Association of classroom participation and examination performance in a first-year medical school course

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Millis RM, Dyson S, Cannon D. Association of classroom participation and examination performance in a first-year medical school course. Adv Physiol Educ 33: 139–143, 2009; doi:10.1152/advan.00028.2009.—The advent of internet-based delivery of basic medical science lectures may unintentionally lead to decreased classroom attendance and participation, thereby creating a distance learning paradigm. In this study, we tested the hypothesis that classroom attendance/participation may be positively correlated with performance on a written examination for first-year medical school instruction. The study subjects consisted of 115 first-year medical students. The introductory respiratory structure-function instruction was designed to include one noncompulsory pretest, four short postinstruction noncompulsory self-evaluation tests that were unannounced as to date and time, and one compulsory comprehensive examination. The relationship between attendance/participation, measured by the number of noncompulsory tests taken, and performance on the comprehensive examination was determined by Pearson’s correlation coefficient, one-way ANOVA, and a χ²-test of significance. The average score on the pretest was 28%; for the same items on the comprehensive examination (posttest), the average score was 73%. For the 80 students who took the pretest, this translated to an overall score increase of 161%. Attendance/participation in four or five of the noncompulsory tests resulted in an 83.3% pass rate on the comprehensive exam compared with a rate of 52.9% for attendance/participation in three, two, one, or none of the five noncompulsory tests; the overall pass rate was 60.9%. There was a significant association between a high rate of classroom attendance/participation and a high score on the comprehensive examination (Pearson’s χ² = 8.599, P < 0.01). These findings suggest that classroom attendance/participation may be a significant determinant of performance of medical students on comprehensive examinations in first-year basic medical science courses. It is concluded that a substantial number of first-year medical students in this study could be at risk for poor performance because they may believe that there is an equivalency between internet- and classroom-based instruction in basic medical science courses.

METHODS

One hundred and fifteen first-year medical students enrolled at a historically black university were informed that the respiratory physiology section of their Structure and Function course’s cardiorespiratory unit III (S&FIII) would include one noncompulsory pretest, four short postinstruction noncompulsory self-evaluation quizzes that were unannounced as to date and time, and one compulsory comprehensive examination (posttest). Students were advised that the pretest and quiz results would not affect their grade in the course. Because attendance is not required or recorded by the college, the number of unannounced quizzes students took was used as a measure of attendance. Attendance was categorized as “frequent” if students completed four or five of the quizzes and “sporadic” if students completed zero to three quizzes. Posttest scores were compared with pretest scores to determine knowledge gain. Grades on the comprehensive examination were analyzed by the frequency of attendance using one-way ANOVA. Passing rates for the comprehensive examination and final course grade were analyzed by the frequency of attendance using a χ²-test of significance. The correlation between class attendance and course grade was analyzed using Pearson’s coefficient.

RESULTS

Five assessments administered to the first-year medical students (n = 115) were included in the study. The mean number of S&FIII assessments the freshman class completed was 2.29 (SD 1.556). Sixteen students (13.9%) completed no assessment, 28 students (24.3%) completed one assessment, 19 students (16.5%) completed two assessments, 22 students (19.1%) completed three assessments, 20 students (17.4%) completed four assessments, and 10 students (8.7%) completed all five assessments.
Seventy students (60.9%) passed the S&FIII comprehensive examination. The percentage of students who passed the S&FIII comprehensive examination who took zero, one, two, three, four, or five unannounced assessments was 56.2%, 57.1%, 57.9%, 40.9%, 80%, and 90%, respectively (Fig. 1). Students who passed the S&FIII comprehensive examination attended classes more frequently (as measured by the number of quizzes taken) than their counterparts who failed. Students who passed the S&FIII comprehensive examination (n = 70) averaged 2.49 unannounced assessments. Students who failed the S&FIII comprehensive examination (n = 45) took an average of 1.96 unannounced assessments (Table 1). Of the students who attended frequently (those who took 4–5 quizzes), 83.3% passed the comprehensive examination. Only 52.9% of the sporadic attendees (those taking 3 or fewer quizzes) passed the comprehensive examination ($\chi^2 = 8.599, P < 0.01$; Fig. 2). When analyzed based on the frequency of attendance groups, the difference between the mean S&FIII comprehensive examinations of frequent attendees and sporadic attendees was statistically significant ($F = 73.91, P < 0.01$). The average comprehensive examination score for frequent attendees was 77.0 compared with 70.89 for sporadic attendees (Table 2).

