Medical Students and the Drive for a Single Right Answer

Teaching Complexity and Uncertainty

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ABSTRACT

The arrival of Generation Z, the next generation of medical learners, has been accompanied by efforts to adapt teaching practices for this new group of students. Many have identified challenges associated with addressing the needs of modern medical learners. One particular trend we have observed is that medical students are increasingly requesting an "answer key" for all aspects of their medical education. Students often expect to have the correct answers readily available to them to ensure they have reached the correct conclusion and to determine the precise knowledge they need to master. Yet, for much of medicine, and particularly in the care of critically ill patients with multisystem disease in intensive care units, answers are uncertain, and the body of knowledge is ever-growing. Students' regular requests for solutions to be provided to them threaten to undermine their development into critically thinking, self-sufficient physicians. We outline three potential contributors to this multifactorial problem and offer corresponding pedagogical solutions. Specifically, we address how prioritizing outcomes over process, discomfort with uncertainty, and fear of faltering can cause students to seek excessive levels of support that may ultimately do more harm than good. Addressing students' concerns in these three key areas will not only serve students well during their undergraduate medical training but will also equip them with the skills needed to succeed in the clinical realm. To produce physicians capable of navigating an increasingly uncertain world, medical educators will need to help students appreciate that finding the answer is more complex than being provided an answer key.

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Many educators have raised concerns about challenges associated with adapting medical education teaching practices to meet the needs of Generation Z, the new generation of learners (1–3). In our personal experiences at our institution, an emerging trend we have observed is students' desire for, and often expectation of, an "answer key" during each phase of the medical school curriculum. As students navigate a medical education path riddled with information overload, question banks, and standardized examinations, one potential consequence is that they are increasingly concerned about delineating the bounds of what they are expected to know and receiving affirmation about whether they have arrived at the correct answer.

There are several notable characteristics that distinguish modern medical learners. These students have come of age in an era defined by technology, virtual connectedness, and a rapid acceleration in the ability to generate and access large amounts of information (4). As a result, they are likely to expect high degrees of interactivity, collaborative learning, and instant gratification (3, 5). Moreover, in our own experience as students and educators in this new era, students often struggle to find ways to prioritize the most important information given the ever-growing amount of material that they could master. It is prudent, therefore, to consider how our educational strategies should shift to address these unique challenges. Prior work has highlighted ways in which different generations of learners might benefit from tailored educational strategies that take into consideration their unique expectations, experiences, and values (1–4, 6, 7). Others have emphasized the importance of mutual understanding and "generational humility" for bridging any potential generational gaps (8, 9). Given the complexity of pulmonary critical and care medicine, it is particularly important for educators in this field to consider how these challenges might apply to learners, many of whom will be challenged by increasingly complex and acutely ill patients across multiple specialties.

The pedagogical shift to accommodate modern medical learners has risks, however. In particular, there is apprehension about our ability to achieve the optimal balance between tailoring teaching to address the most current student learning requirements and associated preferences (recognizing that learning "styles" are a form of preferences that do not correlate with performance [10]) and the need to provide students with the skills and knowledge required to be self-sufficient physicians (11). We suggest that providing answer keys is one prominent example of an intervention that students prefer but that might not best serve their ultimate learning needs.

Despite discussion among medical educators about the idiosyncrasies of modern learners and their desire for answers, less is known about the student perspective on this issue. We agree that the answer is not to simply provide an answer key. But we also think it is important to explore why students may express this strong need. We explore three potential root causes for this trend to

suggest curricular structures that address both students' immediate needs and support their long-term development. Although the problems and solutions that we outline within these three areas apply to medical education broadly, the field of pulmonary and critical care medicine is well positioned to assist learners in three areas given the inherent importance of process-based reasoning, diagnostic uncertainty, and high-stakes clinical scenarios to the field.

PRIORITIZING OUTCOMES OVER PROCESS

One prominent contributor to students' desire for an answer key may be their prioritization of learning outcomes above the learning process. Throughout medical school, many students tend to focus exclusively on obtaining the correct final answer for the immediate question at hand, and fail to emphasize and hone the thought processes required to reach the solution not only for the current problem but also for those that will follow (12). In part, students may concentrate on attaining outcomes because it is a more direct and measurable goal than improving reasoning skills. Medical students often survive by simplifying and choosing the most straightforward method for learning. Moreover, for many students, the ultimate outcome of residency selection may become a prominent point of focus, as evidenced by the growing number of annual applications (13). Getting the right answer and the highest score, even in a pass or fail system, may still be perceived as the key to a successful match.

