Reinvigorating Continuing Medical Education: Meeting the Challenges of the Digital Age

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Abstract

Clinicians in today's health care environment face an overwhelming quantity of knowledge that requires continued education and lifelong learning. However, traditional continuing medical education (CME) courses cannot meet these educational needs, particularly given the proliferation of knowledge and increasing demands on clinicians' time and resources. CME courses that previously offered only in-person, face-to-face education must evolve in a learner-centric manner founded on principles of adult learning theory to remain relevant in the current era. In this article, we describe the transition of the Mayo Clinic Cardiovascular Review for Cardiology Boards and Recertification (CVBR) from a traditional course with only live content to a course integrating live, online, and enduring materials. This evolution has required leveraging technology to maximize learner engagement, offering faculty development to ensure content alignment with learner needs, and strong leadership dedicated to providing learners an unparalleled educational experience. Despite stagnation in growth of the traditional live course, these changes have increased the overall reach of the Mayo Clinic CVBR. Learners engaging with digital content have demonstrated larger increases in knowledge with less educational time commitment. Courses seeking to implement similar changes must develop formal learning objectives focused on learner needs, build an online presence that includes an assessment of learner knowledge, enlist a cohort of dedicated faculty who teach based on principles of adult learning theory, and perpetually refresh educational content based on learner feedback and performance. Following these principles will allow traditional CME courses to thrive despite learners' resource constraints and alternative means to access information.

Continuing medical education (CME) in the 21st century is evolving rapidly.[1-6] Advances in technology now permit multiple points of learner contact. Busy clinicians can access educational material through a variety of digital recordings and online platforms. In this setting, an explosion of clinical knowledge underscores an ongoing need for continuing education.

These changes have shifted the paradigm of CME. Live courses are no longer necessary to deliver knowledge. In addition, clinicians are less able to leave their practices because of productivity, financial, and administrative expectations, and fewer are willing to spend nonworking time away from their families. Ubiquitous access to information makes live didactic knowledge delivery, a stalwart of traditional continuing medical education, less necessary in the current era. Learners now expect easily accessible activities that facilitate knowledge synthesis and prioritize clinically relevant problem solving.[1] Finally, evolving proof of competence requirements from medical specialty boards oblige continuous rather than periodic learning.[7-9] All these factors have negatively affected attendance at and engagement with traditional live CME meetings.

To meet the needs of learners in this changing environment, CME courses must themselves evolve. Courses can no longer consist of a series of loosely related content

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experts lecturing to the audience about their own field of expertise. Instead, traditionally didactic courses must shift from a teacher-centered to a student-centered model, design curriculum to meet the specific needs of their learners, and build a team of faculty members who cohesively deliver broad and deep content without gaps or redundancies. This evolution of CME needs to remain grounded in established, evidence-based principles of lifelong continuing education.

This article describes our experience contemporizing a live CME course with a blend of both online and live learning. This evolution has been made possible by 3 important factors: (1) learner engagement through technology, (2) faculty development, and (3) visionary leadership and mentoring for the next generation of educators. These changes have improved learner performance and increased longitudinal involvement with educational materials while still maintaining relevance of the live CME course despite challenges from the external environment.

THE MAYO CLINIC CARDIOVASCULAR REVIEW FOR CARDIOLOGY BOARDS AND RECERTIFICATION COURSE AND ADULT LEARNING THEORY

The Mayo Clinic Cardiovascular Review for Cardiology Boards and Recertification (ie, Mayo Clinic Cardiovascular Review for Cardiology Boards and Recertification [CVBR]) began in 1995. The course was initially structured as a traditional CME program, with didactic lectures spread over 5-6 days. Sessions covered the gamut of topics in general and subspecialty cardiology, with a focus on preparing first-time certifiers and recertifiers to pass their American Board of Internal Medicine (ABIM) Cardiovascular Board Examination. Given its comprehensive content, the course also attracted practicing cardiologists seeking to refresh their knowledge from a comprehensive, evidence-based curriculum. At its peak in 2008, 850 participants attended the live annual course.

