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A Continuum of Innovation: Curricular Renewal Strategies in Undergraduate Medical Education, 2010–2018

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Abstract

Purpose

Since 2010, medical schools across the United States have engaged in a new cycle of curricular revision and renewal for their undergraduate medical curricula. But what structures, features, and trends have emerged in U.S. medical schools as a result of deliberate curricular redesign efforts? An analysis of the ways that medical schools have approached the reorganization of their curricula to prepare their students for the growing complexity of medical practice is presented.

Method

This study drew a total pool of 40 U.S. MD-granting programs, of which 25 met the inclusion criteria for the study. The authors used a qualitative coding approach to materials from the undergraduate medical education (UME) program websites to identify 4 dimensions of strategies that these programs used to renew their curricula.

Results

The analysis of the curricular maps and website content of the UME programs provided evidence for a continuum approach to the description of innovation strategies: 96% of schools employed a cohort-based linear pathway, 80% of schools used thematic basic science blocks, 47% placed their Step 1 exams outside of the second year, and 68% moved their clerkships to the second year.

Conclusions

The Continuum of Innovation strategies will enable programs to renew their curricula in ways that promote deliberate curricular changes that are consistent with emerging needs in the field. This study and future research may be useful for UME programs with limited resources by providing consensus practices that enable them to plan curricular changes in ways that best serve their institutions.

Over time, various forces influencing medical education, health care, and society contribute to the emergence of cycles of curricular revision and reform efforts in medical schools across the United States. Since 2010, a date that coincided with the 100th anniversary of the Flexner Report,[1] schools have engaged in a new cycle of curricular revision and renewal for their undergraduate medical curricula. This recent cycle of renewal was prompted in part by evolving expectations of physician skills, knowledge, and competencies within changing health care systems and in the meaning of the medical degree itself. During this renewal cycle, the Carnegie Foundation's 2010 report[2] on physician education influenced many undergraduate medical programs to focus on consistent approaches to curricular design, active learning strategies, professional identity formation, and the integration of classroom-based education with clinical experiences. Further, the American Medical Association's (AMA's) 2013 Accelerating Change in Medical Education initiative has promoted innovative, technologically augmented approaches to teaching and learning and greater attention to health systems science topics as a complement to undergraduate medical programs' long-standing focus on basic science content and clinical experiences.[3] While the recommendations of the Carnegie Foundation and the AMA's initiatives do not address all drivers of change in contemporary curricular renewal (such as the demands of residencies, hospital systems, and accreditation), these 2 organizations have already had a substantial effect on the curricular designs and trends that are emerging in undergraduate medical education (UME).

In this article, we present an analysis of the ways that medical schools in the United States have approached the problem of renewing their curricula to prepare their students for the growing complexity of medical practice. This brief analysis will help to advance the work of curricular renewal in 3 ways. First, we hope to inspire the field-wide study of medical school curricular renewal to develop multi-institutional expertise on the best processes and best practices. Second, the study of curricular renewal on its own terms will benefit educators and physicians because it provides the opportunity to proactively identify and evaluate broader trends in medical education. Finally, we hope that this analysis and future work in the field will help other medical education programs avoid the expense and difficulty of independently planning and conducting their curricular renewal process de novo. Through this qualitative analysis of the publicly available materials on these curriculum renewal efforts, we hope to enable administrators and curriculum developers to deliberately plan ongoing curricular change and avoid the trauma and expense of a ground-up renewal process.

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Acad Med. 2019;94:S79–S85.
First published online July 30, 2019
doi: 10.1097/ACM.0000000000002909

Background

Curricular renewal cycles are more than examples of the churn of innovation in medical education. These periods bring into focus a phenomenon identified by Donald Schon[4] as a "crisis of confidence" in the ability of professional disciplines to adequately prepare their students for independent practice. In Schon's paradigm, the constant flux within the conditions of medical practice (as a result of changes in technology, policy, regulations, and culture) requires constant changes in the process of creating new physicians. Further, the evolution of medical education itself can also drive the need for renewal and change. Cooke et al note that "what is also clear is that the very act of resolving one era's problems often contributed to the dilemmas of the next generation."[2(pvi)] As a result, the epochal renewal cycles that require considerable expenditures of time and resources are not only predictable but also inevitable.

