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Thinking Outside the Box: The Research-Education Nexus

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For this issue, I have a question that I definitely do not have an answer to: What is the proper balance between research and teaching, especially at an institution that historically has focused on undergraduate education? There are many excellent reasons why access to high quality research experiences is important to the education of electrical and computer engineers. It is because of the value of such experiences that our community supports the highly successful multi-university program *Smart Cities Research Experience for Undergraduates and Teachers* (SCR²). (NSF Award #1849454) Participating students and teachers have rated their research experiences very highly, even during the challenging time of Covid.

Since its inception, IEC has explored ideas for increasing the level of research activity at its member institutions. Two general hypotheses formed the basis of this effort: that student learning and development as engineers is enhanced by opportunities to participate in active research and that opportunities for learning and professional development can be expanded through collaboration. However, as we have explored various opportunities for and approaches to collaboration in research, we have seen more and more that we must address one additional hypothesis: that faculty can more fully engage in the ECE enterprise by finding the right balance between research and education. That is the source of the question I have raised above.

Probably every ECE program in the US has had a discussion of this question and many ideas have been shared in the literature. However, it appears that little has been written on how the question should be answered on a practical basis at all types of universities. The Boyer Commission [Boyer Commission on Educating Undergraduates in the Research University, *Reinventing Undergraduate Education: A Blueprint for America's Research Universities*, State University of New York at Stony Brook for the Carnegie Foundation for the Advancement of Teaching, Stony Brook, NY, 1998] addressed this issue quite extensively more than 20 years ago, but only for major research universities. Even they concluded that 'Research universities have failed, and continue to fail, their undergraduate populations.' One study that is quite useful in establishing whether faculty research can and does improve undergraduate teaching, in both research and teaching intensive programs, is described in the excellent 2007 paper by Prince, Felder and Brent. [*Does Faculty Research Improve Undergraduate Teaching? An Analysis of*



Existing and Potential Synergies, M. J. Prince, R. M. Felder, and R. Brent, October 2007, Journal of Engineering Education 96(4):283-294]

The authors had five recommendations for strengthening the research-teaching nexus at the local level:

1. *'Formally recognize and reward faculty members who successfully integrate their teaching and research'*
2. *'Establish faculty development programs in both teaching and research at the school or college level, including ways to integrate the two domains'*
3. *'Promote involvement in research for a broad spectrum of undergraduates, and make sure there is meaningful contact between the researchers and their advisors'*
4. *'Recognize and reward faculty performance in all four Carnegie scholarships [Discovery, Integration, Teaching, Learning] and apply the same performance standards to all of them'*
5. *'Encourage faculty members to use inductive teaching methods (e.g., inquiry-based, problem-based, and project-based learning); provide faculty development programs that prepare them to do so; recognize and reward those who use the methods effectively; and assess the effectiveness of the methods for integrating research and teaching'*

I highly recommend reading the full paper from Prince, Felder and Brent, who conclude:

'In summary, the answer to the question "Has undergraduate research been shown to strengthen the research-teaching nexus in the sense that it produces better learning?" is a qualified yes. Involvement in research has been shown to correlate positively with student retention, with the greatest observed effects being seen for African-American students, and most participants in undergraduate research programs report that their experiences were both instructive and enjoyable. Research participants also report gains in research related skills, although direct measures of these gains is currently lacking, and there is very little evidence that undergraduate research has much of an effect on students' content knowledge. Research involvement may also have a positive effect on students' plans to pursue graduate study. Finally, undergraduate research at most universities is limited primarily to relatively strong students who constitute a small percentage of the student population, so that the impact of whatever benefits may exist is similarly limited.'

Please share any thoughts you may have on this question, particularly if you are part of the SCR2 mega REU/RET site. I can most easily be reached by email (connor@rpi.edu).