A PERSONAL VIEW | Curricular Integration of Physiology

Integrating the basic sciences in medical curricula: focus on the basic scientists

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INTRODUCTION

There is a trend in modern medical school curriculum design to integrate the basic sciences and clinical sciences (4, 10, 22). Integrating basic science education with its clinical application from the initial stages of learning is thought to improve retention of information and facilitate the transfer of knowledge to the clinical setting (14, 19, 36). Indeed, the concept of integration is not new to medical education, as innumerable papers have been written on the topic since Case Western became the first school to incorporate an integrated curriculum in the 1950s (25). However, despite decades of effort, practical implementation of integration remains a challenge, as illustrated by the continuing calls to prioritize integration in medical education reform (7, 17, 29). It has been argued that one of the reasons for this ongoing challenge is a lack of focus on a fundamental facet of the process: the basic science educators themselves (15, 17).

The basic sciences (also called “foundational sciences”) are a core component of most medical curricula, as they address the biological underpinnings of the human body, disease, and associated therapies. Biomedical Doctor of Philosophy (PhD) scientists typically teach these topics, and these scientists play an active role in contributing to health care curricula. According to the 2018 U.S. Medical School Faculty Report from the Association of American Medical Colleges, in 2018, 21% (37,503 individuals) of all full-time academic medical faculty hold a PhD or other doctorate degree, excluding medical doctors (MD/PhDs) (2). While it is difficult to determine how many of these faculty are educators, biomedical PhD scientists at medical schools are active and crucial contributors to most medical school curricula.

A challenge to the integration process is that, in an integrated curriculum, these basic science educators must recontextualize their content to mesh appropriately with its clinical application, despite not being trained as clinicians. Most biomedical PhD scientists have limited to no exposure to medical education or application during their own training. Yet to appropriately integrate basic science content with clinical application, these educators must develop an understanding of what scientific content is most relevant in a variety of specialties to appropriately focus their teaching for a medical audience (15, 17).

We argue that a practical way to facilitate curricular integration is to create opportunities for basic science educators to learn about the clinical application of their topical area of expertise through shadowing and collaborations with clinician educators, and to pair these initiatives with training in effective medical education practices. It is important to note that these strategies can also benefit clinician educators as well as basic science educators in other health care curricula besides medicine (28). Here we discuss practical strategies to develop these opportunities and how they benefit educators.

Distinguish the Goals of Medical Educators from Those of Graduate Educators

The role of a basic science educator in a medical school is distinctly different from that of a basic scientist who teaches scientific trainees. Traditional biomedical PhD training emphasizes the biological processes and mechanisms that drive the normal and pathological functions of the body. Medical training, on the other hand, emphasizes rapid application of biomedical principles to solve problems (e.g., diagnostic and therapeutic decisions), typically in the context of particular patient scenarios. Basic science medical educators should appreciate that the goals of educators in the two settings are quite different in scope, focus, and priorities.

One mechanism to help basic science educators appreciate the clinical application of basic science is to provide them clinical shadowing opportunities. Basic science and clinician educators differ substantially in focus, pace, and even vocabulary used in teaching, which can create a “cultural divide” between these two groups of educators, which can, in turn, create barriers to effective integration of teaching efforts (12, 27). By shadowing clinician educators during patient care or...
clinical teaching, basic scientists can observe how clinicians apply basic science concepts and the relative priorities of subtopics within a field. Such opportunities help basic science educators better understand how to prioritize and communicate information that has long-term relevance for their learners. Another benefit of such pairings is that it may facilitate collaborative relationships between basic science and clinician educators for developing effective integrated curricular content in the future (15, 17).

In a medical school setting, it can be relatively straightforward to create opportunities for scientists to shadow clinicians. Typically, setting up such collaborations involves reaching out to clinician educators who are already engaged with medical student or resident education. Many clinician educators are aware of the cultural divide between basic science training and clinical training in medical schools and are open to participating in initiatives to address this issue. These interactions are most productive when the clinician educator appreciates the importance of basic science integration in medical education and has a strong ability to explain basic science concepts to different types of audiences (37). One potential constraint is that the schedules of both scientist and clinician educators are typically busy, so it is essential to build in flexibility in the time and timing of these interactions. Allowing for this flexibility opens opportunities for scientists to shadow a variety of types of clinicians in a number of settings (e.g., inpatient and outpatient settings, in the clinic and in didactic settings, at Grand Rounds, etc.).