As the environment surrounding CME evolved, the course directors recognized the need to grow the course beyond the traditional didactic format. In 2013, they partnered with a third party consulting group, Knowledge to Practice (K2P). K2P provided unique services compared with other third-party CME vendors, such Oakstone's Practical Reviews or Wolters Kluwer's Audio Digest, that offer digital content delivery without comprehensive integration into existing live programming. The partnership between the Mayo Clinic CVBR and K2P sought to integrate curriculum design, faculty development, course management, and learner analysis to deliver personalized, competency-based learning. Both K2P and course leaders understood that changes of this magnitude required a strong theoretical basis. Therefore, they founded the evolution of the Mayo Clinic CVBR on established principles of adult learning theory.

The concept of adult learning theory dates to the 1970s, when educational expert Malcolm Knowles outlined his principles of andragogy, also known as *adult learning theory*.[10-13] These principles contrast with pedagogy, which takes a teacher-centered approach to education. The curriculum in andragogy is learner defined rather than teacher defined. Teachers must focus on concepts relevant to a learner's specific goals. Concepts build on learner experience as opposed to an instructor's area of expertise, because learners must integrate their prior experiences into new knowledge to feel comfortable changing their behavior. Objective self-assessments shift motivation from extrinsic to intrinsic sources. Therefore, learning in andragogic theory is directly applicable to a learner's knowledge gaps instead of predefined subjects or tasks.
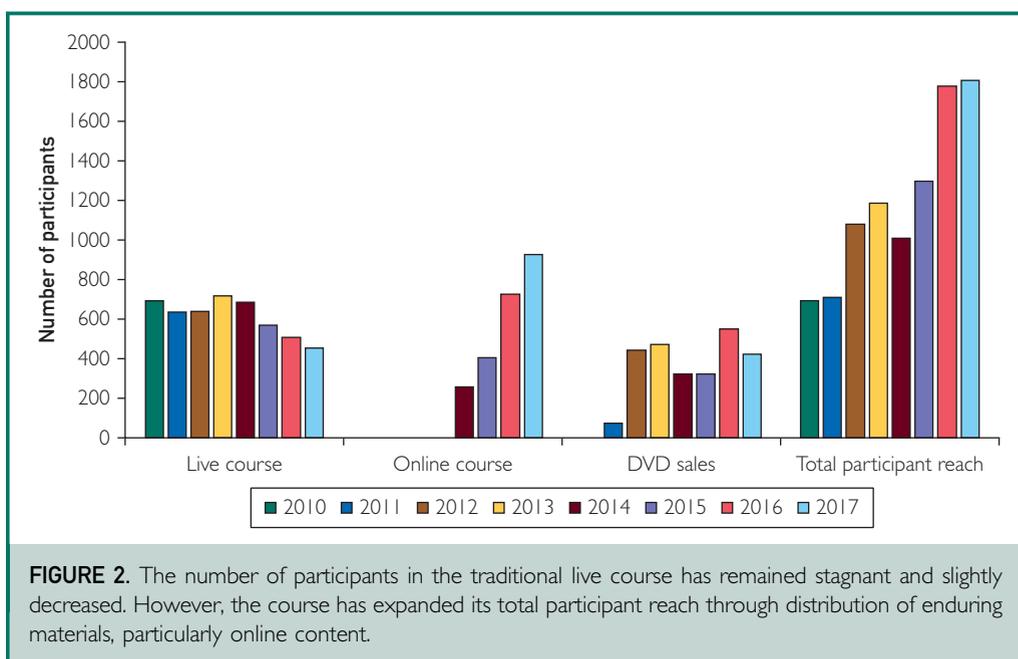
For more than 25 years, studies have documented that approaches that use principles of adult learning theory improve the effectiveness of CME. For instance, multiple systematic reviews have demonstrated that didactic sessions alone are less effective for improving performance or affecting patient care.[14,15] In contrast, workshops and case discussions, which are more interactive, learner-centered, and engaging, demonstrate higher degrees of effectiveness.[14,16]

FIGURE 1. This image offers a representative screenshot of the online portal developed by Knowledge to Practice and the Mayo Clinic Cardiovascular Review for Cardiology Boards and Recertification. The portal includes pre-course and post-course assessments. Performance on the pre-course assessment generates a personalized study guide for learners. Learners can use their performance on the post-course assessment to measure their progress as they engage the learning content and seek to fill specific knowledge gaps.