Since the comprehensive examination was a part of the final grade in the S&FIII course, higher scores on the S&FIII comprehensive examination translated into higher final grades in the S&FIII course. As the frequency increased from zero to five unannounced sessions, the passing rate increased from 87.5%, 88.9%, 89.5%, 95.5%, and 95.0% to 100%, respectively (Fig. 3). Students who attended more sessions (as measured by taking more unannounced assessments) earned higher final grades in the S&FIII course than students who attended fewer sessions. When analyzed based on the frequency of attendance groups, the difference between the mean S&FIII final grade range for sporadic attendees (range: 39–91). The mean S&FIII final grade range for frequent attendees (those taking 4 or 5 unannounced assessments) was 80.00 (n = 30) with a SD of 7.529. The mean for sporadic attendees (those taking fewer than 4 unannounced assessments) was 75.87 with a SD of 10.149 (n = 84). Additionally, the S&FIII final grade range for frequent attendees (range: 54–92) was higher than the range for sporadic attendees (range: 39–91).

### DISCUSSION

Interactive lectures may represent the best practice of teaching respiratory physiology in medical school, partly because it has been shown to overcome disadvantages of the students with poorer science backgrounds (4, 5). This may be especially important in a medical school with a sizable enrollment of students with diverse backgrounds. However, the advent of internet-based support of instruction by making all teaching materials, including the lectures, available 24 h/day, 7 days/wk, might encourage students with weaker science backgrounds to miss opportunities for student-faculty interactions. On the other hand, the availability of internet-based lectures in physiology is thought to be a remedy for not providing enough classroom time for teaching critical-thinking and problem-solving skills (12). The results of this study indicate that the frequency of attendance was related to academic performance in an introductory structure-function course for first-year students. Frequent attendees had higher passing rates on the comprehensive examination and for the course than the passing rates for sporadic attendees. In addition to being more likely to pass, frequent attendees earned higher scores on the comprehensive examination and higher final grades than those of their sporadic attendee counterparts. The frequency of attendance for the unannounced quizzes undoubtedly mirrors the frequency of attendance for the unannounced quizzes.

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**Fig. 1.** Percentage of students passing the comprehensive exam of cardiopulmonary unit III of the Structure and Function course (S&FIII) by attendance. Bars show the pass rate of first-year medical students on a comprehensive respiratory physiology exam in a structure- and function-based thorax, abdomen, and pelvis unit (S&FIII) ranked by attendance/participation in five unannounced noncompulsory respiratory physiology self-evaluation tests that did not impact their grade.

**Fig. 2.** Percentage of students passing the S&FIII course by the frequency of attendance. Bars show the pass rate of first-year medical students in a structure- and function-based thorax, abdomen, and pelvis unit (S&FIII) by attendance/participation in five unannounced noncompulsory respiratory physiology self-evaluation tests that did not impact their grade.

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**Table 1.** Mean numbers of unannounced quizzes attended by pass or fail in the S&FIII comprehensive examination

<table>
<thead>
<tr>
<th>Number of Students</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fail</td>
<td>45</td>
<td>1.96</td>
<td>1.33</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Pass</td>
<td>70</td>
<td>2.49</td>
<td>1.65</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td>2.28</td>
<td>1.55</td>
<td>0.198</td>
<td>0.198</td>
</tr>
</tbody>
</table>

S&FIII, cardiorespiratory unit III of the Structure and Function course.
frequency of attendance for other class lectures and activities. Oftentimes, students make a conscious decision as to the frequency of their class attendance, govern themselves accordingly, and develop a pattern. While students who attend classes also have the opportunity to use out-of-class resources, they avail themselves of in-class resources that are forfeited by absent students. The additional knowledge, material, and/or support gained from class attendance potentially provides an advantage when it comes to mastering course content and passing the subsequent examinations. Assuming that students developed attendance patterns that carried over into other courses, post hoc analyses were conducted to compare attendance with cumulative grade averages. The results demonstrated a significant correlation between attendance and students’ grade averages at the end of their sophomore year \((r = 0.203, P = 0.05)\). As attendance increased, grade averages increased. The mean for frequent attendees \((76.86)\) was higher than the mean \((73.45)\) for sporadic attendees \((F = 5.773, P < 0.05; \text{see Table 4})\). Students may assume that self-directed study and distance learning parallel in-class activities. The present study suggests that, in classes not intentionally pre-arranged, the additional benefits afforded class attendees are likely multiple, varied, overlapping, and, consequently, difficult to identify. The Medical College Admissions Test (MCAT) is considered, by many medical educators, to be the “gold standard” for predicting success in medical school \((8)\). Therefore, post hoc analyses of MCAT scores, attendance, and performance were conducted to address two competing explanations for the positive influence of attendance on academic performance as measured by grade. These notions were 1) whether academically stronger students simply tended to attend classes more regularly or 2) whether stronger students inherently performed better by virtue of being “better” students. The former notion was addressed by analyzing attendance while using the MCAT score as an indication of academic strength. This notion was debunked by the fact that there was a significant negative correlation between MCAT scores and attendance \((r = -0.214, P = 0.05)\). Those with higher MCAT scores were less likely to attend frequently. Students who did not attend any sessions had higher MCAT scores than students who attended one or more sessions. Perhaps stronger students were more confident in their ability to master the material and, therefore, more likely to attempt to do so independently.

