Adv Physiol Educ 43: 408–413, 2019;
doi:10.1152/advan.00033.2019.

HOW WE TEACH | *Classroom and Laboratory Research Projects*

Using technology to increase student (and faculty satisfaction with) engagement in medical education

Denise Kay and Magdalena Pasarica
Medical Education, College of Medicine, University of Central Florida, Orlando, Florida

Submitted 4 March 2019; accepted in final form 28 July 2019

Kay D, Pasarica M. Using technology to increase student (and faculty satisfaction with) engagement in medical education. *Adv Physiol Educ* 43: 408–413, 2019; doi:10.1152/advan.00033.2019.—Faculty dissatisfaction with diminishing levels of student engagement in lifestyle medicine sessions prompted this exploratory project that compared differences in students' substantive engagement in medical preclinical and clinical level lifestyle medicine sessions. The preclinical and clinical level sessions had the same learning objectives and learning tasks, properly aligned with that level of student learning, but were offered in different learning formats, either traditional classroom approaches or technology-enhanced approaches. At the preclinical level, we transferred a nonmandatory, face-to-face session to a nonmandatory, fully online session. At the clinical level, we introduced two novel technology tools. We utilized Zoom technologies, which afforded students the ability to access the session from anywhere, and employed Hickey's use of "promoting" student submissions as one method for increasing student-student interaction during the synchronous session. We used indicators of behavioral engagement of Henrie et al. (Henrie CR, Halverson LR, Graham CR. *Comput Educ* 90: 36–53, 2015) as the framework for determining applicable engagement behaviors, including attendance, assignment completion, interactions (responding/feedback/endorsements), and the quality of (and faculty satisfaction with) the face-to-face and/or online interactions. We expected to observe higher levels of engagement behaviors in the technology-enhanced approach and found that to be the case at both the preclinical and clinical levels, in both mandatory/nonmandatory and synchronous/asynchronous formats. However, it was the increase in both the level and substance of the students' interactions in the technology-enhanced sessions that provided surprising results. A review of the sessions with enhanced engagement highlight the role of student autonomy, a construct with strongly established associations to student motivation and engagement.

distributed learning; instructional technology; lifestyle medicine; student engagement; synchronous/asynchronous

INTRODUCTION

The notable decrease in student engagement across the educational spectrum (1) is also evident in medical education. Recent literature highlights concern with decreased attendance at instructional sessions in both medical school and continuing medical education (6, 8, 12, 14, 18, 21, 35). Others have noted (and we concur) that, even when learners attend sessions, they are often inattentive, distracted, and/or superficially engaged, regardless of the adopted active or passive instructional modalities (14, 34).

Explanations for decreased engagement and attendance vary from the depersonalized nature of large-group lectures (30), new technology (14), utilization of electronic resources for self-directed learning (35), student apathy (8), issues of professionalism (18), and generational and value differences (14). Additionally, others have noted a decline in respect for authority and institutions, perceptions of formal education as "boring," and a "work avoidant" motivational style that fosters "getting by" while doing as little as possible (5, 16).

We propose that there are now fundamental differences between what engages students today, what engaged students even as short as 5 yr ago (15), and certainly what engaged us when we were students. It is from this perspective that we compared differences in students' "substantive engagement" during lifestyle medicine sessions for preclinical and clinical students at our medical school. The learning objectives and tasks aligned with either the preclinical or clinical student level. The sessions were offered using either traditional didactic or technology-enhanced approaches.

While student engagement has been defined in a variety of ways (5, 9), our interest focused on the description of behavioral engagement by Frederick et al. (5). We used the indicators of behavioral engagement of Henrie et al. (9) as the framework for determining what constituted student engagement. Behavioral indicators included attendance, assignment completion, interactions, and the quality of the face-to-face and/or online interactions. The technology enhancements we introduced included transferring a session from an in-class, face-to-face, synchronous session to a distributed (asynchronous, fully on line) learning session and the introduction of the Zoom platform to host a virtual, synchronous session.