Sequenced education (ie, learn-work-learn) can also improve physician performance.[14] A more recent synthesis of multiple systemic reviews of CME effectiveness reported similar findings: CME improved performance more when it was interactive and focused on outcomes that physicians considered important.[17] These data have led to a call for CME providers to invoke dissonance between a learner's actual and perceived knowledge, give learners the opportunity to reflect on desired levels of performance, and facilitate open communication among individuals involved in CME.[18] Organizations like the American Medical Association and Accreditation Council for Continuing Medical Education now recognize the need for CME to offer leaner centric content focused on gaps in clinical knowledge.[19,20] However, despite recommendations and evidence demonstrating the effectiveness of implementing principles of adult learning theory, traditional CME courses have been slow to adopt such changes.[2]

By leveraging principles of adult learning theory, Mayo Clinic CVBR leaders sought to differentiate their course in the marketplace and ensure the Mayo Clinic CVBR's ultimate sustainability. The partnership with K2P offered course leaders the technological tools necessary to apply these adult learning principles to the educational goals of the Mayo Clinic CVBR.[21] In particular, K2P developed an online learning portal to provide learners consistent and uninterrupted access to educational content. This portal also serves as a data repository that permits CVBR leadership and the K2P staff members to perform ongoing analysis of course metrics before, during, and after the live course.

K2P's online learning portal currently includes a 250-question formative assessment for learners to complete in the weeks preceding the live course. Each question in the assessment links to a learning objective in the course. We designed questions to assess a balance of knowledge ($\sim$20%), application of knowledge ($\sim$50%), and synthesis of

FIGURE 2. The number of participants in the traditional live course has remained stagnant and slightly decreased. However, the course has expanded its total participant reach through distribution of enduring materials, particularly online content.

knowledge (∼30%). Learners do not typically complete the pretest in a single setting, which distributes the burden of answering 250 questions. Despite the large number of questions, over the last 3 years, 58% of attendees have completed the formative assessment. The formative assessment helps learners to evaluate their current knowledge, identify knowledge gaps, and focus their attention while they attend the live course. When learners complete their formative assessment, the online portal generates a list of personalized learning recommendations. These recommendations highlight sessions in the upcoming course that address a given learner's knowledge gaps. During the live course, learners use the portal to follow lecture content, ask faculty questions, access supplemental reference material such as guidelines important publications, complete faculty evaluations, and review supplementary online-only presentations that are not part of the live course. The Mayo Clinic CVBR first integrated K2P's online learning portal as part of the 2014 course. Figure 1 displays a representative screenshot of K2P's portal.

These tools from K2P have allowed the Mayo Clinic CVBR to expand beyond a

traditional live course. Digital recordings of the course have been available for purchase as DVDs for several years and remain a popular method through which learners asynchronously engage with the content. However, DVD technology is becoming less accessible, and simple viewing of recorded lectures remains a passive form of learning. Therefore, in 2015, the course began offering an option for online-only registration, giving learners access to content through the online learning portal without attending the live course. These offerings expanded in 2016, when content from the Mayo Clinic CVBR became available as a segmented online course, giving learners access to content in smaller, 5-10-minute segments targeted to specific learning objectives and knowledge gaps. Those participating in this segmented online course do not have the benefit of direct interaction with faculty and peers or dedicated time away from other personal and professional demands that attending the live course offers. Rather, the segmented approach facilitates "learning-on-the-go," allowing learners to access small pieces of knowledge without requiring them to invest large segments of time. Over the past several years, the Mayo Clinic CVBR has increased

its reach by more than 2000 total participants, driven largely through an increase in online access to the course. In contrast, live course participation has stabilized while growth of DVD sales has slowed (Figure 2). Moving forward, these trends will likely accelerate, as resources for live learning become more limited and technology increasingly permit online and digital access to information and medical knowledge.

