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Exodus From the Classroom: Student Perceptions, Lecture Capture Technology, and the Inception of On-Demand Preclinical Medical Education

Uzoma Ikonne, PhD; Anna M. Campbell, PhD; Kate E. Whelihan, MPH, CPH; Ralph C. Bay, PhD; Joy H. Lewis, DO, PhD

From the Departments of Basic Medical Science (Dr Ikonne), Anatomy (Dr Campbell), and Public Health (Ms Whelihan and Dr Lewis) at the A.T. Still University (ATSU) School of Osteopathic Medicine in Mesa, Arizona, and the Department of Interdisciplinary Sciences at the Arizona School of Health Sciences at ATSU in Mesa (Dr Bay).

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Address correspondence to Uzoma Ikonne, PhD, ATSU School of Osteopathic Medicine in Arizona, 5850 E Still Circle, Mesa, AZ 85206-6318.

Email: uikonne@atsu.edu

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Context: Some medical educators have noted a decline in classroom attendance. Understanding student preferences for content delivery and the relationship between student attendance and learning outcomes may enhance curricular design and best practices for technology-supported learning.

Objective: To measure the attendance of first-year osteopathic medical students, evaluate the relationship between classroom attendance and aggregate mean course grades, and characterize factors that influence attendance decisions when recorded lectures are available.

Methods: In nonmandatory class sessions during the 2015-2016 academic year, student attendance data were collected using audience response technology and were linked to course grades. Pearson product moment and partial correlations, controlling for Medical College Admissions Test scores, were calculated to quantify the relationship between classroom attendance and aggregate mean course grades. Students were surveyed to characterize factors influencing attendance decisions and compare the perceived convenience, efficiency, and effectiveness of classroom attendance vs lecture capture technology. The preferred modality for receiving didactic content was assessed, and open-ended questions were included about the advantages or disadvantages of lecture capture, classroom attendance, and podcasts. Responses were analyzed using open and axial coding.

Results: A 78% reduction in first-year student classroom attendance was measured from the beginning to the end of the academic year ($P<.001$). The correlation between classroom attendance and aggregate mean course grades ($r=0.17$; $P=.29$) and the partial correlation between them after controlling for admission test scores ($r=0.18$; $P=.08$) were not significant, except in the Neuromusculoskeletal A course ($r=0.22$; $P=.027$). Students regarded lecture capture recordings as more convenient, efficient, and effective than classroom attendance, and podcasting was the preferred method of content delivery. Major themes associated with the open-ended questions were effective or ineffective time management, enhanced interaction, learning advantages or challenges, and positive or negative content characteristics.

Conclusion: First-year classroom attendance decreased significantly during the academic year, but the authors found no significant relationship between attendance and aggregate mean course grades. Students regarded lecture capture recordings as a practical alternative to attending class; however, podcasts were the preferred modality for receiving didactic content. These findings may help in developing learning-centered curricula at colleges of osteopathic medicine.

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A 2014 study¹ suggested that attendance in medical school classrooms has been decreasing. Results are mixed about the relationship between student attendance and academic performance in undergraduate medical education.²⁻⁶ Most studies investigating this relationship have analyzed a single course or a few courses in a discipline-based curriculum or within clinical rotations.^{5,7,8} Studies that investigate the relationship between availability of recorded lectures and student attendance have also had mixed results. Some investigators^{7,9-11} have found that the availability of recorded lectures does not significantly change classroom attendance, but others^{5,12-15} report that attendance is reduced, to varying degrees.

Lecture capture technology has been widely incorporated into classrooms at institutions of higher education.¹⁶ This technology records live audio and visual aspects of classroom content, including the presenter and material projected on classroom screens. The use of lecture capture technology at undergraduate medical institutions is a valuable resource that allows students to view missed class sessions or review classroom content. Numerous studies report that students consider lecture recordings a valuable tool for learning.^{7,12,17,18} However, there is no consensus regarding student use of lecture capture technology and academic outcomes. Studies investigating this relationship report mixed results.^{5,7,15,17,19,20}

The first-year curriculum at A.T. Still University School of Osteopathic Medicine in Arizona (ATSU-SOMA) is organized into integrated systems-based courses that are primarily lecture based. By using lecture capture technology, these courses can be recorded and the content made available to students approximately 4 hours after class. The initial intent of incorporating lecture capture technology at ATSU-SOMA was to enable students to review classroom content or view missed content in cases of illness or family emergency. However, attendance for most lecture courses for first-year students is not mandatory, and faculty anecdotally noted that an increasing

number of students did not attend courses as the academic year progressed and became increasingly concerned about the effect of classroom attendance on academic performance. This issue is particularly important at ATSU-SOMA because second-year students are located at community health centers and receive most didactic course content through podcasts. Thus, faculty wanted to understand student preferences for content delivery and the relationship between classroom attendance and academic performance.