Crises of confidence need not occur if undergraduate medical programs are better equipped to anticipate and plan for changes in practice and learning needs. In a recent summary of lessons learned about curricular renewal, Mcleod and Steinert[5] note that health sciences curricula "should be perpetually responsive to change" and that "regular evidence-based renewal must be accepted and valued by educational leaders, teachers, and learners." In their review of tips for curricular renewal, Mcleod and Steinert outline several important principles for achieving this responsiveness, such as the imperative to articulate reasons for curricular change and ongoing renewal, critically review the teaching methods and educational strategies, and ensure appropriate content and sequencing in the curriculum. But how do medical schools characterize this cycle of curricular renewal now that it is underway? Little research has been conducted on the actual outcomes of curricular renewal and revision as it has been implemented in medical schools across the country. However, a more recent series of papers on the specifics of curriculum development processes at individual institutions has emerged to provide some information on decision processes.[6–9] To identify the broader themes of this renewal cycle, it is essential to trace the emerging centrality of the concept of integration to the evolution of medical education.

The key features in the published literature accompanying the beginning of this current cycle of renewal (2010 onward) center on the theme of integration along 3 dimensions. First, several authors have promoted the tighter integration of basic sciences across disciplinary lines.[10,11] Today's ubiquitous organ-systems-based approach to organizing basic science education emerged as a designed alternative to the previous approach, a 2-pass, normal physiology/disease physiology sequence that emerged in the 1980s and 1990s.[12] In the mid-2000s, medical educators expressed frustration with the artificial boundaries created by the organ-systems-based approach, as this logic necessarily created silos and redundancies in teaching,[11] and have sought new directions for the teaching of preclinical science content.

Second, medical educators have broadly supported initiatives that promote the tighter integration across basic and clinical sciences.[13,14] In this view, the bright line between preclinical and clinical activities is counterproductive to student learning. While students routinely attain excellent scores in measures of their biomedical content knowledge, a growing body of evidence indicates that they are having difficulty deploying this knowledge in the clerkship and residency contexts.[15,16] Some authors suggest that integrating need-to-know foundational science information with clinical practices could produce better outcomes.[17] As such, several schools have integrated clinical activities into preclerkship basic science activities in ways that fundamentally restructure their programs.[18]

Third, medical educators continue to grapple with the integration of both basic and clinical sciences with social science approaches and broader interpersonal skill sets. Developments in the field of health systems science have led scholars to look for ways to integrate important concepts from social sciences into UME. In 2010, Sales and Schlaff[19] identified 5 ways that the literature has shown medical education to come up short in this regard. These include a lack of integration of evidence-based medicine and population medicine, a lack of coverage of health policy, and poor integration of heuristic learning. Ultimately, Sales and Schlaff call for a greater integration of social science approaches and content into the medical science curricula. In response to the critique of medical education offered by Sales and Schlaff, a number of authors both expanded the call for greater integration of relevant social science content[20,21] and questioned the value of this proposition.[22,23] With regard to integration of interpersonal skill sets, Alexandraki and Mooradian[24] identified issues such as patient–physician communication, patient-centered medicine, and interdisciplinary learning experiences as central to the development of medical education within this current cycle of renewal.

Because the integrations within the basic sciences, between basic and clinical sciences, and among basic, clinical, and health systems sciences require a rethinking of medical education processes, this article focuses on a central question: What structures, features, and trends have emerged in American medical schools as a result of deliberate curricular redesign efforts since 2010? To provide a framework for the operationalization of the research question, we turned to *Educating Physicians*,[2] the 2010 Carnegie report on the state of medical education. The Carnegie Foundation identified 4 key pillars of medical education reform that reflect trends in other educational domains. These pillars include the following:

1. Standardization of learning outcomes and the individualization of learning processes,
2. Integration of formal knowledge and clinical experience,
3. Development of habits of inquiry and innovation, and
4. Focus on professional identity formation.

For the purposes of this article, we focus on the impact of pillars 1 and 2 because the strategies used by schools to construct their curricula to differentiate and integrate didactic learning and to address the acquisition of clinical skills provide insights into the deepest structural changes made to the educational experience for students. To accomplish this analysis, we

asked 4 key subquestions about features of renewed curricula that serve as proxies for progress along these goals:

- RQ1: How do students progress through the curriculum?
- RQ2: How do schools organize the basic science content within the curriculum?
- RQ3: Where do the programs place the United States Medical Licensing Examination (USMLE) Step 1 exam?
- RQ4: When do students begin their clerkship experiences?