The primary differences between the traditional and technology-enhanced sessions relate to the choice of time (when to engage) and location (where to engage). By nature of our curriculum, another primary difference between the preclinical and the clinical sessions is the attendance policies, with preclinical level sessions being nonmandatory and clinical level sessions being mandatory. An additional difference was response type, either group or individual, as the tools available in the technology-enhanced sessions afforded a wider range of possibilities for capturing and utilizing individual student responses in real time. The following is a brief description of previous work related to these session characteristics.

Address for reprint requests and other correspondence: D. Kay, Medical Education, College of Medicine, University of Central Florida, 6850 Lake Nona Blvd., Orlando, FL 32827 (e-mail: Denise.Kay@ucf.edu).

Choice of Time: Synchronous/Asynchronous

Traditional synchronous learning formats capitalize on simultaneous student and faculty interactions and require students and faculty to be in the same place at the same time. In contrast, asynchronous learning formats are not bound to a particular time or place or to the need for simultaneous student-student or student-faculty interaction. Students (and faculty) are able to independently access the event or course at a time and location of their choosing via the affordances of technology (13). Even more robust, the increasing sophistication and accessibility of virtual, synchronous conferencing techniques represent one method for offering the convenience of online learning without sacrificing opportunities for real-time engagement with peers and faculty. In a study that included both undergraduate and graduate courses utilizing a synchronous, virtual method as some part of the course, a high number of student comments praised the convenience of the method since it afforded the students the ability to remain at home for class, save on travel expenses, and participate in class when ill or while still caring for their children. Students also noted an increase in student-student and student-instructor interactions in this format (19). Within medical education, synchronous, virtual learning has been used in one-on-one interactions to teach clinical skills. A small sample of first-year students in Malaysia was paired with fourth-year medical students in the United Kingdom to learn clinical skills. Reported findings included positive learning outcomes, as well as student satisfaction and increased confidence with clinical exam skills (22). We could not locate any reports of the use of virtual, synchronous learning to accommodate large groups of students simultaneously in medical school settings. However, this format has been used in nursing education, with reports of an 89% volunteer attendance rate, a 33% higher exam passing rate for students who engaged in the virtual classroom versus students who took the course on campus, as well as positive comments from students about good access to the instructor, enhanced interactions with students, and, since their peers are able to view them, the need to be more thorough in postings (23).

Choice of Location: Distributed Learning

Whereas there is continued skepticism regarding the efficacy of distance education, online learning has increased significantly over the last 2 decades. According to a 2016 report, 32% of students have taken at least one distance course (31), and a U.S. Department of Education meta-analysis comparing learning outcomes for online learning versus face-to-face instruction reported that learning outcomes for online learners were equal to or greater than those for students in face-to-face instruction, that online learning formats were equally effective for undergraduate and graduate students across a wide range of academic and professional studies, and the effectiveness was not significantly influenced by variations in online learning practices (19a). Students taking online courses in college report higher levels of engagement than their on-campus peers for all engagement variables measured (28). Other reports suggest that students in online learning environments spend more time preparing for the course, and that the writing involved in online learning requires more reflection (7, 29) "a more thoughtful process of communication" (26, see p. 213).

Online learning is relatively new to medical education, so there is less investigative focus on learning outcomes or engagement in this format. However, Pickering and Swinnerton (25) were able to identify evidence of emotional, cognitive, and behavioral engagement in first-year medical students' perceived interactions with the online portions of their compulsory, blended learning anatomy course. Sheringham and colleague's (32) report highlighted students' discomfort with having to engage with other students in the discussion forum and attributed the discomfort to the need to write, not only more, but also more carefully. Even students who did not post in their course reported the discussion forum as useful, suggesting a "lurker" approach to the course format.

It appears that the growth of online learning is here to stay. But the potential for student isolation and diminished levels of faculty-to-student and/or student-to-student interaction is a concern with this medium (4). One proposed goal is to find teaching methods that honor the convenience and benefits of online learning without sacrificing the social interactions available in synchronous face-to-face formats (19).