The decreasing classroom attendance of students in first-year courses at ATSU-SOMA and the mixed reports in the literature about the impact of student attendance on academic performance²⁻⁴ encouraged us to evaluate this relationship at ATSU-SOMA. To our knowledge, no osteopathic medical institution has evaluated the influence of lecture capture technology on student attendance behavior or the relationship between classroom attendance and academic performance during an academic year. Therefore, the objective of the current study was to measure the classroom attendance of first-year students, evaluate the relationship between attendance and academic performance, and characterize factors that influence attendance decisions when recorded lectures are available. Because recorded versions of lectures were available to students, we hypothesized no significant relationship between class attendance and academic performance. Furthermore, to optimize future content delivery, we surveyed student attendance decisions, perceptions, and preferences regarding delivery modality. We hypothesized that students would consider lecture capture recordings preferable to classroom attendance.

Methods

Participants

The current study was conducted from July 2015 through June 2016 (2015-2016 academic year). During orientation, first-year osteopathic medical students from the class of 2019 were recruited to participate on a

voluntary basis. Students were told that their participation would help evaluate the use of lecture capture technology. They were informed that attendance records would be created, academic records would be assessed, and investigators would be blinded to identifying information. The A.T. Still University-Mesa Institutional Review Board approved the study, and participants signed informed consent forms.

Attendance and Academic Tracking

Attendance was tracked for all nonmandatory class sessions in 9 systems-based, first-year courses (Basic Structural Foundations, Foundations of Health, Neuromusculoskeletal A and B, Cardiopulmonary I and II, Renal-Endocrine-Metabolism I and II, and Gastrointestinal) for 44 weeks. Data from osteopathic manipulative medicine classes and laboratories were not included, because attendance in these sessions was mandatory. The university issued audience response technology TurningPoint clickers (Turning Technologies) to students during orientation. At the beginning of each class session, students participating in the study used their clickers to indicate attendance. A student worker was also stationed in each classroom to remind students to click in. These clickers have a unique identifier for each user, enabling attendance tracking for individual students. Course grades were obtained and coded by a data informatics specialist with Family Education Rights and Privacy Act authorization and were linked to attendance data for each student.

Survey Instrument Design

Two electronic surveys created specifically for the current study were administered to first-year students, who were given 2 weeks to complete them. Demographic information was collected in a fall survey that requested information about age, sex, race/ethnicity, marital status, and highest degree attained. A second survey assessing factors that influence attendance decisions was administered to students at the end of the spring semester. The spring survey

included quantitative and qualitative (open-ended response) questions to characterize how students used lecture capture technology and to determine the perceived importance of factors influencing attendance decisions. Podcasts are occasionally used to deliver content during the first year, so students were also asked to rank lecture capture, classroom attendance, and podcasts as their preferred modality for receiving didactic information. The 6 open-ended survey questions asked students to report the advantages and disadvantages of these 3 learning modalities. The face and content validity of the survey were established using an expert panel of ATSU-SOMA faculty.

Data Analysis

Personal identifying information for first-year student attendance records, academic records, and survey responses was coded by a data informatics specialist. Frequencies and percentages were used to summarize demographic characteristics, factors that influenced attendance decisions, and student perceptions. Pearson product moment correlations were calculated to quantify the strength of the linear relationship between class attendance and aggregate mean course grades. These analyses were conducted for the mean attendance vs the aggregate mean course grade across the academic year and were then repeated for individual courses. For the partial correlations, the effect of the Medical College Admissions Test score, a proxy for student aptitude, was removed from the relationship (controlled for) to yield a more precise estimate of the linear relationship between attendance and grade without the potentially confounding influence of student aptitude. Independent-samples *t* tests were used to determine whether mean attendance or mean grade differed by student sex.