While these 4 questions do not assess every aspect of innovation or interest in an MD program, they are each designed to probe key areas of focus in this cycle of curricular renewal. The purpose of RQ1 is to assess the degree to which schools have begun to adopt individualized, adaptive pathways through their programs (if at all). RQ2 examines the general strategies used by schools to organize the formal, basic science knowledge of the preclerkship period. RQ3 focuses on the timing of the USMLE Step 1 exam, as this exam has traditionally occurred at the conclusion of basic science training. RQ4 focuses on the timing of the start of clerkships in the curricula. While many schools have established innovative activities or programs within the broader frameworks of their MD programs, these 4 curricular features serve as indicators of the degree of structural change that these programs have engaged in during their most recent renewal cycle.

Method

Given (1) the lack of methodological processes for performing analyses of curricula and (2) the lack of existing frameworks for describing differences across renewed curricula, we opted to use a grounded document analysis approach in our analysis. This consisted of first identifying a sampling strategy, then developing a coding structure, and finally developing a framework for describing these changes. The results of this analysis yielded (1) a census-like quantitative count of the design decisions made in the renewal of specific programs and (2) a qualitative framework that provides insight into the kinds of renewed programs that emerged from the process.

Sampling strategy and data sources

This study drew a total pool of 40 MD-granting programs from *U.S. News & World Report*'s (USNWR's)[25] 2018–2019 top 100 ranked undergraduate medical programs in the United States. USNWR's list of schools is nationally recognized and was judged most likely to contain a broad range of public and private medical programs. The first 30 schools in our pool were drawn randomly from the top 50 medical schools in the rankings, with the remaining 10 drawn randomly from the next 50 schools. We used this tiered selection strategy because we theorized that schools ranked in the top 50 of the list would be more likely to have had the human and capital resources necessary to undergo and implement a renewal process early in this cycle. However, we did not want to exclude schools in the bottom 50 schools, which may have been able to produce an innovative renewal strategy. Thus, we adopted a 3:1 sampling approach.

To meet inclusion criteria, for this analysis, each program must (1) have undergone some form of curriculum renewal since 2006 (with a first graduating class of 2010) and mention it in their public materials, (2) provide suitable information for analysis via their websites, (3) have obtained full Liaison Committee on Medical Education (LCME) accreditation as a medical school in the United States, and (4) feature a 4-year curriculum. Of the total pool of 40 curricula, 25 met the inclusion criteria for the study. During the analysis, we used the 15 unrenewed schools as a comparative sample.

This study uses 3 kinds of data sources drawn from the websites of the selected schools between May and November 2018. First, most institutions provide a curriculum map, diagram, or course descriptions that provided sufficient information to answer RQs 1 through 4. Second, institutions provided substantive information about their renewal process on their websites, including messages from their deans about the process, guiding principles for renewal, and descriptions of the schools' approach. Finally, we also reviewed videos and multimedia materials from schools that featured those resources on their websites. Those materials contained additional details that informed the qualitative coding model. We chose to draw these data sources directly from the schools' public websites because these are the most immediate kinds of information that students and prospective employees would encounter during decision making.

Qualitative analysis process

During the analysis, we used a base-open-axial-thematic coding process[26,27] to develop our qualitative analysis. In the first step, we downloaded, sorted, named, and base-coded our MD program data with low-inference, factual information in preparation for the analysis. We then used an open-coding approach to generate an initial set of codes based on a sample of 10 schools that had undergone renewal. As we added more programs to the corpus, we engaged in constant case comparison to ensure that our codes were consistently applied across cases. In the axial phase, we condensed and grouped the generated codes into categories and consolidated them into the form represented in Table 1.

Table 2 contains the application of the resulting codes for each research question, arrayed by all UME programs included in the study. In the thematic phase, we applied these codes to the entire corpus of data and used these findings to create the framework presented in the Results section.

Results

Quantitative findings

Table 2 lists the 25 schools that were selected for inclusion and the codes applied to each of them based on the research questions. After arraying the data in the table, we were able to answer the research questions by quantifiably representing trends among the schools and performing a simple count of the schools that adopted one set of strategies or another. This count is represented as percentages in our quantitative results.

