

A comparison of professional-level faculty and student perceptions of active learning: its current use, effectiveness, and barriers

Cynthia J. Miller¹ and Michael J. Metz²

¹Department of Physiology and Biophysics, School of Medicine, University of Louisville, Louisville, Kentucky; and

²Department of General Dentistry and Oral Medicine, School of Dentistry, University of Louisville, Louisville, Kentucky

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Miller CJ, Metz MJ. A comparison of professional-level faculty and student perceptions of active learning: its current use, effectiveness, and barriers. *Adv Physiol Educ* 38: 246–252, 2014; doi:10.1152/advan.00014.2014.—Active learning is an instructional method in which students become engaged participants in the classroom through the use of in-class written exercises, games, problem sets, audience-response systems, debates, class discussions, etc. Despite evidence supporting the effectiveness of active learning strategies, minimal adoption of the technique has occurred in many professional programs. The goal of this study was to compare the perceptions of active learning between students who were exposed to active learning in the classroom ($n = 116$) and professional-level physiology faculty members ($n = 9$). Faculty members reported a heavy reliance on lectures and minimal use of educational games and activities, whereas students indicated that they learned best via the activities. A majority of faculty members (89%) had observed active learning in the classroom and predicted favorable effects of the method on student performance and motivation. The main reported barriers by faculty members to the adoption of active learning were a lack of necessary class time, a high comfort level with traditional lectures, and insufficient time to develop materials. Students hypothesized similar obstacles for faculty members but also associated many negative qualities with the traditional lecturers. Despite these barriers, a majority of faculty members (78%) were interested in learning more about the alternative teaching strategy. Both faculty members and students indicated that active learning should occupy portions (29% vs. 40%) of face-to-face class time.

active learning; lecture; engaging lecture; professional development

FOR STUDENTS pursuing a professional-level degree, the following situation may be familiar:

You look at your watch and give out a slight groan as you realize there are still 30 min left in the class period. The professor stands behind the podium, droning on in a monotone voice while clicking through the slides, rarely making eye contact with the class. You feel your head nodding forward as you struggle to stay awake. Another glance at your watch reveals that only 5 min have passed.

Since the beginning of higher education, the main teaching method used has been the traditional didactic lecture (17). This method establishes an instructor-centered classroom setting in which students are passive listeners (12, 16, 18, 28). Passive learning does not incorporate open student interactions and focuses more on simply exposing students to predetermined course material (34). While many would argue that the lecture method is sufficient for educating professional students, evi-

dence suggests that alternative teaching methods exist that can enhance the performance levels and qualitative experiences of students (17). For example, active learning is an instructional approach in which students become engaged participants in the classroom. Students are responsible for their own learning through the use of in-class written exercises, games, problem sets, audience-response systems, debates, class discussions, etc. Rather than focusing on rote memorization of fact, active learning encourages students to accomplish higher-order objectives on Bloom's taxonomy, such as analysis, synthesis, and evaluation (6). Studies (7, 18, 34) have indicated that active processing of information can improve students' comprehension of physiology, problem-solving abilities, and critical thinking skills.

Although active learning has recently become a popular term in higher education, the teaching methodology is not new. Professors from the early 1900s were emphasizing the importance of active learning strategies on student knowledge and comprehension (25). One of the key benefits of active learning methods is the ability to conduct formative assessment of student progress (29). This allows not only students to gauge their own knowledge of the material being presented but also instructors to identify areas of deficiencies possibly needing emphasis (15, 22). The instructor is thus transformed from a "sage on the stage" to a "guide on the side." The activities themselves are typically collaborative in nature, requiring students to work together as a group to achieve a common goal. Collaborative learning has been shown to improve student scores, encourage a deeper understanding of physiology, and promote classroom discussion (16).

Many institutions have focused on the complete replacement of traditional lectures with active learning in the "flipped" classroom (5). Students are given the opportunity to access key content information online, outside of class time, and class meetings are used for problem solving, discussions, or other applications of the material. The flipped classroom format has been indicated to improve the quality of student learning as well as student engagement in the classroom (5). However, an integration of traditional lecture and active learning methods may also be beneficial (8, 21). In engaging lectures, also referred to as interactive lectures, students are given short periods of lecture followed by "breaks" in which active learning is used to help reinforce the material just presented. These breaks are incorporated into the lecture to improve student performance, increase alertness, promote engagement, and allow immediate application of course material (12, 16, 28).