Response Type: Individual versus Group Responding

In our work, we observe that engagement in face-to-face sessions is typically limited to the same few students. Since we consider participation in class activities a positive work habit (33), this observed phenomenon is a concern. One method for addressing both social isolation and increasing student engagement is to create assignments and tasks that require students to interact with both content and each other in relationship to the content (4). While we typically did not require all students to submit responses to questions or tasks, in some cases we directed students to submit their responses on a classroom projected chat board, viewable by all students during the sessions. Student's submissions are identifiable, versus anonymous, and visible to all students in attendance. We also incorporated a "promotion" component, as described by Daniel Hickey (10), into some of our sessions. In the promotion process, students review the task or assignment submissions of their peers and select one as "exemplary." In our case, we directed students to use the "like" feature in our learning management system to promote one peer's submission that represented the best response to the task prompt.

Choice of Time and Location Session Type: Mandatory versus Nonmandatory

Faculty assumptions about the associations between attendance and academic performance likely derived from our own commitment to studiously attend class. Historically, these assumptions were warranted, given studies linking college classroom attendance to academic performance in higher education (2), with similar trends noted in medical education (17, 20). However, as early as 1986, Hyde and Flournoy (11) warned against mandatory attendance, noting some of the top performers in their investigation were low attenders. More recently, Kauffman and colleagues (15) reported no association between nonmandatory classroom attendance and exam performance, also noting that some high performers were low attenders. Similarly, with the exception of one course, Ikonne et al. (12) reported no association between classroom attendance and course grade. Previous studies relating at-

tendance and academic performance may not reflect the impact of the nearly immediate access to content through both formal curriculum, now made available outside of class, and commercially available study resources. These resources place faculty in competition for students' attention, as students seek the most effective, efficient route to meeting their learning goals (15, 35).

Poor attendance can affect not just students, but faculty. ZaZulia and Goldhoff (35) reported that 75% of faculty somewhat agreed or strongly agreed that poor attendance decreases faculty enthusiasm for teaching. This represents at least one motivational force for this exploratory investigation: our own dissatisfaction with both students' level and quality of engagement in lifestyle medicine sessions. This project derived from our interest in exploring how sessions utilizing different technologies impacted not only objective measures of student engagement behaviors, but also our own subjective satisfaction with the observed level of student engagement. We hypothesized that we would observe more student engagement behaviors in the technology-enhanced formats. In the preclinical sessions, our aim was to determine how asynchronous access to content influenced students' engagement behaviors in a nonmandatory educational session. In the clinical sessions, our aim was to determine how students' synchronous, virtual access to a mandatory session, supported by the ability to submit responses in real time and viewable by all session attendees, would impact student engagement behaviors.

Context

Our medical school has a 4-yr (2 preclinical, 2 clinical) curriculum. While faculty still utilize lecture formats, they also use other approaches, such as small-group sessions and online, asynchronous learning modules. The small-group learning sessions require students to collaborate with peers to complete assigned tasks. There are also required opportunities for students to interact with faculty and peers in both the large- and small-group settings.

All mandatory sessions are video-recorded. Students can access the recorded sessions at their convenience. Attendance to nonmandatory sessions varies by class and time of year but can be as low as 20%. In the mandatory didactic sessions, while students may "attend," their participation in the session and the substance of their contributions and dialogue are less than desired. In the preclinical curriculum, all teaching takes place at the Health Sciences campus, and commute length is determined by where students elect to live during medical school. In the clinical curriculum, students are assigned to preceptors at both local (<50 miles) and distant (>50 miles where students are provided with accommodations) locations. We utilize videoconferencing to provide equitable didactic experiences across sites. Videoconferencing affords students the ability to participate synchronously in didactic sessions, regardless of their location.

In the second preclinical year, some didactic sessions are mandatory. All lectures are presented in a lecture hall with a seating capacity of 170. Large lecture halls can inhibit engagement, especially in nonmandatory sessions, when fewer students attend and, based on where they elect to sit, can be scattered across the hall.

Didactic sessions in the first clinical year are mandatory. Students placed at local clinical sites attend these sessions at the Health Sciences campus. The sessions are held in a U-shaped stadium, classroom-style hall, with a seating capacity of 62. The U-shape conveys a less formal setting and is more conducive to engagement than a large lecture hall. Students placed at distant clinical sites have live access to the mandatory sessions via videoconferencing.

