

## **The Biologists' Forum: The Undergraduate Research Experience: It's Really Not for Everyone, Students and Faculty Alike**

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Source: BIOS, 80(2) : 53-58

Published By: Beta Beta Beta Biological Society

URL: <https://doi.org/10.1893/011.080.0201>

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## The undergraduate research experience: it's really not for everyone, students and faculty alike

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### Introduction

Several years ago a department colleague caused quite a stir among his peers when a statement was posted outside his office door attributed to John Slaughter, former president of Occidental College, that read "research is to teaching as sin is to confession; if you don't participate in the former you have very little to say in the latter". Indeed, since the early 1960s academicians have debated the interrelationships between teaching and research and whether one would suffer without the other. Assuming of course that all faculty think similarly, and that a healthy synergy does exist between research and teaching, we did not give the quote a second thought. However, as word of our colleague's posting spread throughout the building we were amazed by the degree to which some faculty were offended, if not insulted, by the statement. Most recently as we sought to uncover more about the context in which the statement was first made it became obvious that it had indeed infiltrated the academic community and was not without impact. That no unanimity of opinion exists with respect to the interrelationship between research and teaching, or the lack thereof, is an under-

statement. Is doing research really a requisite for good teaching (Karp, 2002)? Does a synergy actually exist between research and teaching (Elton, 1986, 2001; Ramsden, 1994; Druger, 1998)? Are research and teaching separate, unrelated, independent activities (Ramsden and Moses, 1992; Lindsay et al., 2002), conflicting activities, or complementary activities? Irrespective of whether doing research is a requisite to good teaching or not, we question why the relationship between the two is as divisive an issue as it is with faculty both within and among disciplines.

Each of us with a Ph.D. in a scientific discipline would acknowledge that the degree requirements encompass a triad of hurdles, specifically, the taking of graduate courses, the passing of an oral comprehensive exam, and the writing of a thesis. A rhetorical question we would pose at this time is to ask whether the traditional undergraduate experience actually prepares students for the graduate research experience or not, or whether it should even attempt to do so. Presumably the typical science undergraduate experience prepares prospective graduate students for any course work they would encounter. Maturity, drive, skills, interest, and being founded in the fundamentals of the discipline would assist with making it through the dreaded comprehensive exams (we hope). However, which of life's academic experiences could the fledgling graduate researcher draw on to ensure success in enduring the endless hours of laboratory

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work that are required to form the basis of those dreaded thesis chapters.

Why is it then that the undergraduate research experience has been embraced by academia with such fervor? Why do academicians view the undergraduate research experience as the magic bullet, the elixir that will rid undergraduate education of its woes?

That undergraduate research, in one form or another, is a long-standing tradition that has served generations of students is undeniable (Hughes, 1972; Scalzi and Kovacic, 1973; Parsons and Bentley, 1975; Powers and Black, 1977; Sanzone, 1977). Undergraduate research is not “a game of numbers”, that is, credit hours generated, students involved, or projects completed. It is not a faculty member doing their research through an undergraduate but rather students doing research through faculty and faculty efforts. Although likely complementary, undergraduate research is not an appropriate substitute for course work, as the goals of each are different. Although course work forms the basis of a student’s understanding, research provides the depth. The former is typically broadly defined whereas the latter is narrow in scope. Further, course work deals with the known whereas research involves the unknown. That undergraduate research is becoming increasingly common, if not in vogue, at Institutions of higher learning whether these are the small liberal arts schools or the large land grant institutions are undeniable (e.g. Blockus, 2003; Boone, 2003; Camac, 2003; Cook and McCauley, 2003; McGee, 2003; Noice, 2003; Turens, 2003). Indeed, over the past decade much has been written about the immediate benefits of undergraduate research to the student, the faculty advisor, and the department per se (e.g. Brandenberger, 1990; Warner, 1998; Shellito et al., 2001; Chopin, 2002; Henry, 2005), as well as the potential long-term benefits to the student (Pallman, 2002; Lopatto, 2003, 2004, 2005).

That admissions personnel, faculty, and administrators alike are encouraging undergraduates to pursue research endeavors is undeniable. As such, the undergraduate research experience is being, or could be, used as justification for undergraduate recruitment in the sciences (Beer,

1995), especially among underrepresented groups (Brush, 1991). That this behavior is occurring is adequately documented in journal volumes dedicated at least in part to advocating the undergraduate research experience such as BIOS, the CUR Quarterly (e.g. Brandenberger, 1990) or Chemical Engineering News (Henry, 2005).