LEARNER ENGAGEMENT AND IMPACT OF TECHNOLOGY

A key component underlying the evolution of the Mayo Clinic CVBR has been the focus on learner engagement through technological innovation. This engagement has occurred on several levels, all of which are founded on principles of adult learning theory.

Learner engagement begins several months before the live CVBR course, when registrants receive access to the online pretest. The online pretest drives engagement through multiple mechanisms. For example, literature demonstrates that physicians' ability to self-evaluate their competence in relation to their peers is notoriously poor.[22,23] After completing the pretest, learners receive an objective assessment of their own performance in relation to competency and the performance of their peers. These results identify knowledge gaps and create discordance between actual and perceived competence, which can drive intrinsic motivation and engagement. During the 2017 Mayo Clinic CVBR, learners who completed the pretest had 28% more online portal views than did learners who did not complete the pretest. This result demonstrates that engagement before the course is associated with subsequent engagement during and after the course.

Learner engagement continues during the live course as well. Learners can take and store lecture notes directly in the online portal. They can post online questions that faculty members answer immediately after their lecture. Course directors use analytic data from audience response questions in

the lectures to formulate "sprint tests" at the end of each day that reinforce teaching directed toward the audience's learning gaps for that day's content. Finally, a large portion of the ABIM's certification examination in cardiovascular diseases includes interpretation of coronary angiograms, echocardiograms, and electrocardiograms. The online portal provides sample cases in which learners can practice their interpretation of these critical imaging modalities through an interface that simulates the environment of the ABIM Cardiovascular Board Examination.

After the live course, learner engagement continues. Learners retain access to the online portal for 1 year after the live course. This access allows them to review content from the live course lectures along with supplemental online-only content in a variety of formats, including videos, slide sets, transcripts, and audio files. They complete a board-style assessment after the course, which contains the same questions as the pretest. Learners who do not participate in the live course maintain access to digital recordings of the live course and the dedicated online only content. This approach has not adversely affected knowledge gain. In contrast, learners who engage through the complete or segmented online courses have
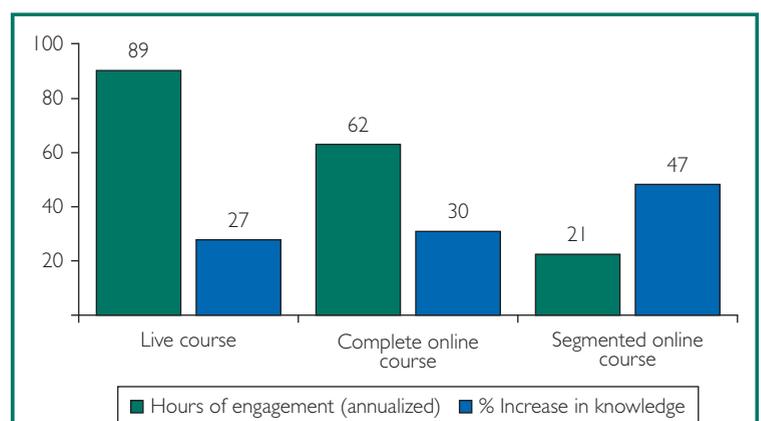

FIGURE 3. Data from the Mayo Clinic Cardiovascular Review for Cardiology Boards and Recertification demonstrates that, while hours of engagement decreases, knowledge lift can actually increase with a move from traditional live learning formats to online learning.

Before the live course	During the live course	After the live course
Online pretest assessment	Digital note taking	Online posttest assessment
	Moderated question-and-answer sessions with faculty members using submitted online questions	Portal access for online content review in multiple formats, including learning session videos, slide sets, transcripts, and audio files
	Daily sprint tests focused on the audience's learning gaps	
	Sample coding examinations for angiograms, echocardiograms, and electrocardiograms	
	Access to animated faculty slides	

FIGURE 4. Methods of learner engagement that leverage digital technology before, during, and after the live Mayo Clinic Cardiovascular Review for Cardiology Boards and Recertification.

demonstrated 3-fold increases in knowledge from pretest to posttest, with 50% less time dedicated to content engagement (Figure 3). This finding suggests that novel approaches to learner engagement can augment knowledge in a more time- and resource-efficient manner. Although it would be impossible to isolate the influence of education from our course relative to other continuing professional education endeavors in which our attendees participate, future efforts must still attempt to assess the impact of this increased knowledge on practice behaviors and patient-level outcomes.