Intrinsic factors may further explain students' outcome-focused approach. Qualitative studies have found that student well-being is affected by factors such as intellectual tension caused by stress, fatigue, and cognitive overload as well as personality characteristics such as lack of self-confidence or motivation, which can result in significant barriers to the development of students' critical thinking skills in undergraduate medical education (14). The source of this stress and fatigue is likely multifactorial and derived only partly from the rigor of courses or time spent studying. The enormous amount of new knowledge students feel they need to master—including familiarizing themselves with the new language of medicine—combined with performance-related concerns as students think ahead to residency applications might provide a partial explanation. Additional nonacademic stresses, such as stereotype threat and micro- or macroaggressions related to racism or sexism, may further hinder students' ability to develop complex reasoning skills (15, 16).

However, students' persistent drive for answers is also likely to be externally reinforced by the educational incentive structures that consistently reward students for identifying a single correct answer. As seminal work by Prosser and Trigwell has shown, students tailor their learning strategies to what is expected of them and are more likely to adopt a surface, as opposed to deep, approach to learning when they feel the method of assessment encourages a recall of facts (17). From preclerkship curricula to shelf tests to board examinations, the path to becoming a licensed physician often feels like a series of multiple-choice tests in which students succeed by selecting the answer the test creator has determined is the single best option, regardless of the reasoning behind their choice. These exams typically test rapid, system 1–type associations and incompletely assess for deeper

understanding and critical, system 2 thinking that is equally—or, arguably, more—important for future physicians to foster (18). It is therefore unsurprising that medical students may frequently request a way to check their answers—it is a surefire method to improve along the metrics by which they are most frequently evaluated. As others have repeatedly pointed out, however, these types of high-stakes examinations have failed to correlate well with meaningful metrics of student achievement (19).

Reinforcing this type of rapid thinking on exams has implications for students' clinical learning, too. The current assessment format could impede students' ability to recognize the nuance and complexity of medicine in the real world, in which there are often many right answers depending on multiple physiological variables. For example, students may be able to correctly calculate an alveolar–arterial gradient on a multiple-choice exam without fully understanding the meaning behind its component parts or how the result contributes to a nuanced explanation of why the patient in front of them is experiencing worsening dyspnea. As a result, in the clinical environment, students may struggle to flexibly adapt their thinking because they have focused on memorizing correct answers or simple associations rather than refining their cognitive approaches to clinical problems.

Bridging the gap between simple association or pattern recognition and complex reasoning requires specific instruction. Indeed, explicitly developing students' critical thinking skills during medical school is increasingly recognized as an important goal of undergraduate medical education (20, 21), and medical educators routinely define critical thinking as a skill or process that can be developed and refined over time (22). Educators need to help students similarly view critical thinking as a mutable skill. In line with the well-being theory proposed by Martin Seligman (23), by helping students to appreciate that refining their reasoning processes is meaningful work that, when mastered, is an important accomplishment, teachers can help promote an enduring sense of well-being instead of the short-term gratification of getting an answer correct (23). Encouraging students to emphasize learning over outcomes can also help mitigate the feelings of defeat, discouragement, and burnout that can occur when students provide incorrect answers and can directly interfere with students' ability to think critically. By the nature of their specialty and the problems they encounter, pulmonary and critical care physicians are aptly suited to take on this task.

One possible solution to encourage students' development of critical thinking is to adapt incentive structures in medical school to reward students for their reasoning rather than solely their final answer. This process of transition has partly begun, as medical schools have increasingly moved to pass–fail preclerkship curricula, and other major licensing examinations have followed suit (24). Although many have lauded these pedagogical changes as an antidote to students' performance-related stress (25), these examinations remain multiple choice and, thus, imperfectly assess students' critical thinking.