Recent work by our group analyzed the effectiveness of the engaging lecture format in the Dental Physiology course for first-year Doctor of Dental Medicine (DMD) students at the University of Louisville. It was found that the use of engaging

Address for reprint requests and other correspondence: C. J. Miller, Dept. of Physiology and Biophysics, Univ. of Louisville, School of Medicine, HSC A-1115, 500 S. Preston St., Louisville, KY 40292 (e-mail: cjmill04@louisville.edu).

lectures in the professional-level course improved both short-term student performance on unit exams and long-term retention of information for the final exam (20). Furthermore, the data showed that the engaging lectures resulted in an increased perceived effectiveness of lectures, decrease in student distractions during lecture, and increased student confidence with the material (20).

Despite the abundant research that has taken place in the Department of Physiology and Biophysics at the University of Louisville on the success of active learning, the movement toward educational reform has been slow. While the administration is supportive of alternative teaching strategies, faculty members continue to rely primarily on lecture as an instructional technique. This could be due to many factors, such as an absence of faculty interest in active learning or a perceived lack of educational benefit. On the other hand, it may be that faculty members who are convinced of the benefits of active learning experience difficulties with the creation or implementation of active learning strategies in a classroom setting. For example, instructors may not have the planning time necessary to develop the materials or may not have the classroom time or flexibility needed to implement the teaching strategy. In fact, a study by Silverthorn et al. (31) found that some instructors who were interested in active learning failed to use active learning modules even when they were provided for free and professional development was available.

Before educational reform and the adoption of active learning can occur in classes facilitated by the department of physiology at the University of Louisville, it would be useful to conduct a systematic analysis of where the process currently stands. This study was developed to characterize the current faculty use of active learning in the department versus other teaching methods. Furthermore, a major goal was to compare faculty member versus student perceptions of active learning in the classroom. This information may help to determine the main factors that are currently preventing faculty members in the department from adopting active learning strategies and to gauge faculty interest in adopting the alternative learning technique. The results of this study could then be used to tailor professional development activities to more effectively incorporate active learning into the curriculum.

METHODS

Institutional context. The Department of Physiology and Biophysics at the University of Louisville is responsible for teaching over 10 courses and annually teaches >400 students through >450 contact hours. In the traditionally based curriculum, the physiology courses are not integrated with other basic science courses. While some of the other basic science courses do include an active laboratory component, didactic lectures are the predominant instructional method at the university. The physiology courses are team taught, with most courses containing 4–6 instructors/semester. In the majority of the courses, individual lecturers are responsible for determining the content covered in their section, the teaching methods used, and the content of the exam questions.

Faculty participants. Faculty participants were members of the Department of Physiology and Biophysics at the University of Louisville. Each of the 13 faculty members asked to participate in the study were involved in teaching at the Schools of Medicine, Dentistry, or Graduate Studies. Faculty members who participated solely in research, with no significant teaching responsibilities, were excluded from the study.

Student participants and implementation of active learning. Student participants were first-year DMD students enrolled in the University of Louisville School of Dentistry (Louisville, KY). Dental Physiology (BMSC 805) is a general science course for first-year students, with a class size of 120 students. The course is team taught by five faculty members in the Department of Physiology and Biophysics. The Dental Physiology course follows a system-based approach divided into 11 sections.

As reported in a previous study (20), students were taught five of the physiological systems using traditional lecture methods and six of the physiological systems using engaging lecture methods. The class format remained the same for the previous study completed in the 2012 course, which examined the effectiveness of engaging lectures, and the present study in 2013, which analyzed student perceptions of the active learning technique. There were four different professors that taught the traditional lectures and one professor (C. J. Miller) that taught all of the engaging lectures.

The engaging lectures consisted of 10–15 min of lecture followed by an activity that allowed students to actively apply the content to which they had just been exposed. These activities included problems or prompts that required students to brainstorm outcomes, classify components, compare/contrast pathologies, match terminology and definitions, complete case studies, solve mathematical equations, complete Venn diagrams, watch professor-designed video clips and complete worksheets, do “think-pair-share” activities, write 1-min papers, etc. In the 39 contact hours of engaging lectures, there were 125 active learning segments. Faculty and student participants were not presented the results of previous studies by C. J. Miller regarding the effectiveness of active learning, and surveys were completed before publication of these results.