A generalized linear mixed model with random effects for participants was used to evaluate change in attendance over time. Quantitative data were analyzed using SPSS software, version 24 (IBM Corporation). Differences were considered statistically significant at $P < .05$. Qualitative survey data (open-ended questions)

were analyzed using open and axial coding to categorize student responses.²¹ The coding process began with individual investigators independently annotating the open responses and identifying themes and subthemes that emerged from the data. Investigators then individually reviewed each data set and made suggestions for recoding some comments and organizing the themes and subthemes. Investigators met collectively to discuss comments and define themes and subthemes. Thematic tables were finalized when consensus was reached. Student comments and thematic tables were reviewed by the entire research team.

Results

Participants

Of the 108 first-year osteopathic medical students in the class of 2019, a total of 104 agreed to participate in the study. One student left the academic program before administration of the fall survey, and 94 of 103 students (91%) receiving the survey completed the demographic information. Three students who did not complete the academic year were removed from attendance and correlation analyses for a total of 100 students in these analyses. Demographic characteristics are summarized in **Table 1**. Neither mean classroom attendance ($P=.69$) nor mean grade ($P=.26$) differed by student sex (data not shown).

Classroom Attendance and Course Grade

The mean percentage of student classroom attendance declined significantly during the academic year, decreasing by 78% from the first course of the academic year, Basic Structural Foundations, to the last course of the year, the Gastrointestinal course ($P<.001$) (**Figure 1A**). A logarithmic function accounted for 97% of the variance.

The correlation between student attendance and mean aggregate course grade ($r=0.17$; $P=.29$) (**Figure 1B**) and the partial correlation between them after controlling for Medical College Admissions Test score ($r=0.18$; $P=.08$) were not significant. When

Table 1.
Demographic Characteristics of the First-Year Osteopathic Medical Students From the Class of 2019 (n=94)

Characteristic	No. (%)
Age, y	
20-25	59 (62.7)
26-30	26 (27.7)
>30	8 (8.5)
No response	1 (1.1)
Sex	
Male	47 (50.0)
Female	46 (48.9)
No response	1 (1.1)
Race/Ethnicity	
Asian	37 (39.4)
Black	2 (2.0)
Hispanic	3 (3.2)
White	37 (39.4)
Other	6 (6.4)
>1 Selected	6 (6.4)
No response	3 (3.2)
Marital Status	
Single	75 (79.7)
Married	16 (17.0)
Widowed	0
Divorced	1 (1.1)
Separated	0
No response	2 (2.1)
Highest Degree Attained	
BA	21 (22.3)
BS	57 (60.6)
MS	15 (16.0)
PhD	0
Other	1 (1.1)
No response	0

these analyses were repeated for individual courses, the correlation between attendance and grade was significant only for the Neuromusculoskeletal A course

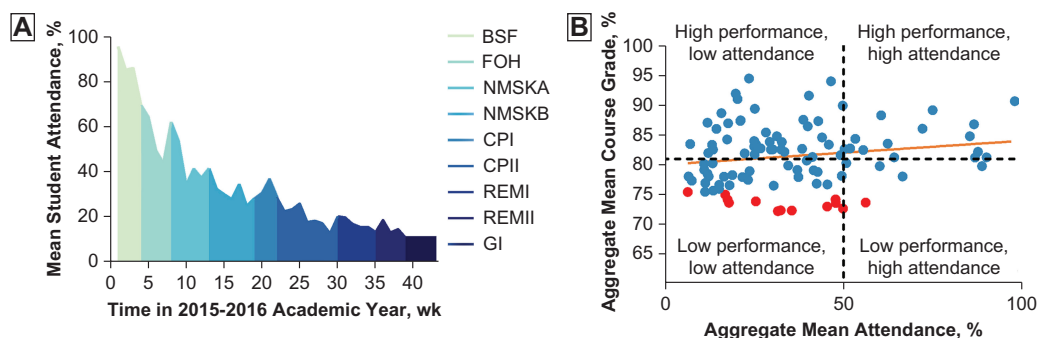


Figure 1.

