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Guest Column

"Wisdom begins in wonder." – Socrates

Anyone who conducts research will attest to the fact that every answer revealed generates at least one more question. While this endless game of "whack-a-mole" might frustrate most people, I believe it is this pursuit of never-ending questions that most motivates academic scholars.

Why? Research, scholarship, creativity, and innovation are fueled by curiosity and the drive to improve the human condition. Whether it's understanding the origins of the universe, the mechanistic workings of a subcellular organelle, the causes of human conflict through the course of history, or the most effective pedagogical techniques to inspire learning, research questions are pursued in generally the same way: ask the question, determine the answer(s), use the answers, discover new questions, and repeat. It's a cycle powered by creativity, resourcefulness, collaboration, observation, and perseverance. We, the scholars of academia, are a key component of this successful cycle, but like any other cycle, we depend on many other factors to succeed.

The professoriate has a unique role and responsibility to pursue questions and problems that may broadly benefit society. This stands in contrast to research in business, government agencies, or the nonprofit sector, where research must specifically benefit a particular mission or purpose, and therefore, may be directed more by institutional interests than by individual creativity and curiosity. Academic scholars pursue knowledge without regard to immediate utility, bottom line, or accepted norms. In fact, I would argue that conducting research and scholarship that challenges existing paradigms is a role uniquely conferred to academic scholars. The challenge is that there are limited resources

available to conduct such research and scholarship. That's why it's essential that our society must continue to take every opportunity to champion investment in higher education research and scholarship – and see this as an investment in the betterment of society, whether realized immediately or, more likely, in the distant future.

"The greatest obstacle to discovery is not ignorance - it is the illusion of knowledge." - Daniel J. Boorstin

All research begins with a question to be answered, a problem to be solved. It is vital to see the origination of questions and the identification of problems as a collective task, not an individual endeavor. When we, as academic scholars, see our students, our graduates, our colleagues, and our practitioners as partners in the quest for new information, we will not be bound by the illusion of knowledge.

I recall a situation many years ago when I was teaching a class of undergraduate pharmacy students. I was asked a question by a talented and inquisitive undergraduate student (Melissa Flagg, now Ph.D., Deputy Assistant Secretary of Defense, Research and Engineering, U.S. Department of Defense). I did not know the answer to the question, and I had learned by then to simply admit it when that was the case. Melissa apologized for asking, and I explained that, contrary to being unhappy about her question, I was very pleased, as it allowed me to explain why I encourage all students to ask difficult, thought-provoking questions. If I did not know the answer, there were only two possible explanations: (a) the answer is known, and I just don't know it, or (b) the information is not known — nobody knows it. If the answer is known, then I (and my students) should look up the answer and learn something. If the answer is unknown, is it something that should be known? If so, it is a potential research question.

Assuming we could develop a testable hypothesis to answer the question, we could then devise a research plan, which, when executed, would provide new information and insights for the field, and eventually become part of what we teach our students and what our graduates use in their work.

While it is a cycle that takes some time to complete, it is the asking of the question that initiates the process. If you know the answer (or think you do), or if you have the solution (or think you do), there is no motivation to seek new information or to develop new solutions. Yet not many questions or problems have been optimally answered or solved; this is the need that motivates research and the never-ending story of academic scholarship.

The "illusion of knowledge" is the main reason I always encourage students to *question everything*. In my experience, some of the most thought-provoking questions are asked by those who are not so expert in a particular subject that they are constrained by the "illusion of knowledge." It is also this very sort of experience that makes an education at a research university distinctive and valuable. With scholars in the classroom, students are learning from those who shape the field, are encouraged to think more deeply about what they're learning and how to use it, and ask probing questions that challenge the existing body of knowledge and stimulate new thinking. Such experiences benefit both the students and the faculty.

Since most students will not pursue graduate education or become researchers themselves, their connection to faculty scholars is vital for identifying and communicating the challenges and problems they will face as professionals. After all, it is the educator who sees the shortcomings of existing pedagogies, the physician who is most aware of unmet therapeutic needs, the engineer who can see

where new technologies are most needed. Like the student who asks a question that currently has no answer, the practitioner observes problems that need solutions — both should inform new research areas. And faculty benefit from having their views and ideas challenged, which should lead to better research and scholarship.

Good research — or more accurately the results of good research — should drive sound public policy, professional practices, consumer behavior, and major technological advances in the fields of education, healthcare, engineering, technology and the environment. Good research requires critical thinking, which makes for much better problem solving and ethics because it removes bias and ensures openness to other interpretations of data. This is true whether the research is primary or secondary — the value of the research is only as good as the experimental design and objective interpretation of the data.

For example, in primary research, where new data is acquired firsthand through experiments, it is vitally important to recognize the constraints of the data acquired and resist the temptation to disregard data that does not seem to 'fit.' Most primary research begins with a hypothesis, comparing a null hypothesis (there is no effect of x on y) to an alternate hypothesis (x affects y) (Siegfried, 2010). What would happen, for example, if a researcher did not have a hypothesis to test? He or she might observe interesting patterns that may correlate, but that are not linked in a meaningful way. For example, you may find it alarming that the number of murders by steam, hot vapors and hot objects annually has an 87% correlation with age of Miss America (Fletcher, 2014). Does this mean the Miss America pageant must strive to select ever-younger winners as a public health safety measure? Of course not. This is an extreme example designed to illustrate the distinction between causality and correlation and, more importantly, to underscore the importance of knowing the constraints related to data interpretation, especially when such interpretations may become the basis for public policy, professional practices, or curriculum content.

Similarly, when primary research suffers from inadequate experimental design, the result is multiple conflicting studies that lack statistical and predictive power. Since secondary research is collation and summation of previously published primary research data, it necessarily relies on the ability to determine if the previous work was sufficiently rigorous to be included in analysis. Making sense of multiple primary research studies is a science into itself. How do we evaluate various sources and types of information to draw sound conclusions and make informed decisions? Is it enough to have a leader in the field summarize the results in a narrative review? While a summary may be helpful to clarify concepts and provide a historical perspective, narrative review may be subjective and may not have concrete criteria for including or excluding particular studies. Consequently, two experts could review the same subject and report different conclusions (Koricheva and Gurevitch, 2013). Without a critical mass of quality primary research, secondary research cannot lead to sound conclusions.

Both primary and secondary research provide excellent training in critical thinking. Understanding how to conduct primary research — from developing sound hypotheses to proper experimental design and data interpretation — and having the tools to evaluate the existing body of information through secondary research should be part of our undergraduate and graduate-level educational literacy. After all, these undergraduates and graduate students make up our future, and sound policy decisions rest on the ability of policy makers, legislators,

journalists and the general public to understand societally-relevant academic research (Gormley, 2011), whether primary or secondary.

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