RQ1: How do students progress through the curriculum? Ninety-six percent of the renewed curricula that we reviewed in this study featured cohort-based, linear pathways with fourth-year opportunities for individualized curricula. The only exception in the pool came from Oregon Health & Science University, which attempted to adopt an adaptive competency-based approach to student

Table 1
Codes Developed During the Axial Coding Phase of Analysis

	Code	Definition
RQ1 codes: Student pathways	Linear	A linear pathway through the curriculum, with no opportunities for individualization
	Individualized	A purely individualized curriculum that is tailored to students' needs and abilities
	Competency based	A competency-based curriculum that aligns students' needs and abilities against objective performance states
	Linear w/ Individualization	A linear pathway that includes some opportunities for individualization during predefined periods
RQ2 codes: Preclinical organization	Systems based	Organ-systems-based approaches to organizing preclerkship sciences
	Thematic blocks	Theme-oriented organizations that integrate basic science across multiple organ systems
	Modules	Self-contained modules that integrate necessary basic science content into case-based or problem-based learning blocks
	Two-pass	A 2-pass, normal/disease approach to curriculum that was popular through the 1990s
RQ3 codes: USMLE Step 1 timing	Year 2	Step 1 is primarily located in year 2, at the end of preclerkship training
	Year 3	Step 1 is located in year 3, at some point after the clerkship period began
RQ4 codes: Clerkship timing	Year 2	Clerkships begin in the second year
	Year 3	Clerkships begin in the third year
	Variable	Clerkships begin whenever students complete preclerkship training

progress. We posit that nearly all schools have selected a linear pathway strategy as a result of the demands placed on their curricula by (1) LCME program length requirements, (2) clerkship requirements of national and state boards, and (3) the fourth-year residency interviewing processes. A completely adaptive curriculum may not be possible at many schools because of the constraints imposed by accreditation and other agencies and limitations of material and human resources.

RQ2: How do schools organize the preclerkship content within the curriculum? Eighty percent of renewed curricula include thematic, integrated blocks in the new curricular structure. In many cases, this new structure replaces the systems-based approaches to basic science curricula that were in use before the renewal effort. However, within these blocks, schools have developed many novel approaches that are worth analyzing in greater detail in future studies.

RQ3: Where do the programs place the USMLE Step 1 exams? Forty-eight percent of curricula in the sample have placed USMLE Step 1 somewhere other than at the end of the second year of their program. In most cases, schools moved the taking of Step 1 into year 3, following the clerkship period. However, limitations in residency application periods do not allow schools unlimited leeway in the placement of study periods for the Step 1 exam.

RQ4: When do students begin their clerkship experiences? Sixty-eight percent of programs sampled in this study moved their clerkship experiences from year 3 to sometime in year 2. In most cases, the placement of clerkships followed a shortened basic science period. In many cases, schools reduced their preclerkship period from roughly 24 months to 16 or 18 months. The movement of the clerkship experiences to the middle of the second year enabled some programs to take advantage of the longer third-year/fourth-year boundary periods for enrichment, research, or professionalization periods.

The answers to these research questions provided us with substantial insight into the ways that schools have been able to accommodate their overall goals for curricular change given enduring systemic and external requirements such as the residency application cycle. Still, in working within these parameters, schools have found substantive ways to change their modes of teaching to accommodate the changing demands and conditions of medical practice.

Qualitative findings

Our analysis of the curricular maps and website content of the UME programs provided evidence that innovation strategies used by the sampled schools could be placed into a continuum. This observation emerged during the analysis of combinations of schools' renewal strategies in the array of curricular and instructional strategies used in Table 2. This analytic framework, which we termed the "Continuum of Innovation," describes 4 major zones of curricular redesign that could be used to categorize the schools, ranging from mild to radical redesigns of their curricula. While many medical schools have employed 1 or more of these trends, we have observed 4 major clusters of curriculum redesign strategies in play (summarized in Figure 1):

- **Conventional designs** were the product of the prior renewal cycle between 1995 and 2005, with linear pathways where students progress as a cohort, the curricula are organized based on physiological systems, USMLE Step 1 occurs at the end of the second year, and clinical experience begins in the third year. These are not included in Table 2 because they did not meet our inclusion criteria.
- **Mild redesigns** use linear pathways but have reorganized their content into integrated thematic blocks that last approximately 2 years. Clerkships occurred in the third year, and USMLE Step 1 remained at the end of year 2.
- **Moderate redesigns** use linear pathways and thematic blocks but have redesigned the basic science component to end in approximately 1.5 years, with the clerkships beginning in the second year. USMLE Step 1 is taken sometime in the third year.
- **Radical redesigns** use adaptive, competency-based pathways through the curriculum, with thematic blocks that are directly related to their competencies, variable clerkship timing, and variable USMLE timing.