Survey instrument. A 23-question, anonymous paper survey was distributed to faculty members in the Department of Physiology and Biophysics at the University of Louisville. The survey inquired about faculty members’ current use of active learning, their perception of the technique, and plans for future use. The survey consisted of ranking, Likert-scale, and open-response questions and required ~20 min to complete. Faculty members were invited to participate in the study through an e-mail, and surveys were placed in mailboxes in the departmental office. Completed surveys were anonymously returned to a mailbox in the departmental office, and no incentives or penalties were given for completion. Respondents were given 2 wk to complete surveys, and a reminder e-mail was sent 2 days before the close of the survey period.

A 13-question, anonymous paper survey was distributed to DMD students in the last week of the Dental Physiology course. This survey was similar in scope to the faculty survey and consisted of ranking, Likert-scale, and open-response questions. It required ~15 min for students to complete the survey at the conclusion of a class.

To ensure that all participants understood the term “active learning,” the following definition was provided on the survey:

Active learning is an instructional method in which students become engaged participants in the classroom. Students are responsible for their own learning through the use of in-class: written exercises, games, problem sets, i-clickers, debates, class discussions, etc.

Data analysis and Institutional Review Board approval. Statistical analyses were performed using Origin software (version 8.1, OriginLab, Northampton, MA), as shown in Fig. 1, with statistical significance defined as $P < 0.05$. This study was determined to be Institutional Review Board exempt by the University of Louisville (tracking number: 13.0193, 6/15/2013).

RESULTS

For faculty participants, 9 faculty members anonymously completed surveys out of the 13 surveys distributed, for a 69%

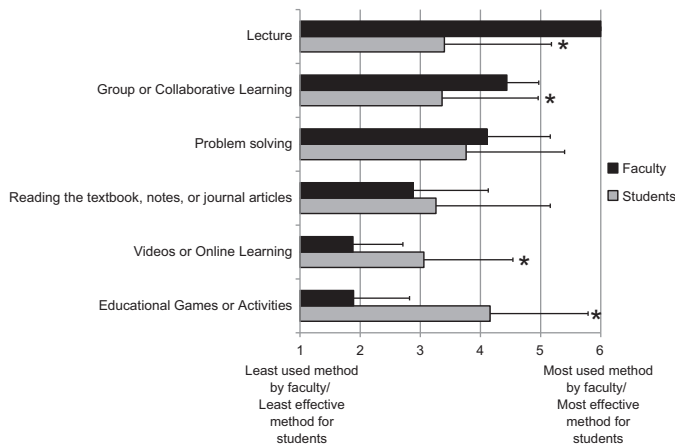


Fig. 1. Comparison of methods used by faculty members with most effective methods for students. Faculty members were asked to rank their current use of six teaching methods, where 6 = the most frequently used method and 1 = the least frequently used method. Students were asked to rank the six methods according to the way they learned physiology concepts most effectively, where 6 = the most effective method and 1 = the least effective method. Data are presented as means ± SD; n = 9 for faculty members and 116 for students. *P < 0.05 by the Mann-Whitney U-test.

response rate. Of those responding faculty members, one was an assistant professor, four were associate professors, and four were professors. Based on the original distribution lists, four full professors elected not to complete the survey, but the identity of these professors is unknown due to the anonymous collection of the surveys. On average, the responding faculty members had 30 yr of teaching experience, with individual responses ranging from 8 to 48 yr of experience. For the student participants, 116 students anonymously completed the survey. This was a response rate of 97% of the 119 students who were currently enrolled in the course.

As shown in Fig. 1, faculty members were asked to rank the frequency that they used six different teaching methods. All faculty members indicated that their most frequently used method was lecture, with low usage of online learning or educational games or activities. Students were asked to rank the same six teaching methods according to their effectiveness in mastering physiology content. Student rankings were similar across the six different methods, with all method averages ranging from 3.1 to 4.2. However, students reported statistically significant lower effectiveness of lectures and group learning compared with faculty use. On the other hand, students reported higher effectiveness of online learning and educational games and activities than faculty use.

Since faculty members relied primarily on lectures to teach courses, it was necessary to determine if they had previously

observed or used active learning in the classroom. Of the faculty members participating in this study (Table 1), 89% had observed active learning in the classroom and 78% had personally used active learning in the classroom at some point. In Likert-scale responses (where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree), faculty members were asked to describe their exposures to active learning. For faculty members observing active learning in the class, the effectiveness of use was rated as 3.88 of 5, and when faculty members personally used active learning, the effectiveness was rated as 4.57 of 5.