We use Canvas as our learning management system. We use either Cisco (allowing only a small numbers of users to participate, but not requiring internet connection) or Zoom (allowing multiple users to participate simultaneously, but requiring internet connection) for videoconferencing. This work was determined to be nonhuman subjects research by the university's institutional review board.

METHODS

Sessions

We designed and deployed four (2 preclinical, 2 clinical) lifestyle medicine sessions to explore the impact on, as well as our own subjective satisfaction with, students' levels of substantive engagement. The preclinical lifestyle medicine sessions were part of the cardiopulmonary module. The clinical lifestyle medicine sessions were delivered in the internal/family medicine clerkship. A description of each session is provided below.

Preclinical: nonmandatory sessions. We deployed a preclinical traditional type (PCTT) and a preclinical technology-enhanced type (PCTE) session to second-year medical students in two subsequent academic years, as nonmandatory sessions with the same learning objectives. PCTT was a face-to-face session, where groups of six students were tasked with solving a clinical scenario (24) on paper. Each group submitted its response to the course discussion board. Each response was projected on a large screen, visible to all students, when groups presented their submission. Students in attendance were invited to provide feedback to the submissions from other groups, and the faculty member provided "real-time" feedback.

The PCTE session was offered in a fully online format. Students individually solved the same clinical scenario (as in the PCTT session) and submitted their case response to the course discussion board. Students were invited to review at least one of their peer's submissions and use the discussion board "reply" feature to provide feedback. The faculty member provided virtual feedback after the discussion was closed.

Clinical: mandatory sessions. We deployed both a mandatory clinical traditional type (CTT) and a clinical technology-enhanced type (CTE) session with different students in the same clinical year. The focus of each session was lifestyle medicine. Each session had the same learning objectives. The learning task was to solve four paper clinical cases. In CTT, local students were required to attend the session in the campus classroom and off-site students were required to attend the session simultaneously at the off-site conference room using Cisco. Students were placed in four groups of six to seven students; each group solved one of the four cases. Their submissions were posted on the course discussion board and projected on the large conference screen. Faculty provided discussion prompts and "real-time" feedback.

CTE utilized Zoom technology, which allowed all students to either attend the session face to face or access it in real-time from any location. Students were randomly assigned to solve one of four cases (the same cases as in CTT) and to individually submit their response to the applicable case on the course discussion board. Students were then asked to review the submissions of their peers, assigned to the same case, and to use the discussion board's "thumbs-up" feature to "promote" the response that represented the "best" response to the

Table 1. *Nonmandatory preclinical lifestyle medicine sessions*

Behavioral Engagement Indicator	PCTT	PCTE
n	120	120
Attendance	15%	At least 67%
Assignments completed	All groups in attendance (total groups = 3)	81 (67%)
Response/feedback	3 prompted interactions during class	71 (59%) students voluntarily posted responses
Quality of student discourse online or face to face	Superficial	Substantive and constructive
Faculty satisfaction	Low	High

n, No. of students. PCTE, preclinical technology-enhanced type; PCTT, preclinical traditional type.

case. Students' submissions were projected on the large screen, viewable to both in-class and virtual attendees. Faculty facilitated class discussion by focusing on the student responses that received the most endorsements for each case, providing feedback about the case as needed. During both CTT and CTE sessions, all students were invited, although not required, to provide feedback to other student's submissions.

Data: Behavioral Indicators

Attendance. In the PCTT, CTT, and CTE sessions, attendance was determined by counting the number of students present at the face-to-face or, when applicable, virtual session. In PCTE, assignment completion was calculated as attendance, since the student had to access enough of the online course to successfully complete the assignment.

Assignment completion. In sessions PCTT and CTT, each group's response was counted as assignment completion. In sessions PCTE and CTE, assignment completion was calculated by the number of posted discussion board responses to the case. Once students submitted the assignment, there was no limitation to the number of subsequent posts a student could make.

