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**A Toxicologist's Perspective on Having and Doing it All:
Teaching, Research, and Service at a Small Liberal Arts College**

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Abstract

In the United States, a small liberal arts college is loosely defined as an institution that provides a residential and comprehensive education to students seeking a bachelor's degree. There are many challenges and opportunities that exist within this educational framework for faculty who engage as teacher-scholars. A primary challenge is making time for research, teaching, and service. However, this can become an opportunity when undergraduate research experiences are integrated into the curriculum. This approach benefits students, who report a gain in confidence, experience, and increased enrollment in advanced degrees. Developing collaborations with faculty at other colleges, especially R1 research institutions, can be extremely helpful in supporting and advancing ones research year-round. Furthermore, salary is often only required for three months, making a liberal arts faculty member less expensive (and more qualified) than a postdoc. A second challenge is how to balance and understand the expectations set forth for tenure and promotion. Productivity in the lab can be advanced during the school year through student independent studies or thesis work; this can serve both the student and the faculty. Scholarship in teaching and learning is very important to many liberal arts schools, thus time spent working on and publishing about these subjects may be an adequate alternative to a "traditional" research trajectory. Finally, toxicology's interface of many scientific disciplines positions professionals in the field in a strong position to succeed as teacher-scholars in small liberal arts colleges.

Keywords:

liberal arts, toxicology, undergraduate

Introduction

In the United States, small liberal arts institutions strive to provide a broad, comprehensive, and residential educational experience to undergraduate students. The American tradition, modeled after medieval learning centers of Europe, started in 1636 at Harvard and 1693 at William and Mary. While traditionally the liberal arts education included a formal education of grammar, rhetoric, and logic, the 20th and 21st centuries introduced a broader interpretation of the type of education that is now expected and provided. Today, many schools, including my own, typically expect a well-rounded liberal arts education to include literature, languages, philosophy, history, mathematics, psychology, and science. While most liberal arts curricula provide breadth, these colleges have also come under increasing pressure to provide a more “practical” education, comprising programs that are professional, vocational, and/or technical in nature. As a product of, and a new professor at such an institution, I am attempting to be cognizant of these trends in the liberal arts tradition while maintaining my scholarly research and preparing the modern student for life beyond college. This calls for balance.

Making Time

Given the expectation for both excellence in teaching and research, one of the major challenges for liberal arts faculty is making time for both. During the school year, faculty at colleges offering a two semester system often teach four to six courses equaling two to three classes per semester. At those offering a quarter system, the load is often one to two classes each quarter. In the sciences, lab sections can count for half or full of a load. Thesis advising is also often a requirement, although it may not count towards the teaching requirements. While not unique to liberal arts colleges, there is also an essential service component to the job. As a new faculty trying to excel at all facets of the job, it has been important to recognize what is most important at a particular time in the year and to make that a priority.

Liberal arts colleges pride themselves on providing an excellent and rigorous education to their students; as such, the priority during the academic year should be teaching. Making time to excel in this aspect of your job from late August until May is first and foremost. Time spent teaching at a small college includes preparing and delivering lectures and labs, as well as holding office hours and thesis advising. Unlike the environment at large institutions, faculty and student relationships at small colleges are close and coveted. Bates College, among its peers, has an open door policy, which means that students are encouraged to come by faculty offices at any time to speak and work with their professors. While this is a fantastic policy that builds trust and strong teacher-student relationships, it can often impede on a faculty member’s busy daily schedule. However, students do reward you for your availability and helpfulness if you embrace this policy and, more importantly, it becomes a critically important part of the fabric of a student’s education.

In addition to teaching during the school year, there is an obligation for service. If you have a choice in your options, invest time and energy into committees doing work that you care about. For instance, Bates College is starting a new biosafety committee. We are charged with developing standard operating protocols (SOPs) and providing

education and guidance to faculty, students, and staff as it pertains to biohazards. As the sole toxicologist on campus, this committee assignment is ideal, as it allows me to draw on my strengths and help make positive changes to ensure the safety of all members of our community.