Faculty members were asked to hypothesize the effects of active learning, and this was compared with student responses (Table 2). For Likert-scale responses, both faculty members and students reported similar positive effects of active learning on student enjoyment, motivation to learn, exam performance, board performance, and retention of information. Mean student responses were slightly higher than faculty members responses, but no statistical differences were found. Faculty members and students reported that they expected the use of active learning to cause similar increases in student exam scores, by an average of 14%.

As shown in Table 3, faculty members were asked to relate the main reasons why they did not use active learning in the classroom. Similarly, students were asked to hypothesize the main reasons why faculty members chose not to adopt active learning teaching strategies. Respondents were asked to select all of the reasons that applied. A high percentage of both faculty members (44% of respondents) and students (91%) indicated that faculty members were accustomed to lecture-based methods. Both groups reported that there could be major issues with the amount of class time available to use active learning (faculty members: 89% and students: 41%), the time needed to develop the materials (faculty members: 33% and students: 29%), and a lack of training (faculty members: 22% and students: 53%). Students also felt that major barriers to the adoption of active learning could include a lack of faculty awareness (35%) or that faculty members did not see the strategy as a productive use of class time (45%). Additionally, many students elected to expand upon “other” explanations for why faculty members might not adopt active learning. The following major themes were detected, with representative student statements:

- Inability or resistance to change (12 students). “(Faculty) are stuck in their old ways and do not care enough to create engaging lectures.”
- Laziness or complacency (7). “Lazy, too much additional effort, easier to just show up and lecture.”

Table 1. Faculty responses on their observation and use of active learning

Statement	Faculty Responses
1A. I have observed active learning used in a classroom setting during lecture.	89% responded yes
1B. When I observed active learning in a classroom setting, it was used effectively.	Likert response: 3.88 (of 5 total); SD: 0.99
1C. I have personally used active learning in a classroom setting during lecture.	78% responded yes
1D. When I used active learning in a classroom setting, it was effective.	Likert response: 4.57 (of 5 total); SD: 0.53

Data reported as means of survey responses; n = 9 faculty respondents. The prompt for each of the statements is shown followed by the faculty responses. For statements 1A and 1C, faculty members were asked to select “yes,” “no,” or “unsure.” For Likert-scale responses for statements 1B and 1D, 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

Table 2. Faculty versus student perceptions of the effectiveness of active learning

Statement:	Faculty Responses	Student Responses
2A. (Students/I) would enjoy the use of active learning in the classroom.		
Average	4.13	4.51
SD	0.64	0.64
2B. (Students/I) would be more motivated to learn when active learning is used in the classroom.		
Average	4.13	4.35
SD	0.64	0.82
2C. (Student/My) performance on exams would improve from the use of active learning in the classroom.		
Average	4	4.18
SD	0.76	0.79
2D. (Student/My) board scores will benefit from the use of active learning in the classroom.		
Average	3.75	4.18
SD	1.04	0.84
2E. (Students/I) would learn better from engaging lectures that incorporated active learning than strictly didactic lectures.		
Average	4	4.65
SD	0.76	0.56
2F. Active learning is important for long-term retention of information.		
Average	3.88	4.44
SD	1.25	0.68
2G. I feel that the use of active learning would decrease (student/my) exam scores by ____%.	No respondents	No respondents
2H. I feel that the use of active learning would increase (student/my) exam scores by ____%.	100% of respondents	100% of respondents
Average	13.57	13.93
SD	6.27	17.74

Data are presented as means \pm SD; $n = 9$ for faculty members and 116 for students. The prompt for each of the statements is shown followed by faculty and student responses. For Likert-scale responses in *statements 2A–2F*, 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. Faculty and student responses were statistically compared for statements. *Statements 2A–2F* were analyzed using a Mann-Whitney *U*-test, with no significant differences. For responses to *statements 2G* and *2H*, respondents were first asked to select whether they felt active learning would increase or decrease scores. Results for *statement 2H* were compared using Student's *t*-test, with no statistical difference.

- Age-related factors (5). “We probably need more young and energetic professors . . . who are familiar with new methods.”
- A focus on research rather than teaching (3). “[Faculty] mainly research and only lecture because it is expected of them. It is not where their heart is.”