Feedback/interactions. In sessions PCTT and CTT, the number of student-student and/or student-faculty interactions was captured via review of the video-recorded session. In session PCTE, the number of student-student interactions was calculated by counting the number of replies that students posted to another student's submission. In session CTE, the number of student-student interactions was calculated by counting both the number of promotions students made to other students' posts, as well as the number of replies that students posted to another student's submission, or, through review of the videoed session, the number of real-time student-student or faculty-student interactions.

Quality or substantive responses. In session PCTT, faculty determined the quality of interactions by reviewing the video recording of the interaction. In session PCTE, the quality of the interactions was assessed by reviewing the nature of the student's narrative responses to other students' posts. In sessions CTT and CTE, faculty determined the quality of interactions by reviewing the video recording of the interactions, as well as the comments or feedback students provided in a narrative reply to another student's post. Interactions were considered binary, either superficial or substantive, based on the length, detail, and specificity of the interaction. Example of superficial interactions would be "great job," or "good job."

Examples of substantive interactions would be the following:

> I think this is a great idea both in terms of saving time and money for the patient. I believe it would be difficult for someone to go from eating fast food all the time to prepping meals, even if it does save time. Questions to consider: Do they have resources to cook? Do they know how? As for the exercise plan, I think it's a wonderful recommendation that focuses on moderate to high intensity exercise in a supportive environment which would benefit this patient immensely.
>
> I enjoyed reading your plan and appreciate the outside of the box thinking, especially as it relates to including some types of fasting regimen or reduced time window eating and weight lifting as a primary means of exercise. For years "eating frequent, small meals to increase your metabolism", has been preached as a gospel for weight loss, when in reality this approach has potential negative consequences and scant scientific support. In fact, in diabetic patients, this advice may actually lead to worse blood sugar control, even when total caloric intake is held constant (as described in a *Diabetologia* article https://www.ncbi.nlm.nih.gov/pubmed/?term=pmc4079942).

Faculty subjective satisfaction with student engagement. For all sessions, faculty satisfaction with the level and substance of the interactions was captured via faculty reflection and discussion after the sessions. Faculty considered levels of subjective satisfaction as binary, either low (faculty and/or student prompts resulted in minimal levels of student engagement with little to no subsequent discussion) or high [faculty and/or student prompts triggered meaningful faculty-student(s) or student-student interaction].

RESULTS

Preclinical

See Table 1.

Attendance and assignment completion. For PCTT, attendance was low and similar to other nonmandatory sessions. Three groups formed, and each group submitted the assignment. Since PCTE was an asynchronous, fully online session, attendance was not considered as a behavioral indicator. Still, four times more students (67.5%) submitted the assignment for this session than did the students in PCTT. It is also possible that more students accessed the session but just did not submit the assignment, as it was not required.

Response/feedback, quality of, and faculty satisfaction with, the interactions. In PCTT, there were three faculty-prompted interactions related to the group assignment submissions. Students did not ask questions about other student group's submissions. The interactions were superficial in nature, and faculty satisfaction with the engagement level and substance of the interactions was low. In PCTE, 59% of the students posted responses to other student's assignment submissions. Faculty satisfaction with the level and substance of student engagement was high.

Clinical

See Table 2.

Attendance and assignment completion. Since these sessions were mandatory, 100% student attendance was as expected. In the CTT session, 19 attended at the campus site, and 8 attended the session via video-conferencing at distance site locations. Each student group submitted a response to its assigned case. In the CTE session, 4 students attended the session at the

Table 2. *Mandatory clinical lifestyle medicine sessions*

Behavioral Engagement Indicator	CTT	CTE
n	27	27
Attendance	100%	100%
Assignments completed	All groups in attendance (total groups = 4)	100% of students completed the assignment
Response/feedback	8 interactions	100% of students promoted one of their peer's responses; 18 students (66%) provided verbal feedback to the response they promoted
Quality of student discourse online or face to face	Superficial	Substantive and constructive
Faculty satisfaction	Low	High

n, No. of students. CTE, clinical technology-enhanced type; CTT, clinical traditional type.

campus site, and 23 students accessed the session virtually from home or other preferred location.

