

**New Program Proposal  
Doctor of Philosophy  
Engineering and Science Education  
Clemson University**

**Summary**

Clemson University requests approval to offer a new program leading to the Doctor of Philosophy degree in Engineering and Science Education to be implemented in Fall 2011.

The Clemson Board of Trustees approved the proposal in January 2010. The Program Planning Summary was submitted to the Commission in February 2010, and it was reviewed and voted upon favorably by the Advisory Committee on Academic Programs on March 18, 2010. The full proposal was received by the Commission on February 15, 2011.

According to the proposal, the purpose for establishing the Ph.D. in Engineering and Science Education is to create a unique graduate program focused on science, technology, engineering, and mathematics (STEM) education research. At present, Clemson's Department of Engineering & Science Education, housed within the College of Engineering and Science, is the only department in the country that combines both engineering education and science education in a College of Science and Engineering. As such, the proposed program would be a unique program in the nation. The department includes faculty members who are subject matter experts in both science education and engineering education, and who also have active research programs in both academic fields. The proposal states that students will be exposed to the extensive range of current STEM education research and will be prepared to contribute to the development of new theory in STEM education as well as the implementation of new research findings. The proposed program will employ a discipline-based education research (DBER) approach and will therefore combine knowledge of teaching and learning with deep knowledge of discipline-specific science content. The DBER approach also describes discipline-specific difficulties which learners face as well as specialized intellectual and instructional resources that can facilitate student understanding.

The proposal states that because of the distinctive way in which faculty from the sciences, math, and engineering will be combined, the proposed program will be unique among doctoral programs which focus on discipline-specific educational investigations. By extension, the program will be of great appeal to potential students as well as to funding agencies. The proposal states that the university as a whole and the College of Engineering and Science have demonstrated a strong commitment to the proposed direction and that faculty members are committed to implementing "a vibrant doctoral program that will support the core educational needs in engineering and science."

Through its proposal, Clemson affirms that the objectives of the new doctoral program will be to prepare students for academic careers in STEM education, science education policy in higher education institutions, or in other careers that require a deep disciplinary knowledge coupled with an understanding of the factors that affect student learning, retention, and inclusion in STEM areas. According to the institution, students who enroll in this program must be content experts in a STEM discipline with at least a Master's degree or its equivalent in their content area of expertise. Graduates will be prepared for faculty roles in traditional departments of engineering or science as well as in STEM education departments. They will also be prepared to lead curricular and pedagogical reform at the post-secondary level, and to conduct research in STEM education. The proposal includes an enthusiastic letter of support

and a positive evaluation from Dr. George M. Bodner, Arthur E. Kelly Distinguished Professor of Chemistry, Education and Engineering in the Department of Chemistry at Purdue University at the University of Georgia as well as from Dr. Karl A. Smith, Purdue University and the University of Minnesota.

According to the proposal, there is an increased need for faculty who are experts in STEM disciplinary content and research on student learning, both in terms of the number of graduates and the quality of their educational experiences. With heightened attention on the growing importance of STEM disciplines nationally, such demand is anticipated to increase dramatically. The proposal states that Ph.D. prepared students in STEM education research are in high demand because of higher education's wide recognition of the type of expertise students with such preparation possess.

The institution reports a high level of student demand and interest in the program. According to the proposal, in recent years, the quantity of advertised faculty positions seeking chemistry education researchers has exceeded the number of available and qualified applicants. The proposal also states that the same is true in other engineering education programs as well. For example, the institution cites numbers from Purdue University's School of Engineering Education which graduated ten students with the doctoral degree as of August 2009. Nine of the ten graduates are employed in various capacities within academic units, including six assistant professors in various engineering disciplines. Moreover, the proposal states that a number of students currently housed in departments such as bioengineering, chemistry, civil engineering, computer science, industrial engineering, mathematics, and mechanical engineering would pursue a major in engineering and science education if the proposed degree program were offered. Moreover, the proposal draws attention to the fact that those students who would like to pursue a Ph.D. in engineering and science education are currently applying to other institutions such as Purdue or Virginia Tech. The proposal reiterates that Clemson currently has the faculty, expertise, and funding to support such a program as well as the requisite student interest. As an example, the proposal states that there are 17 students who have completed requirements for the Certificate in Engineering Education, with approximately 20 additional students who are enrolled in the department's graduate courses. Eleven other students are currently engaged in conducting education research as part of a dissertation project and while currently housed in other departments, a number of these students would major in engineering and science education if the program was in place.

