The Once and Future Myths of Medical Education

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The field of education seems particularly susceptible to the allure of plausible but untested ideas and fads (especially ones that are lucrative for their inventors). One could write an interesting history of ideas based on either plausible theory or somewhat flimsy research that have come and gone over the years. And . . . once an idea takes hold, it is hard to root out.

—*Henry L. Roediger III, PhD*[1]

The past few years have seen increasing attention to myths in education. The entire January 2020 issue of *Medical Education* is devoted to education myths, and they have indicated that this may be a permanent feature. In 2015, De Bruyckere et al[2] published a book describing myths in education. Education myths have also become a personal interest, and I wrote an editorial last year on the subject.[3]

So, is there more to say? The easy route would be to add a few more myths to the growing catalog. But adding more stamps to the collection does not really advance the field. To me, a more intriguing topic is to attempt to understand *how* these myths arise and *why* they persist. As Roediger[1] points out, many of these myths have remarkable longevity. Some myths have not only been around for more than 100 years, but also were disproved more than 100 years ago (see TABLE).

I am aware that my conjectures must be viewed as speculative, rather than definitive. I must also confess that my analysis is from the perspective of psychology. I intend to explore a number of factors related to science and education that may contribute to the durability of myths. In the 2020 *Medical Education* special issue, a completely different analysis was undertaken by Martimianakis et al,[4] where they placed these myths in a social context and argued that simply "myth-busting," by marshalling the scientific evidence, ignores the social and economic context in which the myth arises. Despite the different epistemological perspectives, we do agree on one central point: the robustness and longevity of many of these myths, in the face of multiple assaults based on "good science," is *prima facie* evidence that myth-busting must involve far more than a statement of the relevant scientific facts.

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Characteristics of Educational Myths

Some reflection of the nature of education myths reveals properties common to other myths and some unique aspects. On the one hand, medical education myths endure and are apparently immune to the impact of scientific evidence. In that regard they share common characteristics with other more popular myths, like *the earth is flat*, *vaccinations cause autism*, and *homeopathy cures illness*.

On the other hand, unlike those concerning the earth's flatness or vaccinations, education myths are not proselytized by a small fringe; many, like *adjusting for trainee learning styles enhances learning*, are part of the core curriculum in postgraduate level teacher training courses. Moreover, the community that shares these myths is highly educated and would likely consider themselves scientifically literate. Indeed, it is intriguing that *Medical Education* has published a special issue on education myths. The assumption may be that, by disseminating the evidence against these myths among the educational scientists that comprise much of their readership, there will be an impact on their pervasiveness. Regrettably, we may be preaching to the converted and our sermons may not have the intended consequences.

Why Is the Education Community Vulnerable to the Dissemination of Myths?

I suggest that several characteristics of educators contribute to the proliferation and persistence of educational myths. I explore 3 here: Medical educators are (1) *Human*, with the same cognitive architecture (with all its failings) as everyone else; (2) *Scientists* or informed consumers of scientific literature; and (3) *Teachers*, with a primary role to help students learn.

1. Human

Educators are human, and humans have been shown to be vulnerable to various biases inherent in the way we process information. People do not process information objectively. Rather, people filter

TABLE
Examples of Education Myths (Ancient and Modern)

Myth	Description	Date of Discovery	Reference	Date of Rejection	Reference
Mental faculties	Training to improve one mental function results in improvement in other functions	...	...	1901	19
Kolb learning styles	Using a subject's preferred learning styles (eg, visual versus speech) will produce enhanced learning	1984	28	2008	29, 30
The millennium learner	"Digital natives" learn differently (eg, multitasking) than previous generations	2006	31	2013	30
Self-directed learning and self-assessment	Learners can self-assess their own deficits and best direct their own learning	1975	32	1999	33
Multiple-choice examinations test only knowledge	Multiple-choice tests correlate solely with knowledge, not performance	...	...	2002, 2007	34, 35

information through their preconceptions. While there is extensive literature on cognitive bias, 2 forms of bias in particular are relevant.

Confirmation Bias: People tend to actively seek out and prioritize information consistent with their preconception, higher than information that refutes their prior view.

The initial demonstration of the effect was published by Wason[5] using sequences of 3 numbers. Participants were asked to infer or propose potential underlying rules that created the sequence. They could test a rule by suggesting the next string of 3 numbers in the sequence. Few determined the correct underlying rule, but most demonstrated confirmation bias by consistently suggesting confirmatory examples.

It is difficult to make a bridge from a mathematical game to educational myths. But another study of confirmation bias revealed a much more solid link. In this study, Lord et al[6] identified participants who had strong views for and against the deterrent value of capital punishment. They were then provided with 2 research studies—one supported capital punishment, the other was against it. Participants were able to identify all sorts of methodological problems with the study that was against their prior opinion. However, unknown to the participants, study methods and conclusions were crossed over; in short, participants selectively weighted the evidence in favor of their prior belief more heavily. The researchers concluded that provision of ostensively scientific evidence "will frequently fuel rather than calm the fires of debate."[6]

Given the uncertainties inherent in social, behavioral, and clinical research, it is quite easy to find studies on both sides of a debate. Confirmation bias then leads to the unfortunate conclusion that educators will "cherry pick" the evidence that supports their conclusion, so that the additional data may have the paradoxical effect of increasing their belief in the myth.