Despite the perceived barriers to the adoption of active learning in the classroom, faculty members and students indicated that they felt the method should be used in basic science classes (Table 4). Faculty members felt that 29% of face-to-

face class time should incorporate active learning, and students suggested that 40% of class time should be dedicated to active learning. Furthermore, faculty members reported that they were interested in improving their teaching skills (4.33 of 5 on the Likert scale), and 78% were interested in learning more about the use of active learning in the classroom.

DISCUSSION

In schools across the nation, there is currently a push toward active learning that appears to be supported by the administra-

Table 3. Faculty- versus student-perceived barriers to the use of active learning

	Faculty Members	Students
Do not feel that active learning is a productive use of class time	0	45
Do not see active learning as a useful tool	0	22
Have become accustomed to lecture-based methods	44	91
Lack of administrative support	11	7
Lack of training in the area	22	53
Not enough class time to use active learning	89	41
Not enough time to develop the materials	33	29
Not feasible given class sizes	11	12
Unaware of the method	0	35
Other	0	27

Data are presented as percentages of total faculty or student respondents; $n = 9$ for faculty members and 116 for students. Faculty members were asked to respond to the following prompt: “What is (are) your main reason(s) for not using active learning in the classroom? (Select all that apply).” Students were asked to respond to the following prompt, “What do you feel is (are) the main reason(s) that physiology faculty do not use active learning in the classroom? (Select all that apply).”

Table 4. Faculty versus student responses on the implementation of active learning

Statement	Faculty Responses	Student Responses
4A. What percentage of lecture time in basic science classes should be dedicated to active learning?		
Average	29	40
SD	12	12
4B. I am interested in improving my teaching skills. (Faculty members only)		
Average	4.33 (of 5 total)	N/A
SD	0.71	N/A
4C. Would you be interested in learning more about the use of active learning in the classroom?	78% responded yes	N/A

Data are presented as means \pm SD; $n = 9$ for faculty members and 116 for students. The prompt for each of the statements is shown followed by faculty and student responses. For the Likert-scale response in *statement 4B*, 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. For *statement 4C*, faculty members were asked to select “yes,” “no,” or “unsure.” N/A, not applicable.

tion, faculty members involved in educational research, and students (2, 17, 26). Many articles have focused on the benefits of active teaching strategies, through research conducted by faculty members who have implemented the method. However, little work has been done to systematically assess why other faculty members may be reluctant to adopt new teaching strategies. In the present study, all of the responding faculty members in the Department of Physiology and Biophysics at the University of Louisville reported that their primary instructional method was lecture, whereas the effectiveness of lectures was only moderately ranked by students (3.4 of 5). Faculty members also reported high usage of collaborative learning and problem solving, which could be considered to be forms of active learning. However, faculty members estimated that only 13% of the current class contact hours were dedicated to active learning strategies (data not shown). Surprisingly, educational games and activities were reported as the least used method by faculty members but were reported by students to be the most effective method by which they learned. Educational games and activities are used in engaging lectures, in which students are given short periods of lecture followed by breaks that can consist of 1-min papers, problem sets, brainstorming sessions, or open discussion. All of the students participating in this research study had been exposed to both engaging and traditional didactic lectures in their Dental Physiology course.

One large confounding variable in this study is that faculty members could have different interpretations of the various teaching methods they were asked to rank or connotations of the term “active learning.” This is to be expected, as active learning is an umbrella term that can encompass many teaching methods, including problem-based learning, team-based learning, engaging or interactive lectures, role playing, simulations, discussions, the flipped classroom, etc. In fact, it has been argued that active learning is not a method but rather an “attitude” of shifting from an instructor-centered to a student-centered classroom (27). While a definition of active learning was provided to all participants in this study, faculty members may have different associations of the types of activities that encompass active learning. Through personal observations and classroom visitations, the percentage of class time dedicated to active learning appeared to be much less than the 13% reported by faculty members.

Furthermore, there may have been significant differences in the quality of implementation. This is supported by the evidence that, when faculty members were asked to evaluate the effectiveness of active learning, they rated the effectiveness of their observations as slightly lower than their own personal use of the technique (3.88 vs. 4.57). Students, on the other hand, were exposed to a more controlled example of active learning through engaging lectures. All of the engaging lectures were conducted by C. J. Miller; thus, there was a high level of consistency in the implementation of active learning for the students. However, despite potential issues in the participants’ interpretations of the different teaching methods, it is clear that the responding faculty members rely primarily on lecture-based instructional methods.