Since the school year runs from about August to May, and most of that time is spent either in or preparing for the classroom, use (and schedule) the summer for research. The research expectation and output of professors at liberal arts colleges is on the rise; consequently, to compete, complete, and publish, it is imperative to have an active, dedicated summer research program that includes undergraduates and potentially high school students. Further, using this time to train students can be essential to furthering ones research during the busy school year. However, prioritizing research in the summer limits ones own ability to take vacation during that time.

The importance of undergraduate researchers

The critical importance and value of an undergraduate research program at small liberal arts colleges to both education and research scholarship cannot be underestimated, both for students and faculty alike. This experience has been shown to be an effective teaching tool for enhancing the experience of undergraduates.¹⁻³ It has also been shown to help promote career pathways for students in underrepresented groups,^{4,5} increase levels of pursuit of graduate education,^{3,5,6} and provide the opportunity for learning (research and science) skills not otherwise obtained in the classroom.³ To the researcher, it can provide an opportunity to forge close relationships with students, enhance the process of learning and practicing mentoring and leadership skills, obtain (relatively low cost) assistance on projects that would otherwise need to be carried out by you or a technician⁷, and place students on high-risk, high-reward projects.

The undergraduate research experience often occurs in the summer, with undergrads working in labs between 8-12 weeks over the course of their break. At larger institutions, students may work in R1 research labs, with mentoring from all members of a lab (grad students, postdocs, technicians, and PI). At smaller schools, research may align with internal funding or projects receiving moderate but sufficient external support, and which involve a single PI. During the school year, the undergrad research experience can have additional facets; students may be involved for independent study credit, employed as a 'job', or working towards a thesis. Because students at liberal arts colleges are on campus only an average four years, continuity (and thus productivity) in your research program is important and can be achieved through a cascade mentoring model⁸. Through this model, more advanced students in the lab train and mentor newer students on a particular project or skill. This model helps push forward larger projects given overlap in expertise between students, does not necessitate strict schedules (due to overlap in skill sets), provides important leadership and mentoring opportunities for advanced students, and reduces the time that a faculty member would otherwise spend training students. Faculty at small colleges can and should utilize these educational opportunities to advance their scientific program and scholarly work. In doing so, the benefits flow in both directions: to the student and to the PI. It should be noted, though, that research may progress slower at an undergraduate institution given the time and

personnel constraints listed above, but may be offset through collaborations with research institutions.

The student research experience can extend beyond that of the scholarly lab to also include the classroom. You can often leverage your course work (and have the department pay for you) to obtain preliminary data, collect follow-up data, and, most importantly, create a “real” research experience for students in the classroom. Given that toxicology is at the interface of so many fields (e.g., developmental biology, cell biology, molecular biology, bacteriology, nanobiology, etc.), you can develop a laboratory or series of laboratories to explore small aspects of your own research under the umbrella of a specific class. In my molecular biology course, we have previously collected data on ability of chemicals to induce promoters through a ligand-activated transcription factor. Students were able to learn basic molecular biology skills, gain knowledge in transcriptional regulation, and discover the roles of chemicals in eliciting biological effects. In turn, I had 40 students help me generate and test hypotheses for which I may not have otherwise found time or money. Short and long projects can be developed and utilized at all levels of the undergraduate spectrum, and can help you use your time (and money) wisely in other aspects of your profession.

Promotion and Tenure: balance between teaching, research, and service

Promotion and tenure at liberal arts colleges is most often evaluated on the teaching, research, and service. Exemplary teaching is often a mandatory component of ones promotion and tenure; despite this mandate, most Ph.D.s and postdocs have little to no formal coursework in education and pedagogy before they start their faculty job. However, on the rise are university- and department-wide ‘Preparing Future Faculty’ programs for graduate students and postdocs focused on increasing knowledge and awareness in this area. Once faculty, there are opportunities during the summer (through Howard Hughes Medical Institute, the National Academies, and individual universities and societies) to learn about undergraduate teaching and pedagogy. Within your college there may be opportunities for mentoring between junior and senior faculty through formal programs that involve class visits followed by individual or group discussions on pedagogy (termed “Teaching Triangles” at Bates College). Informal mentoring, which could involve discussions over coffee or class visits, can also be very helpful for new faculty in need of advice or assistance in their teaching. Regardless of your training and preparedness prior to your faculty position, demonstration of teaching excellence will be used in promotion and tenure and is evaluated in a number of ways.