Classroom attendance of first-year osteopathic medical students ($n=100$). (A) Mean percentage of student classroom attendance in nonmandatory, systems-based classes. (B) Relationship between class attendance and academic performance. The mean class attendance decreased significantly during the 44-week academic year ($P<.001$). Each dot in the scatterplot represents the individual student's mean aggregate course grade vs the mean aggregate class attendance. A line of best fit (orange line) was calculated using linear regression (Pearson $r=0.17$). Black dashed lines represent the mean course grade for all students (horizontal line) and 50% attendance (vertical line). Red dots represent students considered at risk because their mean course grade was 75% or lower. *Abbreviations:* BSF, Basic Structural Foundations; CPI and CPII, Cardiopulmonary I and II; FOH, Foundations of Health; GI, Gastrointestinal; NMSKA and NMSKB, Neuromusculoskeletal A and B; REMI and REMII, Renal-Endocrine-Metabolism I and II.

($r=0.22$; $P=.027$; data not shown). Partial correlations revealed the same pattern, with the relationship between attendance and grade significant only for the Neuromusculoskeletal A course.

Figure 1B shows a scatterplot of student mean aggregate classroom attendance and mean aggregate course grades. Each dot represents an individual student's mean aggregate attendance vs that student's mean aggregate course grade. Students were considered "at risk" if they had a mean aggregate course grade of 75% or lower in the systems-based courses (shown in red on the scatterplot). Of 13 students considered at risk, 11 were in the low-performance, low-attendance quadrant of the scatterplot, and only 2 were in the low-performance, high-attendance quadrant.

Factors Influencing Classroom Attendance Decisions and Student Perceptions

Three students withdrew from the program before the spring survey. Eighty-nine of 101 students (88%) responded to the spring survey. For the question asking students to select the level of influence (no, mild, moderate, or extreme) for factors influencing

their decision to attend class, the top 5 factors with an extreme influence on the decision to attend class were as follows: faculty presenting (selected by 36 of 89 respondents [40%]), ability to control the speed of the lecture (31 [35%]), material presented will be on the next examination (19 [21%]), discipline (17 [19%]), and interactive sessions (13 [15%]) (**Figure 2A**). The top 5 factors with an extreme influence on the decision to not attend class were the ability to control the speed of the lecture (44 of 89 respondents [49%]), faculty presenting (34 [38%]), discipline (15 [17%]), preparation for the podcast format of the second year (13 [15%]), and material presented will be on the next examination (9 [10%]) (**Figure 2B**).

When asked to compare the convenience, efficiency, and effectiveness between classroom attendance and lecture capture, students indicated that lecture capture was more convenient (67 of 89 respondents [75%]), efficient (66 [74%]), and effective (42 [47%]) (**Figure 3A**). When ranking lecture capture, class attendance, and podcasts for preferred modality, the majority of students (58 of 87 [67%]) selected podcasts as their primary choice (**Figure 3B**).

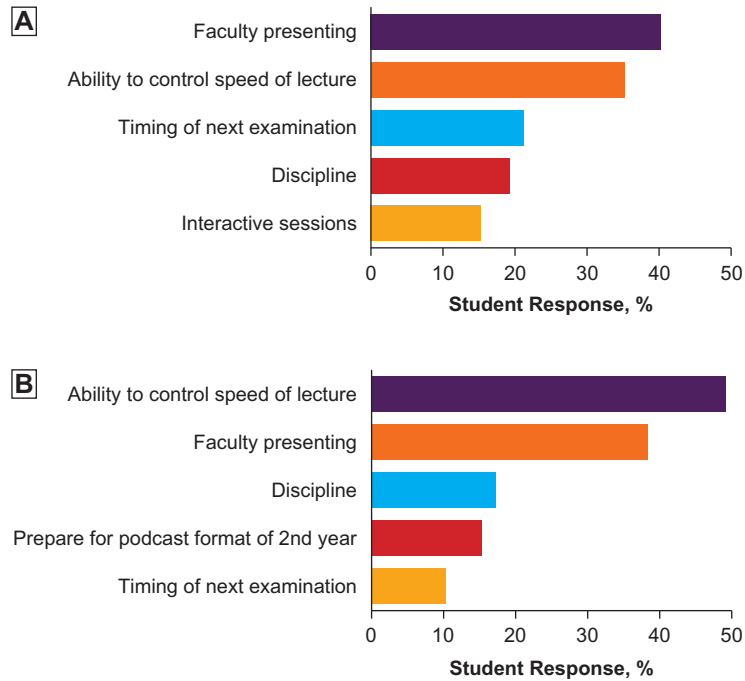


Figure 2. Factors influencing attendance decisions of first-year osteopathic medical students (n=89). (A) Factors that had an extreme influence on students' decision to attend class. (B) Factors that had an extreme influence on students' decision to *not* attend class.