Response/feedback, quality of, and faculty satisfaction with, the interactions. For CTT, there were eight interactions about the group responses. Faculty prompted most of these interactions. The interactions were superficial in nature, and faculty satisfaction with the engagement level and substance of the interactions was low. In CTE, all of the students promoted one of their peer's responses to their assigned case, and a majority subsequently posted feedback or comments to the submission they promoted. The students' interactions, both in class discussion and on the virtual discussion board, were substantive, and faculty satisfaction with the level of student engagement was high.

DISCUSSION

This report describes our observations of the impact on preclinical and clinical student engagement behaviors in technology-enhanced lifestyle medicine sessions. Given the previous research related to online learning, we expected to observe higher levels of engagement behaviors in the formats that utilized technology, either for asynchronous, fully online or for virtual synchronous learning. We were surprised, however, at the high number of preclinical students (PCTE) who accessed and completed the assignment in the nonmandatory, asynchronous, fully online learning module. We were equally and pleasantly surprised to see both the number and quality of the online peer interactions in this format. We recognize that, in the clinical, mandatory, virtual synchronous session (PCTE), the requirement to complete the assigned tasks and to review and promote one peers' submission would predict high levels of engagement. However, a majority of students also voluntarily posted replies and feedback to their peer's submission, which was not a requirement of the session. We also recognize that both of these sessions required an individual versus group response to the assigned task, so we would expect to see higher levels of assignment completion in the former. It is the differences in the subsequent voluntary interactions between students in the asynchronous-fully online (PCTE) and virtual synchronous (CTE) formats that represented a surprising (and satisfying) observation.

A review of the various session formats highlights a previously established theme related to autonomy and student motivation and engagement (27). The PCTE session was not mandatory. Students could choose whether or not to access the online course, to submit a response to the course assignment, to only read, or to read and subsequently comment on the posts from their peers. The CTE session, although mandatory, allowed students the choice of attending sessions in the classroom or via access to the live session from a preferred location. The majority of students accessed this session from their homes. A review of session evaluation comments highlights the benefits of learning in a familiar, comfortable space, saving time by not traveling to the face-to-face site, and increased interest and ability to focus on learning, since students accessing from their personal computer were not distracted by peers in the face-to-face session.

We willingly take ownership of the limitations of this project. We recognize that we offered each session to different preclinical and clinical students, and that engagement levels in these different student populations may have been different at baseline. However, our observations of these (and other) class sessions, as well as the current literature related to medical student engagement behaviors in general, suggest that variances in engagement behaviors are likely insignificant for this generation of medical students across class sessions, topics, and medical schools. Furthermore, while we endorse large-sample, experimental studies in education as the gold standard in establishing educational best practices, these studies are also costly, cumbersome, time-consuming, and impractical when faculty have to make immediate decisions about how to address student engagement in classes taking place now. Since we predicted relatively low, if any, risk of harm with these interventions, they seemed reasonable and safe to implement.

The gap between faculty expectations for engagement and what actually engages students is widening. This gap impacts faculty satisfaction, and we contend that, given the recently published Association of American Medical Colleges brief noting the high percentage of U.S. medical school faculty reporting burnout (3), this is no small consideration. Driven by our own dissatisfaction, we elected to introduce low-risk course formats that utilized technologies like chat, discussion boards, and icons, such as the "thumbs-up" feature, and correctly predicted these would have a positive impact on students' engagement behaviors. We optimized the value of when and where students accessed a session to explore how these variables would impact student engagement behaviors and were happy to see an increase in both the level and quality of the student interactions. It is our hope that this report will encourage and inform faculty who are navigating this ever-widening gap between faculty expectations and students' actual demonstrations of engagement in medical education. We

agree with Millis and colleagues who note that "having opened the door to technology, it is a forgone conclusion that it will not be shut," and that perhaps "our goal must be to reach a balance that best meets student needs" (20, see p. 142), although we might add, that meets faculty needs as well.

ACKNOWLEDGMENTS

We acknowledge Andrea Berry for reviewing and editing this manuscript.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

D.K. and M.P. conceived and designed research; M.P. prepared tables; D.K. drafted manuscript; D.K. and M.P. edited and revised manuscript; D.K. and M.P. approved final version of manuscript; M.P. performed experiments; M.P. analyzed data; M.P. and D.K. interpreted results of experiments.