Vividness/Availability Bias: Human memory makes associations between incoming stimuli and knowledge stored in memory. Repeated exposure enhances these associations. Unfortunately, so do other factors, such as particularly dramatic or vivid portrayals of events.[7] It is much easier to recall a story about an event than to process statistical information about the likelihood of the event. This can actually be an educationally useful strategy; in a series of studies, Woods et al[8,9] have shown that basic science can be viewed as a "story" to aid in recall of signs and symptoms of diseases.

However, more commonly this effect can distort interpretation. As I write, we are in the midst of a coronavirus pandemic, which has brought China and several countries in Europe to a standstill. Yet at this time the total number of cases is about 60 000 (as of February 2020) in a country with a population of about one billion, and the fatality ratio is about the same as that of influenza (1%–2%). Based on those statistics, the COVID-19 (coronavirus) death rate pales alongside Spanish flu, which infected about 500 million and had a case fatality rate of 5% to 10%. But with highly emotional and stark images of health workers in protective suits and empty streets in Beijing, who would believe that COVID-19 can be managed?

The consequence of this *vividness heuristic* is that people have no qualms about dismissing scientific evidence by using a single vivid counter example. One frequently repeated example is that your chance of being killed in a car accident on the way to the airport is higher than your chance of being killed in an air crash. But air crashes, even involving small airplanes and few deaths, make headlines—highway deaths rarely do.

In education, similar mechanisms can arise. For example, no one has any difficulty declaring themselves as visual or verbal learners, so this version of learning style can find many firsthand testimonials to support its veracity. Unfortunately, self-reported visual/verbal learning has been shown to have no relation to either direct measures of spatial and verbal ability, or learning from visually or verbally oriented instructional materials.[10]

2. Scientists

Scientific writing has a peculiar stylistic form, replete with conditional words like "possible," "may," and "likely." Scientific writing comes in shades of gray; black and white do not appear in the palette. While this description is true of all sciences, it is doubly so in clinical, social, and behavioral sciences. Compared with natural sciences, where the fundamental proof lies in a theoretical prediction, our theories generally take the form of H_0–no difference, H_1–difference. Moreover, traditional Fisherian statistical inference builds in uncertainty as an essential component of the logic. Statistical inference always begins with a critical value corresponding to a 5% probability of declaring a difference when there is none: a false positive. This in turn has implications for the false negative rate: if the hypothesis is rejected at exactly the 0.05 level, the likelihood of replication is only 50%.[11,12] Therefore, it is not surprising that failure to replicate findings is a growing concern in the clinical and behavioral disciplines.[13,14]

In clinical research, it is at least possible to have consistency in treatments (a 300mg dose) and outcomes (mortality, cardiac output). In medical education, in realistic environments (eg, classrooms), such consistencies are virtually impossible. While some lab-based experimental research may be able to completely standardize interventions using, for example, written or video presentations, and outcomes, such as multiple-choice tests, such tight control is the exception. Moreover, a concept like problem-based learning (PBL) can be operationalized in so many forms that it defies standardization. It is therefore understandable that non-replication is a significant issue in medical education. A widely cited study, the "Replication Project,"[14,15] reported that only 39% of classic findings in psychology were able to be replicated.

One possible solution to this problem is the use of meta-analytical techniques, as supported by the Best Evidence Medical Education (BEME) project.[16] Here, too, problems quickly arise as a consequence of the nature of educational research. The first is that in clinical research, a literature search can yield a high proportion of appropriate articles, sometimes approaching 50% of those identified. In education, because a term like "PBL" or "self-assessment" or "interprofessional education" can be used in so many contexts, the yield of empirical research from searches is very low. A few years ago, I reviewed 20 BEME reviews in detail and found that, while in the initial search they identified about 100 000 articles, the actual reviews were based on a total of 818 papers, a yield of 0.8%.

The second problem arises from the imprecision of the terms, where a term like "virtual reality" can mean anything from a realistic dynamic presentation on a computer monitor to a headset displaying images directly to the eyes, with very different consequences.[17] Thus, when the interventions and outcomes differ, and the resulting sample of studies is small, an informative meta-analysis is not possible.

The consequence, in terms of the endurance of educational myths, is that it is relatively easy to locate studies that support a particular position as well as its exact opposite. In turn, given our propensity as humans to seek confirming data, we cite the study that supports our position.