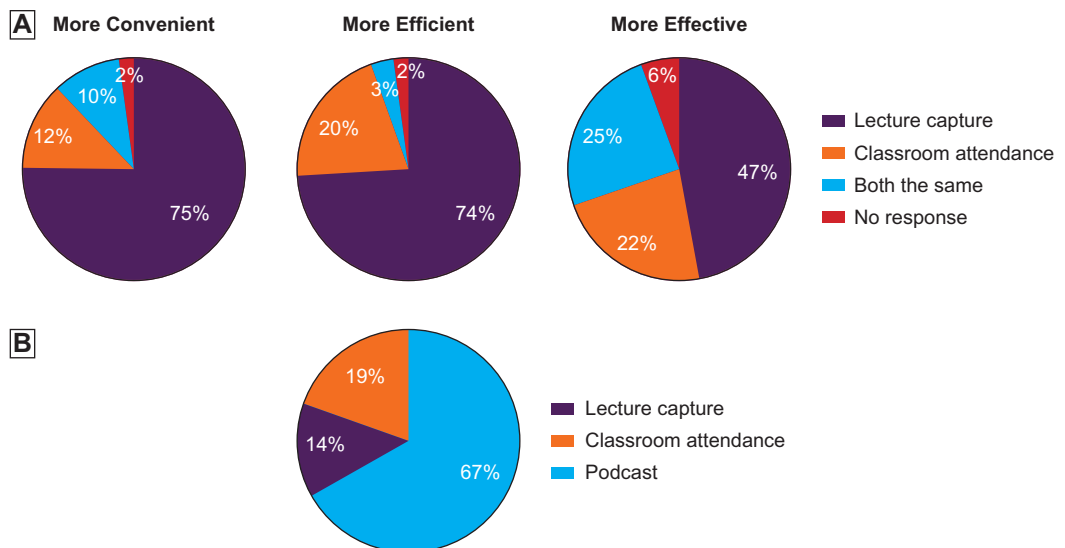


Figure 3. Student perceptions and preferences concerning content delivery modalities (n=89); percentages represent proportion of student responses. (A) Comparisons of the convenience, efficiency, and effectiveness of classroom attendance vs lecture capture. (B) Students' top-ranked modality for receiving didactic information (lecture capture, class attendance, or podcast).

Open-Ended Questions

Student responses to the open-ended survey questions are summarized in [Table 2](#). Seven themes were identified: ineffective or effective time management, enhanced interaction, learning advantages or learning challenges, and positive or negative content characteristics.

For time management themes, subthemes referring to adjusting content speed were most common. “Can’t control content speed” was a disadvantage of class attendance mentioned in 37 comments ([Table 2](#)). “Can control content speed” was an advantage for lecture capture (63 comments) and podcasts (36 comments). Subthemes related to efficiency and schedule also appeared under time management themes. A few students mentioned “more efficient” (3 comments) and “organized schedule” (2 comments) as advantages of class attendance; more students mentioned “restrictive schedule” (13 comments), “increased time commitment” (17 comments), and “inefficient use of time” (18 comments) as disadvantages of class attendance. For lecture capture and podcasts, “flexibility of schedule” (38 and 22 comments, respectively) and “viewing location” (5 and 3 comments, respectively) were considered advantages, but these formats also had the disadvantage of the “potential to fall behind” (10 and 5 comments, respectively). One issue of time management specific to lecture capture was “delayed content access” (18 comments).

For learning themes, some subthemes were related to asking questions. The ability to “ask questions immediately” (47 comments) was an advantage of attending class ([Table 2](#)). A “delay in asking questions” was a disadvantage of lecture capture (6 comments) and podcasts (14 comments). Other advantages of class attendance were “interactions with peers and faculty” (28 comments). Disadvantages of class attendance specific to the learning challenges theme were “difficulty processing live content” (20 comments), “less effective learning” (13 comments), “fatigue” (7 comments), “difficulty taking notes” (6 comments), “difficulty keeping focus” (5 comments), “difficulty paying attention” (4 comments), and “boredom” (3 comments).

