructional practices may explain the outliers. Within the live lecture group, one participant scored lower than the others, which may be attributable to the instructor's instructional practices.

The insignificant results within the recorded lecture group may be due to student preference and lecture components. Students attend online universities, in part for convenience, and they may not have wanted to attend a live lecture at a designated time (Jiang & Koo, 2020). Recorded lectures offer the flexibility students expect in their online courses (Al-Qudah, 2024). Therefore, when courses require students to attend live sessions, they may not engage because the time is

inconvenient or the live format is not their preferred learning method. Students may also be frustrated by the lack of accessibility in live lectures. Recorded lectures are accessible with transcripts and closed captions and allow for self-pacing (Al-Qudah, 2024; Angrave et al., 2020). Compared to courses with no lecture options, the components of a recorded lecture may have been too similar to video content in an asynchronous course to yield a statistically significant result. Asynchronous courses may have presented course content through videos created in advance by the institution, the textbook publisher, or the instructor for students to watch at their own pace. Therefore, instructional videos might have been too similar to recorded lectures to yield significant differences.

Limitations

The study's limitations included possible sampling errors. Despite the purposive sampling technique, participants may not have accurately reflected the entire student population. An ANOVA test compares three or more groups to determine if there is a statistically significant difference (Alverson, 2022; Yu et al., 2021). Ideally, the number of participants within each group will be roughly equal. However, in authentic settings, obtaining equal groups may be challenging to obtain. These imbalances can bias the results (Abulela & Harwell, 2020).

Additionally, the sample population may have affected the results. Because the sample population was drawn from across the United States, participants may have been disproportionately represented from a specific region, demographic category, or type of educational institution or subject matter. For example, if a large percentage of the sample population were enrolled in math courses, the data might be skewed and less transferable to a larger population. Furthermore, all study participants were undergraduate students in the United States. Therefore, the results may not be transferred to master's-level courses or international institutions.

Institutional differences may also have affected the results. Participants were likely enrolled in different educational institutions, and requirements for live and recorded lectures may have varied by institution. For example, some institutions may have required web cameras and breakout sessions for live lectures, while others were teacher centered. The study design and OSE did not account for these variations in the student experience, only the lecture format. These differences may have affected students' survey responses and how the results were interpreted.

The study relied on self-reported data based on the survey instrument. Participants may not have answered honestly. For example, they may have recorded very high or very low responses, which can skew the data. A final potential limitation is related to the nature of engagement itself. While students may have maintained good attendance during a live lecture or a recording, they may not have given the lesson their undivided attention. The literature documents differences between behavioral and cognitive engagement (Gorgun et al., 2022; Kew & Tasir, 2021).

Recommendations

Recommendations for Future Research

The rapid pace of educational change and its effects on student engagement warrant further research. Additional research will provide valuable insights into online students' needs, the nuances of online lectures, and best practices for instruction. Future research should build on this study's findings on lecture formats and online student engagement. Because the study results indicated that live lectures were the most effective, with a small effect size, future researchers could examine which components would increase the effect size. For example, a future quantitative, experimental study could compare student engagement rates between students assigned to live lectures without engaging elements and students assigned to live lectures with engaging elements. An experimental design would allow the researcher to exert greater control over the lecture components by standardizing students' experiences within their assigned lecture groups.

Future opportunities for qualitative research should not be overlooked. Qualitative research explains the reasons behind the phenomenon and captures nuances of students' experiences that quantitative data alone cannot (Busetto et al., 2020). A qualitative approach to exploring students' preferences in live lectures will help clarify their needs in online courses. For example, a researcher may seek to understand if students value flexibility over engagement, their discussion preferences, and the challenges they face surrounding live lectures.

Recommendations for Practice

Flexible Live Lecture Scheduling

Because the study results indicated that live lectures were the most effective format for promoting online student engagement, universities are advised to implement them when feasible. However, universities should also consider students' schedules and responsibilities outside the classroom. One common reason for attending online universities is the flexibility to complete coursework at a time and location convenient to the student (Jiang & Koo, 2020). Additionally, some students may prioritize flexibility over engagement (Suen & Hung, 2025). Therefore, requiring students to attend lectures at inconvenient times will not promote engagement and may result in students being physically present without interacting or watching the recordings.

When scheduling live lectures, instructors should consider student preferences. For example, if many students enrolled in the course have full-time office jobs, a midday weekday lecture would be suboptimal. Additionally, instructors should consider students' time zones. An 8:00 pm lecture in one time zone may result in an 11:00 pm session for another. To identify preferred days and times for live meetings, instructors should run a poll to find the time that works best for most students.

Communicate the Purpose of Live Lectures

Because students may not recognize the potential for engagement in live lectures, they may opt to watch the recording rather than attend. For example, in their study, Hollister et al. (2020) reported that a third of surveyed students were consistently absent from live lectures and that 12% preferred to watch recordings. This study reported similar results on lecture formats and student engagement. Most study participants (approximately 67%) watched lecture recordings. Furthermore, students approach recorded lectures differently from live lectures and view them more as a resource than as an opportunity to get to know their peers and instructors (Nkomo & Daniel, 2021).

To prioritize attending and actively participating in live lectures, students must understand the value and purpose of the learning activities. If students see live lectures as merely supplementary to the course materials and believe they have no opportunity to ask questions or connect, they will be less likely to make the extra effort to attend. Therefore, universities should promote the value of live lectures and encourage students to attend. For example, universities and instructors can tell students what to expect during live lectures. Instructors can share the topics they will cover and opportunities for engagement, such as peer reviews, brainstorming sessions, and question-and-answer sessions. When students know the purpose and benefits of live lectures, they may be more likely to reschedule personal activities and attend with enthusiasm.

Implement Engagement Tools with Live Lectures

Because students in the live lecture group were the most engaged, universities and instructors should optimize live lectures with tools that enhance interactivity. Design lessons and activities in advance to connect students with peers, course resources, and content. A flipped classroom model, for example, can promote cognitive engagement (Barlow & Brown, 2020; Kavaz & Kocak, 2024). Group work can also encourage cognitive engagement. Collaborative activities, such as breakout groups, can promote critical thinking and encourage student connection (Barlow & Brown, 2020; Kavaz & Kocak, 2024). Engagement increases when an interactive lecture requires students to be more than passive recipients of information.

Alongside increasing collaboration and critical thinking, instructors should also make a conscious effort to reduce student hesitancy to participate. Students look to instructors as classroom leaders; therefore, instructors should maintain an online presence. Students respond more strongly when they see their instructors as people. Therefore, instructors should utilize their webcams and allow students to see their personalities (Doherty, 2022). Furthermore, instructors should create emotionally supportive learning environments. When students feel safe and valued, they are more likely to participate in discussions and take risks in their learning (Havik & Westergård, 2020; Jiang & Koo, 2020).

Concluding Remarks

This study on lecture formats and online student engagement shows both the value of live lectures and the complexity of student engagement. The problem examined was low student engagement in online courses (Martin & Borup, 2022), which affects students' motivation and academic performance (Rioch & Tharp, 2022). To address the issue, the researcher aimed to determine whether the lecture format affected online student engagement rates. Using a

quantitative, causal-comparative research design, the results indicated that courses with live lectures were statistically more engaging than those without any lecture option. Therefore, online educators should implement live lectures to increase engagement. However, the small effect size complicates the results, suggesting the increase in engagement may not be observable. To increase engagement, instructors will need to do more than implement live lectures alone. Variables within the lectures themselves likely have a greater effect, such as activities that promote active learning.

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