Motivated individual educators can certainly independently seek out and create such collaborations. In addition, institutions desiring to facilitate effective curricular integration should support their faculty by fostering activities to bring together basic science and clinician educators, such as educator conferences, education journal clubs, or seminars. Institutions can also develop explicit shadowing programs and offer protected time to the faculty participating in these programs and collaborations. Basic scientists who are asked to teach health care professionals should be encouraged or even required to participate in these faculty development experiences.

Basic science educators may desire to improve their ability to integrate into medical curricula but are prevented from doing so by their other responsibilities. Those educators benefit from structural changes in the educational system to minimize barriers to integration and effective teaching. For example, relevant curricular teams can be designed to include both clinician educators and basic scientist educators. Not only will each individual provide his/her expertise, but the clinicians can act as built-in consultants to help the scientists appropriately frame their material. These strategies will minimize communication barriers and contribute to a more extensive and robust network of educators within the institution.

Another mechanism to minimize barriers to effective teaching is for curricular leadership to provide clear expectations and feedback to all instructors. For example, it helps educators integrate seamlessly with the expected structure of an integrated curriculum, if the course leader minimizes the effort required for them to provide a clear and successful lesson. Leadership can describe and even template the expected structure, learning objectives, and scope of the lesson or lesson materials, provide guidance as to the expected instructional design, and give thoughtful feedback after the lesson. Additionally, course leadership should provide the educator with student evaluations of their lesson and provide guidance as to how to interpret the feedback to improve the lesson in the future. Benefits of faculty participation in these activities would include not only improved understanding of clinical application by the basic scientists, but also better student evaluations, a more seamless curriculum, and a positive impact on faculty morale.

Provide Advising and Mentoring for Medical Educators

Biomedical scientists who are asked to teach in integrated curricula often lack explicit mentoring on how to navigate the nuances of the medical educator profession. Biomedical PhD trainees often have strong mentors in the field in which they are working, but, unsurprisingly, these mentors are typically not equipped to advise about how best to navigate other fields (13, 16, 26). Pairing basic science educators with active medical educators has the secondary benefits of providing the opportunity to observe successful navigation of this professional experience while also creating a network of potential advisors and mentors.

Career advising is important because biomedical PhD scientists who are drawn to medical education are likely to be underprepared for the realities of this career. For example, there are different pressures and measures of productivity for educators than there are for researchers. Whereas researchers are expected to acquire grant funding and maintain a productive laboratory and publish, educators are instead expected to display innovation and adaptability to changing curricula and to maintain strong course evaluations. Another difference is the degree of independence of the educator. Medical educators often have less freedom to design courses or determine course content than do their graduate educator colleagues. Medical school courses are typically embedded in a broader curricular system that is strictly monitored and, therefore, enforces certain limits or guidelines about what and how information should be taught. Curricular committees may have influence on instructional design, influencing decisions such as whether content should be administrated in person versus online or in lecture versus interactive settings. Furthermore, since many medical schools are reducing the time allotted to standalone basic science courses, a successful scientist educator must be able to frame essential information in a relatively short amount of time while adhering to the demands of the broader curriculum. This relative lack of independence can be a challenge for basic science educators trained in the cultures of graduate programs that typically allow relative autonomy in both scope and approach to teaching. In addition, the research education methods, journals, and societies in the scholarly field of medical education need to be learned anew (3a, 6, 8, 28, 33).