Several comments mentioned technology as a disadvantage of lecture capture; “technical difficulties” (38 comments) and “technical limitations” (8 comments) were the most common phrases ([Table 2](#)). Other disadvantages noted were “poor audio/microphone issues,” “poor quality recording,” and “lack of faculty cooperation.”

Discussion

In the current study, the class attendance of first-year osteopathic medical students significantly declined during the academic year. Our finding of a 78% decrease in student attendance was a larger change than reported in previous studies.^{7,12,22} Student attendance in other studies may have been influenced by attendance incentives, such as pop quizzes.⁵ Other studies also used varied methods for collecting attendance data, such as self-reporting, instead of audience response technology, and some were conducted at institutions where recorded lectures were not available.^{7,8,22} These variables may explain the larger decrease in attendance at ATSU-SOMA compared with other institutions. Second-year students at ATSU-SOMA receive most of their didactic material online through podcasts, and the ability to “prepare for podcast format of second year” was a top factor in the decision to not attend class.

The mean attendance of our first-year students during the academic year was not significantly correlated with mean aggregate course grades. Furthermore, there were no statistically significant correlations between attendance and academic outcomes for individual courses, except for the Neuromusculoskeletal A course. This observation in that particular course supports other study findings indicating a positive relationship between attendance and performance within a given medical school course.^{5,6} Five students in the current study with low attendance had course grades above 90%, suggesting that nonattendance was not a detriment to academic excellence for them. Although the subgroup is too small for meaningful analysis, this result was supported by previous studies.^{4,23} Most of the at-risk students in the current study were poor

Table 2.
Summary of Student Responses to the Prompt “What are the advantages/disadvantages of classroom attendance, lecture capture, and video podcasts?”

Modality	Disadvantages/Challenges (No. of Responses)	Advantages (No. of Responses)
Classroom Attendance		
Time management	Can't control content speed (37) Inefficient use of time (18) Increased time commitment (17) Restrictive schedule (13)	Prevents falling behind (18) More efficient (3) Organized schedule (2)
Learning	Difficulty processing live content (20) Less effective learning (13) Fatigue/boredom (10) Difficulty keeping focus (9) Difficulty taking notes (6)	Ability to ask questions immediately (47) Interaction with peers and faculty (28) Increased focus (8) More effective learning (7) Enhanced engagement (2)
Total No. of responses	143	115
Lecture Capture		
Time management	Delayed content access (18) Potential to fall behind (10) No set schedule (3)	Can control content speed (63) Flexible schedule (38) More efficient (21) Flexible viewing location (5)
Learning	Lack of interaction (13) Delay in asking questions (6) Missed in-class activities (2)	Multiple views of content (22) Pause to look at resources (16) Independent learning (6) Easier note taking (4)
Technology	Technical difficulties (38) Technical limitations (8) Poor audio/microphone issues (8) Poor-quality recording (5) Lack of faculty cooperation (2)	NA
Total No. of responses	113	175
Podcasts		
Time management	Potential to fall behind (5) No set schedule (2) Hard to locate files (1) Sometimes can't control speed (1)	Can control content speed (36) Flexible schedule (22) Earlier availability (10) Flexible viewing location (3)
Learning	Delay in asking questions (14) Lack of interaction (13)	Same as lecture capture (12) More effective learning (7) Multiple views of content (3)
Content characteristics	Dense content (5) No live activities (2) Extra interactions (1) Not always concise (1)	More concise (18) More organized (9) More focused (6) Interactive features (3)
Total No. of responses	45	129

performers with low attendance. It is unknown whether an attendance intervention would enhance course grades for at-risk students.

The leading factor that influenced first-year students in the current study to attend class was the faculty member presenting the lecture. This finding supported

those in previous studies suggesting that the lecturer can have a positive or negative influence on student decisions to attend class.^{22,24} It is possible that including additional active learning in the classroom would improve student attendance.