Figure 4 outlines these tools for optimizing learner engagement that move beyond the traditional model of CME. The tools emphasize longitudinal interaction with content for continuous knowledge and skill development targeted at learner specific practice gaps rather than isolated lectures based on areas of faculty expertise. This learner engagement can occur through blended engagement at a live course and digital interactions outside the bounds of traditional live destination meetings.

FACULTY DEVELOPMENT

The cardiology community has placed increasing value on the role of educator development[24,25] and presentation design[26] in the delivery of educational content. A key aspect in the evolution of the Mayo Clinic CVBR has been faculty development toward a learner centric model. This evolution has involved developing content based on learning objectives, improving presentation design and delivery, and sharing expertise with learners through traditional and novel means.

Achievable learning objectives represent a key element of lifelong learning.[27] They facilitate transitions between lectures, reduce content gaps and redundancies, improve curricular organization, and facilitate knowledge assimilation. Many courses offer learning objectives only as an obligatory response to accreditation requirements; however, learning objectives serve several important roles. First of all, they focus learner attention on key aspects of their curriculum. Perhaps more importantly, learning objectives provide an organizational framework for faculty to structure their content and presentations. To facilitate the shift to

a "blended learning environment" and target faculty development efforts, the Mayo Clinic CVBR developed formal learning objectives for each session based on the outline in the ABIM blueprint. This effort increased the total number of learning objectives for the course from 9 in 2013 to more than 250 currently. This focus on learning objectives ensures that faculty members cover all relevant material while avoiding gaps and redundancies.

Faculty development also involves educating faculty about design of energetic and engaging presentations that optimize learning. Through a process of iterative feedback from course directors and course attendees, faculty members gradually improve their presentations. During the live course, both attendees and expert observers evaluate faculty presentations. Evaluations from expert observers emphasize the metrics used for faculty development while evaluations from attendees focus on learner needs and satisfaction. The ratings from both attendees and expert observers correlate well (Figure 5). This demonstrates that the emphasis of faculty development initiatives aligns with learner needs and satisfaction. Finally, course directors remove faculty members from the course who do not engage in multiple attempts at faculty development and improvement.

A critical piece of faculty development involves encouraging course faculty members to share their expertise with learners through a variety of channels. After every lecture at the live course, a course director moderates a one-on-one question-and-answer session with each lecturer. These sessions discuss common clinical scenarios plus areas of controversy or ambiguity pertaining to the faculty's content. Much of the content for these discussions comes from online questions that learners submit through the online learning portal during the live presentation. In addition, the course directors design the agenda such that faculty members are available to attendees for direct conversation and peer-to-peer interactions during breaks in the programming. Finally, course faculty

members share their knowledge in the online learning portal by responding to questions learners submit during their lecture. This shared knowledge exchange energizes and engages faculty and drives motivation for future course participation.

LEADERSHIP AND MENTORSHIP
This evolution of the Mayo Clinic CVBR would not have been possible without leadership from course directors with a passion for education and an understanding of the larger CME environment. This passion, coupled with a reputation for clinical excellence, provides the guidance and motivation necessary for individual faculty to maximize their teaching skills and raise their own standards of performance. It also offers vision and scope to the course planning team as they pursue continuous curriculum improvement.

A key element of course director leadership has been an emphasis on mentoring and developing the next generation of clinician leaders and educators. Others have recognized the value that CME can have on leadership development, not only for learners but also for those involved in course
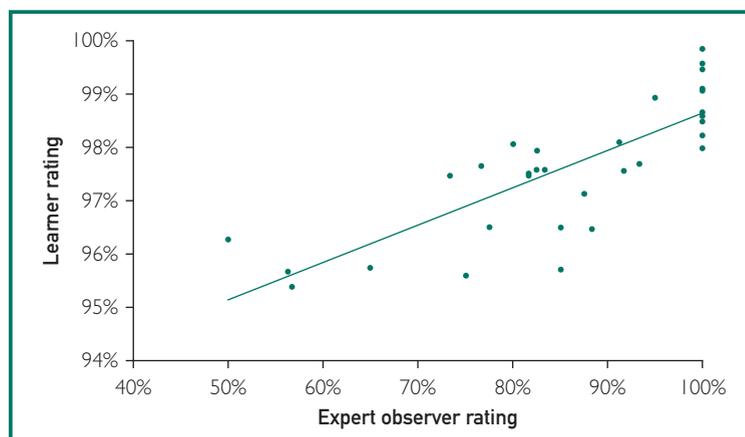