REFERENCES

1. **Brenneman R.** Gallup student poll finds engagement in school dropping by grade level. *Educ Week* 35: 6, 2016.
2. **Credé M, Roch SG, Kieszczynka UM.** Class attendance in college: a meta-analytic review of the relationship of class attendance with grades and student characteristics. *Rev Educ Res* 80: 272–295, 2010. doi:10.3102/0034654310362998.
3. **Dandar VM, Grigsby RK, Bunton SA.** *Burnout Among U.S. Medical School Faculty* (Online). *American Association of Medical Colleges Analysis in Brief*, vol. 19, no. 1, 2019 https://www.aamc.org/download/495534/data/february2019burnoutamongusmedicalschoolfaculty.pdf [20 Feb 2019].
4. **Dixson MD.** Creating effective student engagement in online courses: What do students find engaging? *J Scholarsh Teach Learn* 10: 1–13, 2010.
5. **Fredricks JA, Blumenfeld PC, Paris AH.** School engagement: potential of the concept, state of the evidence. *Rev Educ Res* 74: 59–109, 2004. doi:10.3102/00346543074001059.
6. **Greenberg L.** More about medical students' attendance at lectures. *Acad Med* 88: 149, 2013. doi:10.1097/ACM.0b013e31827b27dd.
7. **Harasim L.** *Online Education: Perspectives on a New Environment*. Westport, CT: Greenwood, 1990.
8. **Hebert RS, Wright SM.** Re-examining the value of medical grand rounds. *Acad Med* 78: 1248–1252, 2003. doi:10.1097/00001888-200312000-00013.
9. **Henrie CR, Halverson LR, Graham CR.** Measuring student engagement in technology-mediated learning: a review. *Comput Educ* 90: 36–53, 2015. doi:10.1016/j.compedu.2015.09.005.
10. **Hickey D.** *Situated Cognition and the Recognition of Learning, APA Division 15 Webinar* (Online). https://www.youtube.com/watch?v=gimSV7c-ETI&feature=youtu.be [24 Jan 2017].
11. **Hyde RM, Flournoy DJ.** A case against mandatory lecture attendance. *J Med Educ* 61: 175–176, 1986.
12. **Ikonne U, Campbell AM, Whelihan KE, Bay RC, Lewis JH.** Exodus from the classroom: student perceptions, lecture capture technology, and the inception of on-demand preclinical medical education. *J Am Osteopath Assoc* 118: 813–823, 2018. doi:10.7556/jaoa.2018.174.
13. **Johnson GM.** Synchronous and asynchronous text-based cmc in educational contexts: A review of recent research. *TechTrends* 50: 46–53, 2006. doi:10.1007/s11528-006-0046-9.
14. **Kanter SL.** To be there or not to be there: is attendance really the question? *Acad Med* 87: 679, 2012. doi:10.1097/ACM.0b013e31825a5a2a.
15. **Kauffman CA, Derazin M, Asmar A, Kibble JD.** Relationship between classroom attendance and examination performance in a second-year medical pathophysiology class. *Adv Physiol Educ* 42: 593–598, 2018. doi:10.1152/advan.00123.2018.
16. **King RB, McInerney DM.** The work avoidance goal construct: Examining its structure, antecedents, and consequences. *Contemp Educ Psychol* 39: 42–58, 2014. doi:10.1016/j.cedpsych.2013.12.002.
17. **Laird-Fick HS, Solomon DJ, Parker CJ, Wang L.** Attendance, engagement and performance in a medical school curriculum: early findings from competency-based progress testing in a new medical school curriculum. *PeerJ* 6: e5283, 2018. doi:10.7717/peerj.5283.
18. **Marzuk PM.** More about medical students' attendance at lectures. *Acad Med* 88: 149, 2013. doi:10.1097/ACM.0b013e31827b2696.
19. **McBrien JL, Cheng R, Jones P.** Virtual spaces: employing a synchronous online classroom to facilitate student engagement in online learning. *Int Rev Res Open Dis* 10: 1–17, 2009. doi:10.19173/irrodl.v10i3.605.