When assessing teaching, student and faculty evaluations as well as a teaching statement are taken into consideration. Student evaluations first became popular in the 1960s and 1970s as a common tool to assess faculty performance in the classroom.⁹ Evaluations have come under increasing scrutiny, given that their effectiveness of rating teacher performance is often anecdotal;¹⁰⁻¹² however, there is no good replacement, to date, to assess the student experience.^{13,14} In support of career advancement, student evaluations at small colleges have to demonstrate one of two things: ratings that begin as initially high and maintain those levels (as compared to the college average), or show score improvement over time. Tenured colleague evaluations are used as another, complementary, mechanism to assess teaching success. Colleagues sit in on your class

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and lab setting and observe your teaching. After one or more visits, and potentially a discussion with you, they will write a letter summarizing their findings. This procedure can be an important mechanism to offset poor student evaluations, but cannot overcome them. Lastly, developing a statement outlining your pedagogy to share with your department is a third, and very different, way to participate in the process. The document should clearly and coherently convey your approaches to teaching and learning, and reflect upon your trajectory within the context of the school and its goals and values. The department can then use this self-guide as part of the assessment.

Research is the second pillar on which you are evaluated for promotion and tenure. While at small institutions the bar is sometimes not as 'high' as it is for colleagues at research institutions, it has become increasingly more important in assessment. To determine how important research scholarship is at your own institution, first consult the faculty handbook, although expectations are often discussed during the hiring process. If not explicit, then have a conversation with your superiors (Dean, Provost, Chair, and colleagues). They often will give you a basic outline of expectations (papers, grants, and importance of students on publications). On average at a small liberal arts school, one paper per year is the expectation. To accomplish this task, grant support is necessary.

Most research at small colleges is supported through three different programs. The NIH R15 grant has been one of the major mechanisms; it seeks to strengthen student research in the biomedical sciences. Projects can be funded for up to three years with a budget of up to \$300,000 in direct costs. At the NSF, grants supporting predominantly undergraduate institutions (PUI) seek to facilitate student-faculty research, and the Research at Undergraduate Institutions (RUI) classification is helpful in calling attention to proposals in this area. Additionally, the Research Experiences for Undergraduate (REU) program supports active experiences for students in areas of research supported by NSF. Given that federal funding rates are currently very low (5-15% depending on institute or program), faculty need to be cognizant of a variety of other mechanisms, from internal grants, state grants, and private foundations, to fund their work. It is also important to assess the importance of obtaining certain types of grants for promotion and tenure; at Bates College there is no preference, but rather the emphasis is that money is only a means to run a successful research program.

The third pillar of promotion and tenure is service to the college and your professional field. Service to the college is often completed through departmental and college-wide committee work, and to your professional field by organizing conferences, serving as journal editors/reviewers, and participating as an expert on panels, among others. Outside service is a great way to stay visible to your professional colleagues, especially if you are not publishing at the same rate that you were in graduate school or during your postdoc. It is important to note that service usually cannot substitute for a strong research program and excellent teaching evaluations. If either are lacking due to over-commitment in service, this component should be reduced. Further, if you are a new faculty, your chair should protect some of your time; don't be afraid to discuss this issue with him or her.

Looking forward: where does the liberal arts education fit into a contemporary undergraduate education and how does toxicology play a role?

Liberal arts colleges have sought to educate students in a variety of fields, and more recently in interdisciplinary fields, in order to provide the most transformational education. Given that interdisciplinary study is now the norm in education,¹⁵ toxicologists at small liberal arts schools are well suited to continue and advance that effort. Toxicology, unlike many fields, has always bridged the divide between many scientific disciplines due to the ubiquity with which chemicals interact in the biotic and abiotic environment. Further, by implementing the use of modern scientific and computer technology in our classrooms and labs to answer toxicological questions, we are setting our students up for great success beyond the academy. The ability to engage with undergraduate students in the classroom and the laboratory make it especially stimulating to be a modern (toxicology) teacher-scholar.

Notes

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