That there is a belief among educators that undergraduate science education is undergoing a positive transformation as a consequence of the undergraduate research experience is longstanding and undeniable (Scalzi and Kovacic, 1973; Mohrig and Wubbels, 1984; Henry, 2005). This presumed transformation is occurring despite the fact that the goals of undergraduate research are still commonly faculty-specific, though this too is changing. Because of our outcome-driven needs we force ourselves to define the expectations of undergraduate research such that some would argue the goal of the experience is to develop scientists through scientific research (Cruz-Garriz et al., 1989), or more generally to expose students to the scientific method through real life situations (Hughes, 1972). Minimally, undergraduate research should produce results that are scientifically significant and thus qualify for publication on their own merit or in conjunction with the work of others. Projects should be self-standing and most importantly tractable (Bunnett, 1984).

That the role of undergraduate research is also one in which students are allowed to work at their individual frontiers (Sanzone, 1977), or to work on projects that are highly original (Chan and Lee, 1991), or involve a group approach to solve contemporary problems (Parson and Bentley, 1975) demonstrates that undergraduate research is indeed broadly defined and may encompass a variety of experiences and expectations for both the student and faculty advisor. Further, the defined purpose of undergraduate research, that is, exposure of students to experimentation, synthesis, and presentation (Hughes, 1972) may very much differ from the realized purpose, that is, to maintain or elevate the research vigor of supervising faculty (Chan and Lee, 1991).

That some universities are eliminating the undergraduate laboratory experience from their

curricula because of costs associated with maintaining laboratory personnel and the acquisition of expendable laboratory supplies and major equipment is undeniable. That the latter occurs while academia concurrently encourages involvement of students in undergraduate research is minimally paradoxical. This said, we acknowledge that the typical undergraduate laboratory course, while educationally valuable in its use of prepackaged, redundant exercises, in actuality provides virtually no preparation for doing novel research, nor appreciation for the effort necessary to be successful in the research laboratory (Pallman, 2002). We are all aware that the typical inquiry-based undergraduate laboratory exercise is designed to complete within a three-hour time slot and pursues answers to questions that are already known. This experience is not comparable to doing novel research and the exercises generally provide students with, at best, the most basic of laboratory skills. However, this historical use of the laboratory experience may change with the proliferation of undergraduate research centers where authentic science is practiced as part of a normal course (Henry, 2005).

It has been argued that through undergraduate research opportunities students can more fully develop as tomorrow's scientists (Brandenberger 1990; Pallman 2002). Nationally, the general consensus is that students involved in undergraduate research are more likely to enter graduate school and therefore continue to do research than are those students who did not participate in undergraduate research (Tuss and Smalley 1994; Abrash et al. 1998; Hoagland 1999; Mabrouk and Peters 2000).

The benefits to students of doing undergraduate research extend beyond discovery and dissemination. Enhanced writing, communication, problem solving, and practical skills are but some of the many benefits identified by students in regards to their respective undergraduate research experience (Brandenberger, 1990; Chopin, 2002; Lopatto, 2003). Most importantly though undergraduate research provides for a degree of ownership in the chosen major and serves as an experiential window to future possibilities.

That undergraduate research has taken on many different meanings in the academy goes without saying. We can think of no other single factor, or combination of factors that faculty deal with on a daily basis, including grade inflation and course content expectations, that is however more divisive or polarizing than is the idea of undergraduate research (Druger, 1998). For some it represents another opportunity for discovery, whereas for others it is a waste of time, effort, and resources, a fad. For some it provides the opportunity to serve as a research mentor and thereby form the basis for a lifelong professional relationship, whereas for others it serves as a time to socialize and form personal relationships. For some it is viewed as being an integral part of their job as a university faculty member, whereas for others it represents the presumed road to promotion. For some it represents but a small fraction of their professional activities, whereas for others it represents the sum total of their professional activities.

As a science Ph.D. our post-baccalaureate roots are collectively founded in research and not teaching. Our professional worth is based on some combination of grants received, presentations made, and numbers of refereed publications (Ramsden, 1994). Yet, once a faculty position is secured and it comes time to establish an independent research program it is not uncommon for faculty to be unsuccessful in completing the transition. Issues associated with creativity, focus, interest, or drive may determine the research fate of some faculty. Others would argue that it is not possible to do their type of research at a typically undergraduate institution. To do research properly involves living a lifestyle, it is not a hobby, and research converts are neither common nor long lasting. Additionally, research is time intensive and not an activity to be engaged in on a part-time basis, it may involve collaboration and includes doses of satisfaction and its fair share of rejection and failure. Indeed, research vigor at the smaller, predominantly teaching oriented liberal arts schools may be maintained by the undergraduate research experience (Chan and Lee, 1991). Further, it could be argued that the overall experience has more to do with sustaining and fulfilling faculty than it

does with training students. Both however do benefit from the experience.