The factor that influenced the most students in the current study to not attend class was the ability to control the speed of the lecture. This factor was also selected as having an extreme influence on the decision to attend class. Results from the open-ended questions supported the importance of this factor. Many written comments referred to the advantages of being able to speed up, slow down, or pause lecture capture recordings or podcasts to look up information or study a concept more thoroughly before moving on. Classroom content recorded by lecture capture at ATSU-SOMA can be viewed at up to twice the normal speed or slowed to half speed.

The ability to control pace and viewing schedule is probably related to the student perception that use of lecture capture technology was more convenient, efficient, and effective (to a lesser degree) than classroom attendance. Paradoxically, when students ranked modalities for receiving didactic information by preference, lecture capture was the least preferred modality, podcasts were the most preferred, and class attendance was in the middle. During the first year at ATSU-SOMA, students are exposed to podcasts with increasing frequency as part of a flipped classroom or as the primary mode of content delivery for some lectures.

Qualitative analysis of the open-ended questions suggested that, although lecture capture and podcasts share many advantages (eg, ability to control speed and schedule), the delay in posting content and technology issues probably explains why students preferred podcasts to lecture capture. Removing the delay in posting lecture capture content and addressing technical limitations may optimize this modality. Although students mentioned some benefits of attending class (eg, peer-faculty interaction and the ability to ask questions), the perceived disadvantages of class

attendance and perceived advantages of lecture capture and podcasts seemed to drive student attendance behavior. Because ATSU-SOMA students receive the majority of their didactic material as podcasts in the second year, by the spring survey, first-year students were preparing to move to their community campus and contextual learning environments, and this anticipated change may have influenced their expressed preferences.

In a separate study conducted at ATSU-SOMA,²⁵ students reported that they preferred exposure to a variety of learning formats rather than only a single pedagogical approach in the classroom. That result and those of our current study suggest that the optimal design for curricular content delivery may include a variety of formats and methods.

Some consequences of student nonattendance during medical education may not have been measured in the current study, such as negative effects on the development of professional identity.^{26,27} At ATSU-SOMA, the statistically significant decrease in attendance created challenges for faculty. With fewer students in class, it is difficult to facilitate learning activities that require in-class work from multiple student groups. When faced with an empty classroom, faculty may alter their classroom approach and be less motivated to develop activities focused on group learning. At this time, the influence of low attendance on faculty morale and content delivery decisions is not known. Future research could evaluate faculty preferences and perceptions regarding professional satisfaction related to curriculum delivery, as well as student performance and preferences related to varied curricular models, such as podcasts followed by small-group active learning sessions. Future studies should also investigate whether an attendance-based intervention would improve academic outcomes for first-year osteopathic medical students in the at-risk group.

The current study was conducted at an osteopathic institution where first-year students were required to attend an osteopathic manipulative medicine class and laboratory 4 hours each week. This built-in interaction

with faculty and other students could affect student attitudes toward classroom attendance for other courses, and these potential influences would not be present in the same way at allopathic medical schools. Future studies could explore this concept further.

The current study had several limitations. First, our results are specific to ATSU-SOMA and may not be generalizable to institutions with different learning environments or content delivery strategies. We also studied only a single class of osteopathic medical students. Additional studies and collaborations with other osteopathic medical institutions are needed to collect data that are more widely generalizable. Another potential limitation was the attendance tracking method. We required students to click in their attendance for each class, and students may have occasionally attended without clicking in, although this possibility was mitigated by using a student monitor and reminders to click in at each class session. Finally, we did not measure the effects of nonattendance on long-term retention. Future work could evaluate longer-term outcomes related to completing the academic program, competency evaluation, board examination results, and residency placement.

Conclusion

In the current study, classroom attendance was not predictive of course grades among first-year osteopathic medical students. Classroom attendance decreased during the academic year more than anticipated. Students regarded lecture capture technology as a valuable alternative to classroom attendance and ranked podcasts as the top choice for content delivery. Our findings may help optimize technology-supported learning—for example, by increased use of podcasts for passive content delivery supplemented by case studies or workshops to reinforce concepts introduced in the podcasts. Enhanced incorporation of such methods and other alternatives to traditional lectures may help create a learning-centered environment for osteopathic medical students.

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Author Contributions

All authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; all authors drafted the article or revised it critically for important intellectual content; all authors gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Rapid Review

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