When piloting the original investigation, engaging lectures were selected to test the effectiveness of active teaching strategies with professional students (20). While there could be specific benefits or disadvantages for each type of active learning, engaging lectures may be the easiest format to inte-

grate into existing curricula. Professors who are highly accustomed to traditional didactic lectures can still use their existing information and supplement this content with additional student activities or tasks. As these professors may not be able to cover the original amount of content, due to time restrictions, this information can be provided via online modules, assigned readings, or alternative methods (19). Thus, engaging lectures may be a beneficial way for instructors to comfortably “dip their toes” into the world of active learning, without embarking on more involved active learning strategies such as the flipped classroom. A level of familiarity may be important for professors to disembark from their traditional lecturing habits.

While the responding faculty members appeared consistent in their reported teaching methods, another concern is that there was a low response rate among the faculty members invited to the survey, with only 9 of the 13 teaching faculty members in the department anonymously responding. This could be due to busy work schedules or a general lack of interest in the subject matter. It is worth noting that, based on the original distribution lists, the four nonrespondents were all full professors in the department. While the identity of these individuals is unknown, it may indicate that more established faculty members are less inclined to adopt new teaching strategies. Additionally, a large percentage of the full professors in the department are nearing retirement and thus may not see the usefulness or feasibility of adopting active learning at the twilight of their careers. Therefore, the motivating factors for faculty teaching styles at different stages of their careers may need to be further investigated. Students, on the other hand, had an extremely high response rate of 97%, without any incentives offered for participation. Thus, students may feel that the subject matter is an important consideration.

While the present study was small in scale and only examined nine faculty members in one department of physiology, any effects on teaching strategies could be widespread. The Department of Physiology at the University of Louisville currently teaches >400 students each year, with >450 lecture hours. A main goal of this research study was to determine why faculty members rely primarily on traditional didactic lectures during these contact hours as opposed to more active learning methods, such as engaging lectures. When trying to elucidate the reasons why faculty members had not significantly adopted active learning techniques, 35% of students hypothesized that the faculty members were unaware of the teaching method. However, this does not appear to be the case, as 89% of the faculty members had observed active learning and 78% had personally used active learning techniques in the classroom. Thus, while a large percentage of faculty members had been exposed to or personally used the technique, there was still limited implementation within the professional-level courses. Consequently, it was important to further delve into the reasons why active learning was not being extensively used.

Students reasoned that faculty members may not feel that active learning is a productive use of class time (45% of respondents) or that faculty members did not see active learning as a useful tool (22%). However, the faculty surveys appear to directly refute these claims. When asked to rate the effects of active learning, both faculty members and students believed that active learning would increase student enjoyment, motivation to learn, performance on exams, board scores, and retention of information. In fact, both faculty members and

students predicted that the use of active learning would increase exam scores by 14%. This is supported by earlier evidence our group conducted on active learning (20), in which engaging lectures improved unit exam scores by 9% and final exam scores by 23%. It is worth noting that faculty and student participants were not presented with the results of these previous studies regarding the effectiveness of active learning, and surveys were completed before publication of the results.

Consequently, the data discussed thus far presents a conundrum. The responding faculty members surprisingly indicated very positive assessments of active learning techniques but continued to rely primarily on traditional didactic lectures. If faculty members are highly acquainted with active learning techniques and see the potential benefits of the method, what are the main barriers to the implementation of active learning?

Many of the faculty concerns focused on the logistics involved with adopting the teaching method. Faculty members reported that they lack training in the area (22%), there was a perceived lack of administrative support (11%), and they did not have sufficient time to develop the materials (33%). Active learning may not be an intuitive technique for professors who are accustomed to traditional didactic lectures, and sufficient training and feedback may be necessary in the area (33). For beginners, there is a wide variety of available literature that focuses on the practical implementation of active learning in the classroom (1, 3, 4, 30). Beyond this initial introduction, it may be necessary to facilitate formal faculty training and to provide faculty members with appropriate leave time to create materials (2). Evidence suggests that faculty members participating in professional development programs are more likely to effectively integrate active learning strategies into lecture (10). Additionally, given the busy schedule of a modern faculty member, administrative support through appropriate scheduling may be crucial to the successful adoption of active learning in the classroom.