Exploration of the second notion was more complex. Neither MCAT scores nor pretest scores correlated with final grades. Because students scoring high on the pretest and MCAT scores qualify to be categorized as “stronger students,” this lack of correlation lends support to the notion that something else, perhaps attendance, may be a contributing factor to academic success and may level the field for freshman students. Additionally, MCAT scores did not demonstrate a significant correlation with the final grade, pretest scores, or freshman through sophomore grade averages. This suggests that students were able to acquire competency in the subject matter, regardless of academic background and level of preparation at the undergraduate level. In fact, students with the lowest pretest scores demonstrated the greatest gain in points when pretest scores were compared with final grades. While it is clear that these students had the most room to gain, it is conceivable that the pretest served as an early warning sign, prompting these individuals to remediate deficiencies in their knowledge base, thereby closing the gap between their scores and those of their higher MCAT-scoring counterparts. Conversely, those who scored higher on the pretest may have adopted a level of comfort with their performance or an attitude of complacency.

It should be noted that some students attended the unannounced assessment sessions but chose not to take the assessment. These students essentially received all of the benefits that those who took the assessment(s) received; however, by virtue of not taking the assessments, they were categorized as having not attended, since the mechanism for determining attendance was taking the unannounced assessment. Thus, these “pseudo-sporadic attendees” likely artificially inflated the number of students in the zero attendance category. This sheds light on

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**Table 2. Attendance compared with grades on the S&FIII comprehensive examination**

<table>
<thead>
<tr>
<th>Number of Sessions Attended</th>
<th>Number of Students</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sporadic(0–3)</td>
<td>85</td>
<td>70.89</td>
<td>11.344</td>
<td>1.230</td>
<td>40</td>
<td>93</td>
</tr>
<tr>
<td>Frequent(4–5)</td>
<td>30</td>
<td>77.00</td>
<td>8.208</td>
<td>1.499</td>
<td>30</td>
<td>92</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td>72.49</td>
<td>10.919</td>
<td>1.018</td>
<td>40</td>
<td>93</td>
</tr>
</tbody>
</table>

**Table 3. Attendance compared with final grades in the S&F course**

<table>
<thead>
<tr>
<th>Number of Sessions Attended</th>
<th>Number of Students</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sporadic(0–3)</td>
<td>84</td>
<td>75.87</td>
<td>10.149</td>
<td>1.107</td>
<td>39</td>
<td>91</td>
</tr>
<tr>
<td>Frequent(4–5)</td>
<td>30</td>
<td>80.00*</td>
<td>7.529</td>
<td>1.375</td>
<td>54</td>
<td>92</td>
</tr>
<tr>
<td>Total</td>
<td>114</td>
<td>78.18</td>
<td>9.672</td>
<td>0.906</td>
<td>39</td>
<td>92</td>
</tr>
</tbody>
</table>

One student withdrew from the college. *\(P < 0.05\).

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Fig. 3. Percentage of students passing S&FIII by the number of sessions attended. Bars show the pass rate of first-year medical students in a structure- and function-based thorax, abdomen, and pelvis unit (S&FIII) ranked by attendance/participation in five unannounced noncompulsory respiratory physiology self-evaluation tests that did not impact their grade.
the fact that 87.5% of those who did not attend any of the unannounced assessments passed the course. This pseudospo-
radic attendee phenomenon probably translates into an inflated passing rate for the zero-attendance group. Additionally, assuming that better prepared students would be more likely to feel confident foregoing the assessments than less prepared students, this group likely represents students entering with stronger academic preparation at the undergraduate level. This phenomenon is likely reflected in the difference in the MCAT scores when analyzed according to attendance ($F = 2.769, P < 0.05$). Students attending zero quizzes had higher MCAT scores than students attending two, three, four, or five quizzes. This finding suggests the potential, perhaps because of a bravado attitude about routine attendance and participation, for MCAT scores to overpredict medical school performance (9).