Table 2
Applications of Open Codes to the Sample Pool in the Axial Phase of Coding

School	RQ1—Pathways	RQ2—Organization	RQ3—Step 1	RQ4—Clerkships
1. UNC Chapel Hill	Linear w/Individualization	Systems based	Year 2	Year 2
2. UC San Francisco	Linear w/Individualization	Thematic blocks	Year 3	Year 3
3. University of Washington	Linear w/Individualization	Thematic blocks	Year 2	Year 2
4. University of Wisconsin	Linear w/Individualization	Thematic blocks	Year 3	Year 2
5. University of Nebraska	Linear w/Individualization	Thematic blocks	Year 2	Year 3
6. Stanford University	Linear w/Individualization	Thematic blocks	Year 3	Year 2
7. University of Rochester	Linear w/Individualization	Thematic blocks	Year 2	Year 2
8. Case Western Reserve	Linear w/Individualization	Thematic blocks	Year 3	Year 2
9. University of Chicago	Linear w/Individualization	Thematic blocks	Year 2	Year 3
10. Indiana University	Linear w/Individualization	Thematic blocks	Year 2	Year 3
11. New York University	Linear w/Individualization	Systems based	Year 3	Year 2
12. University of Kansas	Linear w/Individualization	Thematic blocks	Year 2	Year 3
13. University of Illinois	Linear w/Individualization	Thematic blocks	Year 2	Year 3
14. SUNY Stonybrook	Linear w/Individualization	Thematic blocks	Year 2	Year 3
15. Johns Hopkins University	Linear w/Individualization	Systems based	Year 3	Year 2
16. Vanderbilt	Linear w/Individualization	Thematic blocks	Year 3	Year 2
17. University of Michigan	Linear w/Individualization	Systems based	Year 3	Year 2
18. Harvard	Linear w/Individualization	Thematic blocks	Year 3	Year 2
19. Columbia	Linear w/Individualization	Thematic blocks	Year 3	Year 2
20. University of Connecticut	Linear w/Individualization	Thematic blocks	Year 3	Year 2
21. Rush University	Linear w/Individualization	Thematic blocks	Year 2	Year 3
22. Cornell	Linear w/Individualization	Systems based	Year 2 or 3	Year 2
23. Oregon Health & Science University	Competency based	Thematic blocks	Variable	Variable
24. Yale	Linear w/Individualization	Thematic blocks	Year 3	Year 2
25. Northwestern	Linear w/Individualization	Thematic blocks	Year 2	Year 3

The examples of radical redesigns in this study have achieved some of these goals in design but may face difficulties in achieving full implementation.

Table 3 presents the total counts of the number of sampled schools in each zone of the continuum, along with the names of the schools. These programs were placed in their respective locations based on their responses to RQs 1–4, as well as additional materials and program descriptions that were included on their websites.

Discussion

Applying our Continuum of Innovation framework to organize the schools examined into categories of conventional, mild, moderate, and radical redesigns provides an easy visualization of what Johnson[28] calls "the adjacent possible." In this case, adjacent possibilities are the most different possible innovations that can be imagined and implemented in a system based on its current state. In this case, schools that exist in the conventional design part of the continuum in this cycle of renewal would not be well served by changes that catapult them into radical redesign territory without first implementing substantial incremental changes. In their article on the progress of Oregon Health & Science University, Mejicano and Bumsted report[9] just such an issue. In trying to radically innovate their curricula and make it adaptable to learners' abilities, they reportedly encountered LCME limitations that prevented them from shortening their coursework requirements beyond a fixed time frame. However, schools that moved from conventional designs to

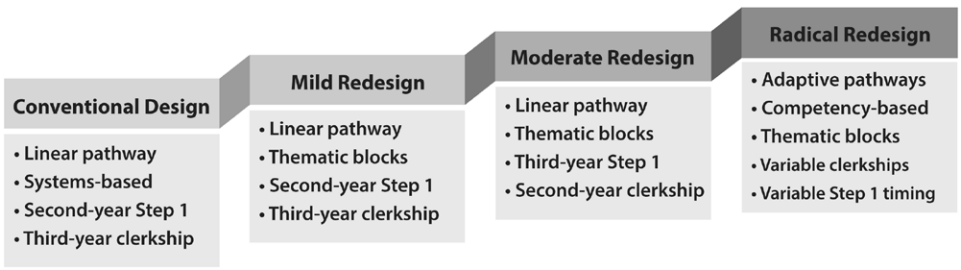

Figure 1 A visualization of the Continuum of Innovation.