Acknowledging that academia includes faculty that continue to successfully be involved in novel research, as well as the pretenders, those that don't do novel research nor are supporters of the lifestyle, it also includes those that personally don't do research, some of which believe in it, but for others not themselves, some don't believe in it at all. In actuality, the pretenders do our cause the greatest harm. Can the pretenders truly offer the student a positive research experience? Unlikely. These faculty members are as counterproductive to the research implementation cause as are teachers to their cause that are dependent on the use of unrevised yellowed lecture notes. Acknowledging that exceptions may occur we would argue that faculty who do not participate in novel research concurrently do not stay abreast of the literature in their research area and as such have the potential for becoming obsolete even over a short period of time. In all likelihood they would be guilty of not rendering proper guidance and failing to inspire enthusiasm for learning (Page, 1972). That the pretenders could believe that it is possible for them to provide an undergraduate with a fulfilling research experience can be summarized as being self-gratifying and irresponsible. It is not a behavior we wish to have enforced in the psyche of fledgling researchers. Further, inasmuch as setbacks are part of doing science, experience tells us that rarely, if ever, does the research experience with these faculty have scientific merit, and this of course is the greatest drawback. Indeed the pretenders do little if anything to advance the value of undergraduate research and their actions belittle the endeavors of those that are involved and concurrently diminish the research accomplishments that do occur within a department by both students and faculty alike. Because research converts are neither common nor long lasting, our experience, as well as that of others (e.g. Powers and Black, 1977), demonstrates that it is only through the efforts of committed faculty that the student can be expected to put forth the devotion to time and effort that is necessary to creatively and productively commit to

the research project and subsequently benefit from it.

Of the many reasons put forth for not doing research, lack of time predominates. However, most of us are guilty of not adhering to some of what we preach to students, especially as it relates to time management. Because of our freedom to manage time how we choose, save for scheduled classes, laboratories, or meetings, in concert with our often times undisciplined nature a phenomenally significant amount of time ends up being wasted. If time is truly so precious why are we so cavalier with its allocation? For faculty legitimately short on time, options do exist (e.g. Freymeyer, 2004; McGill, 2004; Paul, 2004), but excuses are unacceptable.

Inasmuch as each of us has been part of a conversation dealing with excuses as to why research is not being done, we have also never known anyone to acknowledge that they are a less than average teacher. Research is no more for everyone than is teaching. Participating in undergraduate research is not for every faculty member, nor for every student. If either the student or faculty member is not (completely) committed to the exercise then the experience is destined to failure and valueless.

Too many of us live with the belief that doing research somehow makes us more effective instructors. Although discussion continues there is little to no empirical evidence demonstrating the existence of a functional association between research productivity and teaching effectiveness (Ramsden and Moses, 1992). Further, it is naïve to believe there is a simple answer to the question of whether a positive relationship exists between doing research and being a good teacher or not (Elton, 2001). Although it has been stated that the relationship between the two is not only hard to evaluate, but likely discipline specific (Elton, 1986), we should appreciate that the question is long standing (McGrath, 1962; Schmitt, 1965) and will in all likelihood remain unanswered to the satisfaction of most.

Are those that actively participate in research perpetuating the idea that doing research is integral to being a good teacher and are the non-researchers suggesting that doing research leads to inferior teaching? Never have we encountered



an individual doing research to be of the belief that doing research adversely impacts their teaching, however, the same is not true of the faculty that only teach. Doing research does not in turn mean the individual will be an effective teacher. Maybe those individuals that do research and teach well are just overall better at doing what they do than are those they are being compared to (Black, 1972). However, the relationship between doing research and being a good teacher is not necessarily causal. Bad research is as ineffective and counterproductive to achieving the goals of academia as is bad teaching. To believe that undergraduate research is the savior of the undergraduate experience is foolish. Indeed the justification for doing research at typically undergraduate institutions should be founded in reasons other than its relationship to teaching. For example, maybe faculty and students alike feel better about themselves simply because they are participating in research? We should not stray far from the idea that it is our collective responsibility as faculty to create, utilize, integrate, and disseminate knowledge. We do research to satisfy our creative spirit, not because we are expected to or told to, nor so we may enhance the likelihood of promotion, but because we believe it is the right thing to do. For academia to flourish we must acknowledge that both faculty and students are different, they each have their respective strengths, they each have their respective weaknesses, and what we need to do is embrace these strengths to minimize the impact of the weaknesses. Ultimately our graduating students will be the beneficiaries of these actions.

Arguably, doing research is one of the more appreciated measures of professional growth by administrators (Page, 1972), though institutionalizing undergraduate research requires a Herculean effort. Unless both faculty and administrators collectively accept the benefits of doing undergraduate research its implementation and overall adoption is destined to fail. Undergraduate research cannot succeed on the backs of a few. To succeed, we as faculty must be passionate about the idea and recognize that it is the right thing to do, not for just us, but for the Institution and for our prospective graduates, our

future alumna. Just as a plant's roots are responsible for acquiring all the necessary life sustaining nutrients from the soil to keep the whole plant healthy and vigorous throughout its life, so too is the responsibility of research for it represents our academic roots, the roots through which we were nurtured in the fundamentals of doing science and sustained in our commitment to the discipline.

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Received 28 January 2008; accepted 6 June 2008.