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Forging Faculty Student Relationships at the College Level Using a Freshman Research Experience

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Abstract

Coupling the scholarly activities of the chemistry research faculty with that of the freshman Honors general chemistry class has resulted in a rise of productivity within the Department. For seven years, freshman Honors students enrolled in the Honors general chemistry laboratory sections have been assigned to work in the labs of the research active faculty within the Department of Chemistry. Approximately a quarter of those enrolled in the Honors general chemistry laboratory sections elect to continue their research experience. The continued and sustained research experience has resulted in a research journal paper for six participants. For the past four years, four papers have been accepted for publication because of the research activities conducted as freshman stemming from this program. Each paper has had at least one co-author as an undergraduate at the sophomore or freshman level.

Keywords

Curriculum; Inquiry-Based / Discovery Learning; Problem Solving / Decision Making; Undergraduate Research

Introduction

As faculty in academic institutions, our primary instructional responsibilities are to equip and empower our students. By making effective teaching and learning a priority, a faculty member ensures that students will obtain the skills needed to succeed after leaving the university. While a student, it is not uncommon to find that they are in the earliest stages of recognizing the need to couple their academic activities with their professional development, which for many in the physical sciences translates to research. The sooner this connection is made, the more enriched their university experience will be as an undergraduate student. Our experiences of coupling the research activities of our students with mentors within the department as freshman echo that of many other researchers. Simply stated when made early, undergraduate research can have a significant impact on one's professional development.(1)

For seven years, freshman Honors students enrolled in the Honors general chemistry laboratory sections have been assigned to work in the labs of the research active faculty within the Department of Chemistry. The research experience is one unique component of the first- and second-term Honors general chemistry laboratory sections. While a poster presentation at the

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end of the two-term sequence completes the course requirements, approximately a quarter of those enrolled elect to continue their research experience. Regardless in how the metrics are disseminated, our rise of productivity is best documented when assessing the manuscripts accepted in peer-reviewed journals. That is, with a sustained level of published work as a result of the freshman research experience, our goals of increasing our productivity as a Department are met.

As a Primarily Undergraduate Institution (PUI), each research program is staffed by undergraduate research students. While options to utilize postdoctoral and/or graduate personnel exist through collaborations or external support, the bulk of the workforce comes from the undergraduate community. The rationale for our approach was loosely based upon the pairing of the Honors students enrolled in the general chemistry sequence with those in the Department wanting more students in their research labs. The benefits of combining the activities of the instructional and research laboratories are notable.(2)

Background

The University of South Alabama is an urban institution. The institution consisting of just over 14,000 students is classified by the Carnegie Foundation as Master's/L. While degrees at both the masters and doctoral levels are awarded, the frequency by which these degrees are awarded has not removed our overall PUI classification. The Department of Chemistry at the University of South Alabama has as its terminal degree a B.S. and consists of 14 full-time tenured/tenure track faculty. The Department is certified by the American Chemical Society and graduates, on average, 10 students annually. All chemistry graduates are required to complete no less than four credit hours of directed studies, which offer all chemistry majors an opportunity to work in a research lab under faculty guidance. With permission of the department chair, this experience can begin as early as their freshman year.

Results and Discussion

It has been our experience that engaging undergraduate students in discipline specific scholarship early serves as a very effective tool in equipping them with knowledge about what opportunities are available to them upon graduation. If an appropriate match is made, a sustained research experience can, and often does, span the entire time of the student's undergraduate career. The benefits of establishing and maintaining an early relationship with faculty mentors are numerous.(1,2) Career-paths are often molded while active in scholarship outside of the traditional lecture hall setting.(3) The philosophy of a research-supportive undergraduate curriculum has numerous pedagogical advantages.(4) In chemistry, we have found that the truest form of learning is best offered through the laboratory setting. An innovative mechanism in coupling the qualified and motivated students of the Honors Program with the goals of the Department became reality in August of 2002.

Three years after the Program's inception, students enrolled in the Honors general chemistry laboratory sections were divided into groups and assigned to the individual chemistry labs of the research active faculty. Their goal was to integrate themselves into the research environment of the Department. This capsulated research experience substituted for two or three of the 12 laboratory experiments offered each term.

Having students engage with the individual research programs within the Department was a revision of the original plan of the Honors general chemistry laboratory experience. The Honors general chemistry laboratory section initially offered a rotational experience where individual faculty members came into the instructional lab and led a tailored experiment matching their individual expertise. Bringing their specialty to the instructional lab or having the students

farmed into the research labs of the Department offers both the first- and second-term general chemistry laboratory sections the distinctiveness of an Honors section.