We need alternative forms of testing that explicitly evaluate students' ability to think. Indeed, students have expressed a desire for and importance of finding alternative methods of assessment that reward broad critical thinking as opposed

to emphasis on a single best answer (26). Medical educators have developed novel assessment methods to better evaluate students' reasoning abilities and increase students' exposure to the concept that more than a single answer might be "correct" by asking students to suggest and prioritize among a range of possible solutions to a clinical problem (27) or explicitly elaborate their reasoning (28). For example, instead of asking a student to select a single best answer for why a patient with heart failure and chronic obstructive lung disease is dyspneic, it may be more beneficial to assess their ability to generate a list of pathophysiological mechanisms that can be linked in a concept map. This can lead to an inductive reasoning process that improves their understanding of the relationship between each of these mechanisms and the patient's shortness of breath and ultimate diagnosis (29).

To motivate students to focus energy on developing complex critical thinking skills, more time will have to be spent in preclerkship curricula emphasizing clinical reasoning alongside clinical knowledge. Ultimately, if students are validated for taking the right approach to a problem, rather than exclusively rewarded for their correct answers, they may feel more comfortable engaging in the type of complex reasoning that is essential for approaching clinical problems.

DISCOMFORT WITH UNCERTAINTY

The second factor influencing students' desire for answers is discomfort with uncertainty. Uncertainty has been widely recognized as an inevitable and ubiquitous aspect of clinical medicine (30, 31), and many have highlighted the important role of medical education for increasing students' awareness and tolerance of this ambiguity (31–33). Notably, the work of Bhise and colleagues highlights the prevalence of diagnostic uncertainty in the practice of medicine and offers a clearer definition so that it can be better quantified and addressed in clinical decision-making (34). Despite recognition of its importance, medical students express difficulty tolerating uncertainty in clinical situations (35).

Grappling with uncertainty has become increasingly challenging for students because of a number of factors, including an increase in the complexity of medical care, advances in technology, and, more recently, the events of the coronavirus disease (COVID-19) pandemic. In a world of information overload and myriad unknowns, students may be tempted to seek certainty and simple, straightforward explanations. This desire for simplified explanatory models may be a product of growing up in an era in which powerful search engines are almost always within reach and quick answers to everything are at our fingertips. Why pause to wonder about a question and struggle for the answer when the internet can deliver you the answer much more efficiently?

The irony of students' desire for more answers is that, as author Warren Berger notes in his book, *A More Beautiful Question* (36), the value of obtaining the "right" answer actually declines as the world becomes more complex and dynamic. In a world in which knowledge is growing at an unprecedented pace, it would be more beneficial for students to learn how to contend with uncertainty rather than simply resolve it. This is particularly true in the clinical environment, which is rife with ambiguity and difficult, nuanced situations for which there is often no clear right answer. Students may want or come to expect Occam's Razor—a single,

unifying explanation to address a complex set of information. But more often in clinical medicine, we get Hickam's Dictum—multiple explanations to explain a patients' various concerns and findings.

Addressing this issue requires fully acknowledging the challenges that arise when contending with uncertainty. For example, many early learners struggle with the inherent subjectivity and uncertainty associated with reading chest radiographs. During such an exercise, instructors can explicitly name this struggle and make grappling with ambiguity a discrete, intentional learning objective. In clinical scenarios, others have advocated for teaching students and trainees models that explicitly acknowledge uncertainty and focus on strategies for communicating this uncertainty to patients (37).

Educators can also help support and hone students' ability to ask interesting questions. Training learners to constantly generate questions based on unfamiliar concepts enables them to refine their ability to engage productively with, respond to, and learn from uncertainty. For example, instructors can ask students to identify components of a chest radiograph with which they are not familiar to encourage self-directed, inquiry-based learning. It is important to support students not necessarily with an answer key but instead with the skills they need to navigate inconsistent data, conflicting information, and uncertain outcomes.

It is also important to educate students about how grappling with uncertainty now will help them much more in the future than simply being provided with answers. This could be achieved by explicitly naming the benefits of being able to tolerate uncertainty in clinical practice (i.e., improving diagnostic efficiency and reducing burnout) (38). Alternatively, medical schools can incorporate electives that teach students how to navigate ambiguity in other realms, such as in the arts, which has had success at some institutions (38). Medical students are likely quite adept at delaying gratification given that, along the entire path to becoming a physician, short-term sacrifices and hard work are deemed worthwhile in exchange for the ultimate expected outcome (39). Therefore, if medical students were informed of the long-term benefits of learning through exploration, they may be more willing to sit with uncertainty, resisting the urge to take a shorter path to the final answer.