Table 3
The Total Counts of Schools in the Sample, as Represented in Each Part of the Continuum

Mild redesign count (6)	Moderate redesign count (17)	Radical redesign count (2)
UNC Chapel Hill	UC San Francisco	Oregon Health & Science University
University of Nebraska	University of Washington	University of Kansas
University of Chicago	University of Wisconsin	
University of Illinois	Stanford University	
Rush University	University of Rochester	
Northwestern University	Case Western Reserve	
	Indiana University	
	New York University	
	SUNY Stonybrook	
	Johns Hopkins University	
	Vanderbilt University	
	University of Michigan	
	Harvard University	
	Columbia University	
	University of Connecticut	
	Cornell University	
	Yale University	

mild redesigns (such as Northwestern University[18]) reported success in developing these initiatives within existing structures and using those successes to position themselves for future long-term changes. Rather than search for the one, best way forward, researchers in curricular renewal must develop an understanding of the design patterns[29] that allow medical schools to flexibly adapt to emerging conditions in the practice of medicine. By creating plans that allow incremental changes over time, medical school curricular designers and researchers will be able to extend the adjacent possible, realize new opportunities, and mitigate risks associated with innovation.

Limitations

Curricular maps are not the same as the instructional territory, and nuances of curricular changes made may not have been evident in the publicly available materials used in this study. Schools have made many innovations within their curricula; for example, some schools have transitioned from a 2-phase *preclerkship/clerkship* design to a 3-phase *preclerkship/clerkship/career launch* approach that aims to prepare students for the challenges of residency and practice. Similarly, several schools were observed to interweave their preclinical and clinical phases in ways that might promote tighter integration. And still other institutions used active learning strategies to deeply connect their preclerkship content to clinical contexts in ways that blur the boundaries between these features altogether.

Given the variety of approaches to curriculum renewal, this study features 3 limitations that we will attempt to address in future papers. First, though we have taken great pains to represent a balanced sample of schools in our analysis, it is possible that other kinds of program designs may exist that occupy other positions in the Continuum of Innovation that we did not observe. This would include programs that have adopted a 3-year structure, as well as MD/PhD programs and other kinds of programs that did not adhere to our selection criteria. Second, aside from the 4 features that we examined via our research questions, schools have instituted a range of novel strategies in their redesigns that improve the student learning experience. These include mentorship and tutoring programs, student research programs, and leadership opportunities that were not in the scope of this analysis. Finally, schools' plans for renewal are under constant cycles of formulation, experimentation, and revision. As such, the plans that are communicated publicly may not represent the final form of implemented curricula, especially in the most ambitious plans analyzed in this study.

Future research

The findings from this study are the first in a long-term study of the periodic renewal of medical curricula, with 3 lines of research for future investigation. The first area of focus will be an examination of the specific structures of programs' preclinical periods in the renewed curriculum, as the organization of this content can yield insights into the current cycle's conceptualization of the role of basic sciences in preclinical training. The second area of focus will examine the specific uses of active learning that schools have chosen during their renewal process. Third, and based on in-depth interviews with curriculum renewal leaders at several schools, we will examine the organizational and political processes undertaken during renewal processes. This exploration will help to identify best practices to help schools manage future renewal efforts and avoid common pitfalls.

Conclusions

This article contributes to the study of UME's periodic renewal and change in 3 ways. First, the definition of Continuum of Innovation strategies may better enable undergraduate medical programs to periodically and more extensively renew their curricula in ways that promote deliberate curricular changes consistent with the emerging needs in the field. Second, this study and future research may lead to the development of a toolbox of best practices for curriculum renewal. This may be especially useful for undergraduate medical programs with limited resources by providing them with tools to deliberately plan their curricular changes in ways that best serve their institutions. Third, future curricular design research can focus on qualitative interviews with appropriate administrators to illuminate the implementation challenges associated with the aftermath of curricular renewal. This future research is essential to understanding the process of curricular change as an issue of stewardship for the field of medicine, as well as a way to minimize the impact of Schon's "crisis of confidence in the professions."

Acknowledgments: The authors wish to thank Cha-Chi Fung, PhD, Anne Vo, PhD, Cathy

Jalali, PhD, and Amanda Frataccia, MSMI, for their support and efforts in the creation of this manuscript.

Funding/Support: None reported.

Other disclosures: None reported.

Ethical approval: Reported as not applicable.

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