One way a new educator can address this challenge is to pair with experienced educators who can advise him/her on how to effectively navigate his/her individual education career. One approach to aid this process is to draft an individual development plan [IDP; also known as individual learning plan (ILP)] specific for the development of an educator. An IDP is a document that outlines the baseline knowledge set and skills of a professional, their short- and long-term goals (e.g., acquiring specific skills or knowledge, publishing, etc.), and the concrete activities that will help the professional achieve the proposed
goals (10). IDPs for researchers are now encouraged or required for National Institutes of Health (https://www.nigms.nih.gov/) and foundation-sponsored research funding, as they are found to aid career development (35). Education-specific IDPs should be equally effective in aiding career development for educators (18). Education-specific IDPs should factor in the educator’s previous experience and anticipated future teaching responsibilities, availability of resources for the educator, and time commitment required for skill building. IDPs are best laid out in collaboration with an education mentor who meets regularly with the educator to review the progression toward goals and to revise the IDP as needed as career goals change. Example faculty IDPs can be found through both local and national institutions, along with lists of core competencies to guide professionals on the crafting of the IDPs (e.g., Refs. 9, 24, 32).

Institutions can facilitate the development of medical educators by offering advising and mentoring programs tailored specifically to the needs of educators. Such opportunities can be offered through faculty development offices, and for younger PhD trainees through graduate and postdoctoral offices and associations. More locally, basic science departments or units with many faculty members who are charged with teaching can develop mentors or mentoring committees for educators to review teaching statements, provide peer feedback on teaching, and help these faculty generate IDPs. More broadly, educators can participate in online learning communities. Such communities may be offered to generalized educator audiences by federally funded centers (e.g., The Center for the Integration of Research, Teaching, and Learning; see https://www.cirtl.net/) or to specialized populations by scientific societies [e.g., Physiology Educator Community of Practice (PECOP); see https://blog.lifescitrc.org/pecop/; Educator Scholars Program in Pediatrics (4)].

Acquiring the Skills of an Educator

Despite the fact that teaching is an attractive career path for an estimated 20% of PhD students (30), few biomedical science trainees receive any formal training as teachers during their graduate training (5). When trainees do have the opportunity to learn teaching skills, it is most typically as teaching apprentices or tutors, not as independent teachers themselves (20, 34). Even more rare is for biomedical science PhDs to receive explicit training in the methods and skills most common in medical education (5, 9). As discussed by Haramati (15):

... [C]omment expertise is insufficient for educators in the health professions to teach effectively. ... curricular planning, optimal teaching and learning formats, and ... up-to-date assessment strategies are all necessary and ... require additional skills and guidance from education experts.

Due to the lack of formal training in teaching during the graduate school training process, many educators have to learn teaching skills on the job. Therefore, most biomedical PhD trainees and faculty interested in teaching would benefit from explicit training in the skills of an educator (21, 22). Such training could address topics such as lesson or curriculum design, effective instruction methods, assessment, and instructional design. These programs should also give a realistic perspective of the time and effort it takes to prepare for teaching.

Ideally, an educator would be able to participate in a program individualized to their context and needs that also includes experiential practice. Such opportunities may exist locally at the individual’s institution, such as courses, trainings, and workshops, in teaching skills offered through Centers for Teaching and Learning or medical education offices. If such opportunities do not exist locally, individuals may participate in national programs with personalized curricula (28). For example, the “Promoting Active Learning and Mentoring Network” (Palm; see https://palm.ascb.org/) is a national network that helps individuals develop teaching projects as a means to train them in active learning methods and educational best practices, while simultaneously providing education and career mentoring. Individuals wishing for in-depth training may pursue programs explicitly designed to teach advanced skills in medical education, such as the Harvard Macy Institute (https://www.harvardmacy.org/) programs, which allow educators to learn to put into practice effective methods of teaching a medical audience. Postdoctoral trainees may participate in Institutional Research and Academic Career Development Awards (IRACDA; see https://www.nigms.nih.gov/training/careerdev/pages/twodinstres.aspx) programs, which offer dual training in mentored postdoctoral research at a research-intensive institutions and mentored teaching at partner institutions historically committed to developing students from groups underrepresented in biomedicine (22).