Because of the constructive feedback obtained from the students and faculty participating in the program, a revised plan incorporating a more research orientated experience was proposed. After discussing and deliberating the merits of the proposal, a decision was made to modify the nature of the research experience. In August of 2002, students who enrolled in the Honors general chemistry laboratory sections were asked to perform 20 hours of research under the direction of a faculty member of the Department willing to serve as mentor. The research efforts which often exceed the 20 hour rubric culminate with a poster presentation at the end of the two term sequence. The matching of student with faculty member is primarily based upon need — one, two, or in some cases three slots of availability for a particular research group. If a student expresses an interest prior to the selection process, efforts, of course, are made to find an appropriate match.

Since 2002, an average of 13 students or the equivalent of 11% of the Honors program membership enroll and seven faculty members participate in each of the two Honors general chemistry laboratory sections offered each year. Upon completion of the two-term sequence, approximately a quarter of those enrolled continue their research experience in Chemistry. Most of those who elect to continue have majors in the physical sciences. While not all of those who participate are chemistry majors, each year one, sometimes two, enrolled switches their major to chemistry essentially doubling the number of chemistry majors participating in the freshman Honors general chemistry laboratory sections. Be it from underserved populations (2b) or a program of great diversity when considering our Honors program, change stems from the opportunities given to those who express an interest in an environment which promotes scholarship.

While the length of the research experience varies from one individual to another, both student and faculty alike, most students continue their research experience throughout their undergraduate years. Rarely do the initial assignments switch once made. The open-ended investigations offered through the freshman experience has enabled each faculty member willing to participate an opportunity of sustained undergraduate research support. Interesting is that while many in academe can forward names of individuals during their career who showed remarkable interest in beginning their research experience as early as freshmen, this program on an annual basis taps into a pool of recently graduated high school students easily classified as self-starters and highly motivated.

Challenging these students who as a group have an unparalleled desire to succeed is a very good fit when considering the strengths and weaknesses of conducting research at a PUI. That is, the freshman research experience offered through the Honors general chemistry curriculum compliments ongoing activities within the Department. Those active in research in the Department consist of both chemistry and non-chemistry majors. The Department averages on a per student basis, 24 months of research exposure because many of the non-Honors chemistry majors start their four hour required directed studies research experience during their junior year. A 48 month research experience is now possible and often recorded with those who elect to continue their research in chemistry. As a result of having such a high and continuous influx of research productivity, the Department now averages 50 poster presentations per year at local, national and international venues.⁽⁵⁾ The vast majority of the presentations made have undergraduate co-authorship. Because the Department has targeted the National American Chemical Society meeting as a place for our students to gain invaluable experience in presenting their work to a national audience, most of the presentations have as co-authors, students who started their research as freshmen. Not surprising, over the last six years, the

Department has seen a rise in the number of students each year attending and presenting at these meetings.

The level of research documented in the Department on an annual basis is extremely high. This is possible because of the caliber of students conducting research in our research labs throughout the year. Their work ethic and willingness to sacrifice their time has resulted in an extraordinary level of productivity. In addition to the volume of presentations made annually, the Department has averaged over the last six years 1.9 publications per year per faculty member. For a PUI, the average publication rate is 0.6 papers per year.⁽⁶⁾ The average of undergraduate student co-authorship is 31% compared to a national norm of 25%. While both values are higher than that of a national average computed by *Academic Excellence: The SourceBook*, the former is three times higher than the average publication rate at chemistry programs at a PUI.

Four publications have as co-authors undergraduate students who started their research experience as freshman through the Honors general chemistry laboratory sections.⁽⁷⁾ Six of the undergraduate co-authors had their work published during their sophomore year and as a result they most likely will have multiple publications prior to graduation.³ We as a Department have averaged 20 research journal papers published per year. A third of the published work, as an average, has undergraduate students as co-authors.

The rise in productivity includes both involvement, an increase in the number of students participating in research each term (an average of 8-13/term), and the timing, a starting time of when Honors students begin exploring research opportunities. Prior to 2002, we did not have a sustained level of published work or conference proceedings having freshman/sophomore co-authors. What is interesting is that while we see a rise in participation and productivity at an earlier stage, freshman/sophomore rather than junior/senior, career goals have not altered beyond what would be considered normal at a PUI. The data documents and will continue to document the collective efforts of many which stems from our goal of establishing and maintaining productive relationships with our undergraduate community.

Summary

Engaging students in research beginning their freshman year and having that early experience coupled into their Honors Senior Project is one unique component of the University Honors program. A research experience spanning four years offers our students the opportunity to do masters quality research at a PUI. The continued and sustained research experience has resulted in a rise in the number of research journal papers and conference proceedings with freshman and sophomore as co-authors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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³Numeric data (publications and involvement) as a result of the Honors freshman research experience can be found in the supplementary material.

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