On the other hand, research has also shown that educational activities can be developed with a minimal investment of time (9). Furthermore, many free, peer-reviewed resources are available on sites such as MedEdPORTAL (<https://www.mededportal.org/>), the American Physiological Society Archive of Teaching Resources (<http://www.apsarchive.org/>), and MERLOT II (www.merlot.org). While one-third of the faculty members reported that the time needed to develop the materials was a major barrier, research suggests that even faculty members provided with sufficient materials may face difficulties with implementation (31).

A large majority of faculty members (89%) expressed concerns that there was not enough class time to use active learning. This is certainly an important concern, as the time required to implement active learning may appear greater than that required for traditional lectures. However, this argument relies on the idea that what is said during a traditional lecture is learned by the students. Educational research indicates that after 2 wk, students tend to remember 20% of what they hear and 90% of what they say and do (11). Therefore, while lectures may appear more efficient on the surface, they may be limited in their potential for long-term retention. With the use of active learning, content may also be delivered through alternative forms, such as assigned readings or online learning. By making students responsible for portions of the material

outside of class, educational activities can be incorporated without sacrificing content (15, 19, 24).

Implementing active learning in the classroom can be difficult, and a student suggested on the survey that faculty members may “fear losing control of the classroom.” Indeed, 11% of faculty respondents were concerned that active learning was not feasible given their class sizes. At the University of Louisville, graduate, dental, and medical physiology class sizes range from ~15 to 160 students. Given this large range of class sizes, a wide variety of active learning strategies may be necessary. In previous work (20), our group has shown the feasibility of incorporating engaging lectures into classes with 120 students. This has been supported by other research studies (13, 14, 23, 32) that demonstrated that large groups can benefit from an interactive lecture style. Additional observations, training, and practice may be necessary to alleviate faculty concerns over the use of active learning in large, professional-level classrooms.

Each of the faculty concerns presented in this study were legitimate and must be addressed for proper implementation of the learning technique. As faculty members begin to integrate the new teaching method, it may be important to maintain some consistency in courses, particularly when using a team-teaching approach. As previously described, when engaging lectures were used in approximately one-half of the team-taught Dental Physiology course, there was a growing discontent among students for the lectures that were presented traditionally (20). Indeed, in the present study, many students chose to write about negative reasons why faculty members might not adopt active learning, such as an inability to change, laziness/complacency, a primary focus on research rather than teaching, etc. While it can certainly be argued that these explanations are untrue, they may also be indicative of the strong student push for the incorporation of active learning strategies.

Despite the many hurdles that must be overcome to implement active learning in the classroom, faculty members and students appear to be in agreement that active learning strategies are beneficial to student success. While there was a large range of responses, on average, faculty members felt that 29% of face-to-face class time should be used for active learning and students believed that 40% of class time should be dedicated to active learning. Furthermore, 78% of the faculty members surveyed indicated that they would be interested in learning more about the use of active learning in the classroom. Thus, it appears that the first task needed to implement active learning may have been completed, and faculty members and students are now in agreement on the benefit of the technique. Furthermore, there is a genuine interest on the part of the responding faculty members to improve their teaching and learn more about the use of active learning in the classroom.

This study served the important function of determining the main barriers that prevent faculty members from adopting active learning strategies in the professional classroom. In particular, it showed that the main perceived barriers were a lack of necessary class time, a high comfort level with traditional lectures, and insufficient time to develop materials. These results will be used to create a faculty development program that trains professors how to efficiently create and implement active learning in their classrooms. This program will involve observation of effective active learning in large classes, hands-on training in material development and class-

room management, peer feedback on initial implementations, and assessment of the learning strategy from both faculty and student viewpoints. While the development of such a faculty development program will require a great time investment, the present results suggest that both faculty members and students perceive the importance of active learning to student engagement, motivation, and overall performance.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the author(s).

AUTHOR CONTRIBUTIONS

Author contributions: C.J.M. and M.J.M. conception and design of research; C.J.M. performed experiments; C.J.M. analyzed data; C.J.M. and M.J.M. interpreted results of experiments; C.J.M. prepared figures; C.J.M. and M.J.M. drafted manuscript; C.J.M. and M.J.M. edited and revised manuscript; C.J.M. and M.J.M. approved final version of manuscript.

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