Barring access to individualized training programs, individuals may pursue other options to improve their skills as educators more generally. At the most fundamental level, interested biomedical faculty and trainees can build educator training into their existing activities. For example, Ciaccia (5) describes a three-phase, self-driven approach in which individuals explicitly focus on improving presentation skills, seek out advanced mentored training in specific teaching skills, and practice teaching skills during typical scientific practices, such as mentoring others at the bench. Individuals can also pursue generalized training through massive open online courses offered through academic institutions, such as edX (https://www.edx.org/) or Coursera (https://www.coursera.org/) (11). Any individual at any stage of training can take advantage of online educational digital libraries, including the Life Science Teaching Resource Community (LifeSciTRC; see https://www.lifescitrc.org/index.cfm), a searchable digital library that can help expand faculty and trainee knowledge and skill sets on a flexible time frame, The National Science Digital Library (NSDL; see https://nsdl.oercommons.org/), which provides teaching and learning content in STEM disciplines, and the The BiosciEd Net (BEN; see http://www.biosciiednet.org/portal/index.php) collaborative from American Association for the Advancement of Science, which provides biology teaching and learning content.

Institutions can help individuals by providing services to their educators, such as peer review of curricula or lectures, external evaluation of teaching materials, and aid with essential aspects of curriculum design, such as appropriate assessment methods (3, 22, 23, 28, 32). For educators interested in scholarly work, institutions should offer services such as consults on education studies, manuscript writing and review, and aid with education grant application. Finally, institutions may also pro-
vide funding opportunities for educators to attend general or individualized education programs.

Addressing Conflicting Productivity Demands

Biomedical PhD scientists who teach full time have every incentive to get trained on how to be a better educator. However, it can be a challenge for basic scientists who run research programs and engage in medical education only part time to acquire additional education skills. Research productivity pressures, such as acquiring funding and publishing, demand most of their time and attention, particularly in a limited funding atmosphere. While it is typically well regarded for faculty members to add teaching to the service that they provide the institution, the reality is that, for many basic science researchers, teaching is not a driving criterion for promotion. There may be, therefore, little incentive for them to improve their teaching skills or adapt to health care audiences, besides their personal motivation to do so.

Institutions that are committed to facilitating integrated curricula and the career development of their faculty should incentivize faculty to continually grow as educators. One approach is to focus on junior faculty early in their time at the institution, when they typically do not yet have extensive teaching obligations. These faculty could be expected to develop their education skills and facility in addressing multiple audience types before they are relied on for teaching. Research faculty who are already established and who are tasked with teaching should be paid for those teaching activities, which, in turn, incentivizes the highest level performance. Additionally, departments can stimulate faculty by developing bonuses or other incentives for leadership positions in education, attending seminars, completing education trainings or courses, shadowing, participating in education committees, and mentoring and advising of educators. At a higher level, institutions could require a mandatory system of feedback on educator faculty evaluations and offer resources to develop educators’ skills for faculty. Finally, the activities and performance of any faculty member who contributes to the educational mission of the school should be counted toward his/her promotion criteria.

Conclusion

In conclusion, we propose that one approach to address the ongoing challenge of medical curricular integration is to intentionally develop the skills of basic science faculty. In integrated curricula, basic scientists must focus their teaching to appropriately prioritize high-yield, clinically relevant content. Therefore, they must necessarily undergo a learning curve to appropriately refocus their teaching for a health care audience. We argue that a practical and efficient way to facilitate curricular integration is to minimize barriers to success by creating experiential learning opportunities for basic science educators to learn from clinician colleagues about the clinical application of their content. The pairing between clinician and basic science educators can help diminish the "cultural divide" between these two groups of educators, which, in turn, enables ongoing curricular integration collaborations. Individual educators also benefit from developing a network of medical education collaborators and advisors that can help them navigate this career path and from the enhancement of their teaching skill set. There are numerous ways that both individuals and institutions can create and facilitate such faculty development opportunities, both for basic science faculty who are full-time educators and those who engage in medical education part time. Ultimately, these interventions and initiatives will benefit the institution’s curriculum and the student learners impacted by the curriculum.

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AUTHOR CONTRIBUTIONS

I.D. and A.Z. conceived and designed research; I.D. and A.Z. analyzed data; I.D. and A.Z. drafted manuscript; I.D. and A.Z. edited and revised manuscript; I.D. and A.Z. approved final version of manuscript.

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