FIGURE 5. Learner rating of faculty (y-axis) correlates with expert observer rating of faculty (x-axis), demonstrating that learner needs and expectations align with the metrics course directors use for faculty development and expert observer ratings. Each point represents an individual faculty lecture during the live Mayo Clinic Cardiovascular Review for Cardiology Boards and Recertification course. The y-axis reflects the percentage of attendees providing a favorable score averaged across multiple domains. The x-axis reflects an aggregate of scores from expert observers.

Build an online presence, including a bank of digital questions used for formative and summative assessments.
Engage faculty members through direct and novel approaches to audience interactions.
Formalize learning objectives.
Continually reassess needs of learners through survey data and responses to preassessment and postassessment questions.
Establish a succession plan.
Rigorously analyze presentations and learner performance on multiple-choice assessments.

FIGURE 6. Recommendations for continuing medical education courses seeking to reinvigorate their programming.

planning and execution.[28] The leaders of the Mayo Clinic CVBR have similarly recognized the need to engage future generations. To this end, they identified young faculty members who articulated an interest and proclivity toward cardiovascular education. They offered these faculty opportunities to speak and develop their own educational content. Course directors directly mentored these younger educators in content design and delivery. Course leaders gave them reign to offer new and innovative means of delivering content to course learners. As a consequence, despite relatively limited experience, the younger leaders have scored in the top tier of lecturers in the live course. This dedication and commitment to the career development of others underscores the leadership necessary for transformative change to an existing CME program. It also lays a strong foundation for enduring success.

RECOMMENDATIONS FOR OTHERS
How can other courses implement these changes that have transformed the Mayo Clinic CVBR course? Figure 6 offers recommendations for courses seeking to leverage principles of adult learning theory to reinvigorate their programming and more effectively educate an audience of learners in the evolving CME environment. These recommendations encapsulate key steps that the Mayo Clinic CVBR has taken while still remaining broadly applicable across the spectrum of CME courses.

THE FUTURE OF LIVE CME PROGRAMMING
As CME courses evolve to a mix of live and digital content, clinicians and educators may speculate why live courses continue to exist. If learners can access all content online and achieve greater increases in knowledge with less time commitment (Figure 3), why should educators continue to offer live CME programming? The experience of the Mayo Clinic CVBR demonstrates that live courses remain important in the current CME environment. First, they offer dedicated time away from other professional and personal responsibilities for learners to engage directly with educational content. Second, they drive faculty engagement by offering exciting and invigorating interactions with learners. Finally, live courses provide opportunities for learning outside of the traditional structure of the CME meeting. These opportunities occur through informal conversations with colleagues, peer-to-peer networking, and direct interactions with expert faculty members. Therefore, although digital and online content is an important and almost obligatory complement to live programming, it should not completely supplant live programming for CME content.

CONCLUSION
Delivering CME with learner engagement though technology, learner centric faculty development, and visionary leadership, all founded on principles of adult learning theory, can increase the influence and reach of CME programming in the evolving

educational environment. Learner engagement occurs through both traditional and digital means. Digital content adds intrinsic value but does not substitute for traditional in-person learning. Courses seeking to implement similar changes must proceed with a firm understanding of adult learning theory. Identifying learners' knowledge gaps, creating dissonance between actual and perceived knowledge, facilitating open communication between learners and faculty, and using learning objectives and focused scenarios relevant to learners' daily practice and professional scope are critical for CME courses to evolve. Ultimately, this multifaceted approach can serve as an enduring model for CME in the 21st century.

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