3. Teachers

No rational person would presume that they understand quantum mechanics as well as a physicist, or could perform laparoscopic surgery as well as a surgeon. Yet there are areas where everyone presumes that their opinions are the equal of so-called experts. Art is one area: many believe that, given a few cans of house paint and some old brushes, they could be the equal of Jackson Pollock. Regrettably, education appears to be another area. Everyone imagines themselves to have considerable understanding of how people learn, based, if on nothing else, on the many years they spent trying to do just that. As a consequence, education is rife with enduring myths, perpetrated in part by well-meaning academics who have no particular claim to educational expertise.

How many posters of Albert Einstein, accompanied by a maxim about the human condition, have been printed? Here are a few:

Imagination is more important than knowledge.

The true sign of intelligence is not knowledge but imagination.

The only real valuable thing is intuition.[18]

It is not clear to me how Einstein, with his brilliance in physics, came to the conclusion that his opinions about learning were sound. We appear to believe that an expert in one area should be heard in all other areas. (Regrettably, Hollywood actors suffer from the same delusion of grandeur, with far fewer credentials.)

In my view, these few succinct lines summarize what is one of the most enduring and misguided myths in education. Teachers, particularly those who write about learning, aspire to bring students to new plateaus of thinking, judgment, reasoning, or whatever. Knowledge is viewed as an unnecessary evil, acquired to pass all those nasty exams—and then forgotten.

After a century of theories disproved by actual research, by 1990, cognitive psychology resolved that successful problem solving in one domain was determined by the amount of relevant knowledge—not imagination—the problem solver possessed.[19,20] As Perkins and Salomon[21] said:

> *Thinking depends on specific, context-bound skills and units of knowledge that have little application to other domains . . . The case for generalizable, context-independent skills that can be trained in one context and transferred to other domains has proven to be more a case of wishful thinking than hard, empirical evidence.*[21]

Nothing has emerged to challenge this perspective. However, educators appear reticent to accept this now universal finding. To be sure, thinking and expertise do require more than facts. One critical area of research in learning is *transfer*—retrieving relevant knowledge from memory to solve new, dissimilar, but related problems. Typically, participants who have learned the relevant knowledge may be able to retrieve it to solve a new problem more than 10% to 30% of the time.

Many medical educators are not aware of the role of transfer. Instead, the education community defaults to general, content-free skills like *clinical reasoning* or *problem solving*. And, like the child's toy where, when you hammer one peg down another takes its place, the notion of these context-free skills is constantly mutating into different labels like *metacognition*, *cognitive biases*, and *critical thinking*.[22]

What Can We Do About the Persistence of Myths?

There is very little research on strategies to enable people to assimilate new information that will change their minds. Alone, common-sense approaches like presenting scientific information succinctly are insufficient. For all the reasons I have reviewed, it is unlikely that simple presentations of evidence will overcome the inertia associated with the original judgment. Indeed, as Lord et al[6] showed, there is some evidence that this exposure can result in "attitude polarization" where attitudes become more extreme.

Similarly, admonitions to "be as objective and unbiased as possible"[23] had no effect on judgments of the quality of the study or persuasiveness of the data. Similar non-effects have been noted in a number of studies we have conducted on diagnostic reasoning, where instructions to slow down, be thorough, or be systematic had minimal effects on accuracy.[24,25]

However, one strategy that was effective was to get participants to consider how they would respond if the study came to the opposite conclusion.[23] In this condition, biasing effects disappeared. In the *Medical Education* special myths issue, de Bruin[26] advocated for a similar strategy: juxtaposing the incorrect myth with the correct scientific fact. A similar strategy has been used by Mamede et al[27] in their "Reflection" intervention with clinicians working up clinical cases. Getting the student to consider alternative diagnoses and then argue for them leads to a small but consistent reduction in error rates.

The difficulty, as with all laboratory-based interventions, is applicability to the infamous real world. While such strategies may have moderate effects over short periods with small numbers of participants, this is very different from changing the cherished beliefs of an entire community. Indeed it is hard to imagine that teachers, who believe specific myths, will wholeheartedly endorse interventions that counter their own intuitions.

Conclusions

Educational myths appear to have a tenacious hold on many individuals in higher education. While hardly a life and death matter, clinging to theories and interventions that are known to be ineffective represents a squandering of resources. Moreover, the stakes are not always insignificant. Some educational technologies, such as *dynamic responsive whole body simulations*, may cost upward of $100,000, yet the benefit of "high fidelity" remains unproven. What evidence there is suggests that the benefits will be marginal. Similarly, virtual reality technologies for instruction in anatomy may cost $5,000 per set for the hardware, yet to date they have no proven benefit.

The dollar cost is not the whole story. Despite the allure of Google, today's students must master more, not fewer, facts than their predecessors. It is a disservice to learners to not maximally use the known effective strategies and avoid the known ineffective strategies. For that to be achieved, the jingoist "evidence-based" must become a central part of the culture of the medical education community.

Looking ahead to 2030, I am not inclined to hold my breath.

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