FEAR OF FALTERING

Finally, and perhaps most importantly, students' fear of making mistakes is a powerful motivator for their desire for an answer key. Medical students with a maladaptive form of perfectionism may exhibit excessive concern about making mistakes and, as a result, hesitate to admit when there is something they do not know or understand (40). Medical students self-report limited experience with failure prior to medical school, and they find failure events during medical school distressing (41). Years of indoctrination to the pressures of the meritocracy make the fear of failure unbearable for many students (42).

Perfectionism is not limited to medical students. Other preprofessional students are also likely to be high achieving and unaccustomed to failure. Yet, there seems to be a different tenor to the fear of failure in medical education. In part, this fear of failure is motivated by students concern about residency applications and the next phases of their careers (13). However, students may also implicitly fear

mistakes in medicine because of downstream implications on their ability to capably and safely care for patients—an aspect of medicine that is distinct from other fields of study (43).

In addition to limited prior experience with failures, students' anxiety about underperforming during medical school may be influenced by a number of factors, including imposter syndrome, interpersonal dynamics with classmates and faculty members, and concerns about evaluations from supervising residents and attendings (44–46). Moreover, students are often unsure what will happen if they do make a mistake and fear they will be unable to recover in the event one occurs. In fact, difficulty tolerating uncertainty has also been associated with fear of making mistakes (35). Students may believe that having the answers available will reduce the likelihood that they falter.

To combat students' anxiety about making mistakes, it is important for educators to foster an environment in which struggling is normalized and supported (47). The importance of teaching students to recognize knowledge gaps by admitting when they "don't know" has been discussed previously. Retired U.S. Army four-star General Stanley McChrystal once said, "Leaders can let you fail and not let you be a failure" (48). Similarly, educators should encourage students to struggle, to use "I don't know" moments as opportunities to create powerful cognitive dissonance that leads to meaningful learning, and to challenge students beyond the limits of their own knowledge with the appropriate support, encouragement, and reinforcement.

The concept of "productive failure" should be introduced early in medical education and reinforced frequently (49). Instructors may feel apprehensive about proactively discussing strategies for students to respond after doing poorly on an exam, faltering during clinical rotations, or failing to match into a residency program. These conversations can feel uncomfortable, and educators may be concerned about creating unnecessary worry or stress for students. In reality, however, failing to address these undesirable outcomes at the outset can make it all the more difficult for students to understand the next best steps if, and when, failure occurs. In a seminal study on this topic by Manu Kapur, students who were given poorly structured problems that were beyond their current skill set failed in their initial attempts but, on subsequent tests, outperformed students who were originally given well-structured problems (50). Furthermore, although students may not enjoy effortful learning that compels them to find answers for themselves, a randomized controlled study shows that such approaches lead to better performance in subsequent courses (51).

These experiences of productive failure can be constructed in the classroom and clinic. For example, instructors can ask students to apply their understanding of respiratory physiology to novel areas, such as interpreting ventilator settings. Although this exercise may be intimidating and challenging for some, stretching students beyond the bounds of their current understanding can allow them to consolidate prior knowledge and use it in new ways. Moreover, creating intentional opportunities for failure may help students learn the skills they need to appreciate failure as productive and apply the lessons learned from it to future problems they may face.

Rather than provide students with an exact formula for how to learn from mistakes, we recommend helping students develop general approaches for how to

think about and react to failure. Broadly, medical education should incorporate more explicit teaching about how to best develop and foster a growth mindset (52). In addition, medical educators can increase the availability of environments in which students can make mistakes without consequence. These spaces not only serve as powerful learning experiences but also allow students to hone a skill set that will enable them to react to failure in real life (53).

CONCLUSIONS

Curricular and cultural adjustments that address students' prioritization of process over outcomes, discomfort with uncertainty, and fear of faltering may help mitigate students' desire for an answer key. Moreover, the ability to think critically, tolerate ambiguity, and learn from mistakes are cornerstones of the practice of medicine. By integrating an approach to these topics into medical education, educators can both support students' learning and help them develop the strategies needed to succeed in medical school and beyond. Pulmonary and critical care educators, by virtue of their training and the nature of their practice, are particularly well suited to lead the way in transforming medical education and our leaners from a focus on providing the answer key to one that emphasizes the understanding and reasoning that underlies the search for a solution to the patient's problem.

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