19a. **Means B, Toyama Y, Murphy R, Bakia M, Jones K; Center for Technology in Learning.** *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies*. Washington, DC: U.S. Department of Education, Office of Planning, Evaluation and Policy Development, 2010, https://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf [26 Feb 2019].
20. **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.
21. **Mueller PS, Litin SC, Sowden ML, Habermann TM, LaRusso NF.** Strategies for improving attendance at medical grand rounds at an academic medical center. *Mayo Clin Proc* 78: 549–553, 2003. doi:10.4065/78.5.549.
22. **O'Donovan J, Maruthappu M.** Distant peer-tutoring of clinical skills, using tablets with instructional videos and Skype: A pilot study in the UK and Malaysia. *Med Teach* 37: 463–469, 2015. doi:10.3109/0142159X.2014.956063.
23. **O'Flaherty JA, Laws TA.** Nursing student's evaluation of a virtual classroom experience in support of their learning bioscience. *Nurse Educ Pract* 14: 654–659, 2014. doi:10.1016/j.nepr.2014.07.004.
24. **Pasarica M, Topping D.** Innovative education of patient care competencies in lifestyle medicine: A collaborative learning activity for the prevention of cardiovascular events. *Med Sci Educ* 27: 577–578, 2017. doi:10.1007/s40670-017-0475-4.
25. **Pickering JD, Swinnerton BJ.** Exploring the dimensions of medical student engagement with technology-enhanced learning resources and assessing the impact on assessment outcomes. *Anat Sci Educ* 12: 117–128, 2019. doi:10.1002/ase.1810.
26. **Rabe-Hemp C, Woollen S, Humiston GS.** A comparative analysis of student engagement, learning, and satisfaction in lecture hall and online learning settings. *Q Rev Distance Educ* 10: 207–218, 2009.
27. **Reeve J, Jang H, Carrell D, Jeon S, Barch J.** Enhancing students' engagement by increasing teachers' autonomy support. *Motiv Emot* 28: 147–169, 2004. doi:10.1023/B:MOEM.0000032312.95499.6f.
28. **Robinson CC, Hullinger H.** New benchmarks in higher education: Student engagement in online learning. *J Educ Bus* 84: 101–109, 2008. doi:10.3200/JOEB.84.2.101-109.
29. **Rohfeld RW, Hiemstra R.** Moderating discussions in the electronic classroom. In: *Computer Mediated Communication and the Online Classroom. Distance Learning*, edited by Berge ZL, Collins MP. Cresskill, NJ: Hampton, 1995, vol. III, p. 91–104.
30. **Saperstein AK, Ledford CJW, Servey J, Cafferty LA, McClintick SH, Bernstein E.** Microblog use and student engagement in the large-classroom setting. *Fam Med* 47: 204–209, 2015.
31. **Seaman J, Allen IE, Seaman J.** *Grade Increase: Tracking Distance Education in the United States* (Online). Babson Survey Research Group, 2018, http://onlinelearningsurvey.com/reports/gradeincrease.pdf [27 Jan 2019].
32. **Sheringham J, Lyon A, Jones A, Strobl J, Barratt H.** Increasing medical students' engagement in public health: case studies illustrating the potential role of online learning. *J Public Health (Oxf)* 38: e316–e324, 2016. doi:10.1093/pubmed/fdv140.
33. **Turner JC, Patrick H.** Motivational influences on student participation in classroom learning activities. *Teach Coll Rec* 106: 1759–1785, 2004. doi:10.1111/j.1467-9620.2004.00404.x.
34. **White C, Bradley E, Martindale J, Roy P, Patel K, Yoon M, Worden MK.** Why are medical students 'checking out' of active learning in a new curriculum? *Med Educ* 48: 315–324, 2014. doi:10.1111/medu.12356.
35. **Zazulia AR, Goldhoff P.** Faculty and medical student attitudes about preclinical classroom attendance. *Teach Learn Med* 26: 327–334, 2014. doi:10.1080/10401334.2014.945028.