Compared with the classical didactic model of teaching, the lectures in this respiratory physiology section were interactive, e.g., computer simulations, problem-solving exercises, and case studies were all part of the daily lectures. However, with a neutral attendance policy, participation and attendance was, at best, sporadic for the majority of students. The literature is replete with evidence that the effectiveness of student-focused teaching is superior to instructor-focused teaching, and we designed this respiratory physiology section with that in mind. Nevertheless, the participation/attendance and examination performance appeared to be no better than in sections of our first-year medical courses where such efforts to make teaching interactive were not undertaken. The course syllabus consisted of a digital video disk containing the lecture/laboratory/small-group discussion schedules, a complete list of the required and recommended reading, learning objectives, lecture outline, and Microsoft PowerPoint files for each session. All students were provided with software containing the computer simulations and tutorials in respiratory physiology that were used for the interactive learning components.

The present study was performed based on the assumptions that all students had the aforementioned digital video disk syllabus and access to all online materials such as note-taking services, audio and video recordings of lectures and textbooks, etc. Technologies such as online course management software and audience response systems are available for tracking student usage of such resources. In the present study, we have no tracking data. However, our results suggesting that students most at risk may be adversely influenced by the current learning environment imply that tracking data could be useful for counseling and intervening. Indeed, the very existence of tracking may encourage more responsible participation.

It is plausible that students with better classroom participa-
tion/attendance had improved examination performance be-
cause of the receipt of exam cues given in class rather than
greater comprehension of respiratory physiology. Furthermore, participation/attendance may be a consequence of self-selec-
tion, i.e., on average, students motivated to attend class would likely do better in any setting. The results of the present study suggest that a subgroup of students perform satisfactorily whether or not they are regular “attendees.” We do not know whether the majority of students would benefit not only from their own attendance/participation but also from the contributions of the higher-performing students to the classroom dy-
namic. The present study was performed to address the question whether the classroom dynamic of direct student-student and student-instructor interactions may be becoming underrated in the digital age. If we assume that something special happens in the well-designed live interactive classroom, does it make sense to foster the false belief that there is an equivalency between computer-based and classroom-based instruction for all students?

In summary, it makes sense for our institutions of learning to be at the cutting edge of technological advances. At minimum, most higher education institutions have implemented distance learning, digital syllabi, electronic access to lectures, and computerized testing into their curricula. While embracing these innovations, many educators have noticed a marked decline in classroom attendance. It seems reasonable to expect that a generation of students raised on technology with such features as instant messaging, “on demand” and “pay per view,” would customize their study approach with similar personalized enhancements. The question arises as to whether today’s myriad of technological options presents a double-edged sword. No one questions the fact that educational tech-
nology improves the quality of education, transfer of informa-
tion, and delivery of knowledge in our higher educational institutions. However, by providing electronic options, we may create de facto deterrents to classroom attendance, interaction, and participation that affect academic performance. This study begins to delve into the complex, interrelated, and multifaceted teaching issues raised by investigating the effect of classroom attendance on performance in a first-year medical basic science class. Some may assume that the current generation of students is capable of mastering the medical curriculum via electronic instruction such as digital lectures, virtual laboratories, instant messaging, and computer-generated examinations. However, this study suggests that we may need to consider the role of live lectures and, by extension, small-group learning, face-to-face discussion, cadaver dissection, practical exams, and other “old-fashioned” teaching methods in the success of students.

In conclusion, having opened the door to technology, it is a forgone conclusion that it will not be shut. Perhaps the solution is not “either technology or classroom participation” but both. Moreover, if both, our goal must be to reach a balance that best meets student needs. Many faculty members describe attend-
dance in first- and second-year medical school lectures as abyssmal. After a history of live lectures, perhaps the novelty of technology has caused the pendulum to swing disproportion-

### Table 4. Attendance compared with freshman through sophomore grade averages

<table>
<thead>
<tr>
<th>Number of Sessions Attended</th>
<th>Number of Students</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sporadic(0–3)</td>
<td>85</td>
<td>73.4483</td>
<td>7.1301</td>
<td>0.77346</td>
<td>51.38</td>
<td>83.12</td>
</tr>
<tr>
<td>Frequent(4–5)</td>
<td>30</td>
<td>76.8581*</td>
<td>5.17022</td>
<td>0.94395</td>
<td>63.62</td>
<td>87.47</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td>74.3378</td>
<td>6.82128</td>
<td>0.63609</td>
<td>51.38</td>
<td>87.47</td>
</tr>
</tbody>
</table>

* $P < 0.05$.
ately to the technology side. The results of this study suggest that it may be prudent to find ways to calibrate the pendulum to come to rest somewhere in the middle by reengaging students and increasing classroom attendance.

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REFERENCES