The proposal states that although the proposed program is unique, there are a number of departments of Engineering Education (Purdue, Utah State, Virginia Tech) that offer Ph.D. degrees in Engineering Education and approximately 30 other doctoral programs in physics education, with a similar number in chemistry education. The institution has current collaborations with the above-mentioned departments and faculty as well as with faculty at UC Berkeley, University of Colorado at Boulder, University of Iowa, Iowa State, Purdue, Harvard, University of Virginia, University of South Florida, Ball State University, Indiana University, California Polytechnic-San Luis Obispo, North Carolina State, Tennessee State University, University of Houston, and University of Texas-El Paso.

The admissions criteria for the proposed program include a required minimum of a Bachelor of Science degree in a STEM discipline from an institution of higher learning acceptable to Clemson, with preference given to students who hold the Master of Science degree. As such, the program is geared toward students who are STEM discipline content specialists who have a desire to pursue discipline-based education research. Students will be admitted into the program in the Fall, Spring, and Summer semesters. Students will be required to pass a

comprehensive examination and a dissertation qualifying examination before undertaking dissertation research. The comprehensive examination must be scheduled within 12 months after students have completed all required coursework. Upon successfully passing the comprehensive examination, the dissertation qualifying examination follows within another 12 months.

According to the proposal, an evaluation plan for the program has been developed and will monitor the number of students who are accepted to the program and the number who graduate. As part of the evaluation plan, data on the employment patterns of graduates will also be collected. The evaluation plan also includes provisions for monitoring collaborations and funding generated by program faculty and rates of graduate student support.

The proposal states there will be approximately eight Ph.D. students who will either enter or transfer into the program in Fall 2011. Moreover, the proposal indicates that a conservative estimate is to increase enrollment in this Ph.D. program by from eight to 15 doctoral students by 2014, and that a steady enrollment of at least 15 full-time students in the program is anticipated. Recruitment activities are planned which will take advantage of the university's presence at a number of national conferences. These include meetings of American Society for Engineering Education (ASEE), the National Association for Research in Science Teaching (NARST), the American Physical Society (APS), and the American Chemical Society (ACS). The university will also avail itself of the websites of the department, the college, and the university in order to advertise the program's availability. Notably, the proposal states that a web search for "engineering and science education" returns the result of Clemson's Department of Engineering & Science Education as the very first hit.

The proposal states that since several students will transfer from other programs, it is anticipated that the first cohort will take two-to-five years to complete the doctorate (e.g., approximately two graduate students will finish the program and be replaced with new students each academic year). With two additional new students anticipated to enroll in the program for the first five years, the proposal states that a total of four new graduate students are anticipated for the first few years. By extension, between two and four students are projected to replace graduating students each year.

According to the proposal, most estimated program costs will come from reallocation of existing funds. The sole new funding amount is \$15,000 per year for departmental travel and recruiting. Since the Department of Engineering and Science Education was established to develop graduate programs, all necessary funds have already been allocated. Additionally, existing and future external funding will provide a steady revenue stream. The institution states that the department currently receives over \$3 million in external funding and that \$60,000 per year in the departmental budget is allocated for graduate students.

If the enrollment projections are met, the program will meet the Commission's program productivity standards for enrollment and degrees awarded.

According to the proposal, no new faculty will be required in order for the institution to implement the proposed program. The proposal does state, however, that if the department expands, new faculty who are hired will have the same kind of qualifications as existing faculty (e.g., a doctorate in a STEM discipline with an education research background). The proposal also states there will be few to no changes in assignment for existing faculty who are currently teaching required graduate courses. The proposal also states that all faculty are qualified and capable to direct doctoral candidates. These faculty also regularly attend at least two

conferences per year and publish in their fields. Importantly, all faculty members have also secured external funding from the National Science Foundation in the field of engineering and science education to support graduate students.

The proposal states that facilities which are needed to support the program will be adequate for the next five years and that all faculty and staff have adequate office space. Additional space has been renovated for 15 graduate students and the current space is more than adequate to expand should it be necessary. Additional equipment is not required at this time and National Science Foundation funding for specialized equipment is available should there be such a need. The proposal also states that the university's library holdings and access to electronic resources are adequate to support the program. Additionally, the institution subscribes to all major journals in the related fields and these are readily available to students. According to the proposal, there is no specialized accrediting body for the proposed program.

<b>ESTIMATED COSTS BY YEAR</b>						
Category	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	Totals
Program Administration	\$32,558	\$33,535	\$34,542	\$35,579	\$36,647	\$172,861
Faculty Salaries	\$248,412	\$255,847	\$263,523	\$271,429	\$279,572	\$1,318,783
Graduate Assistant	\$240,000	\$270,000	\$330,000	\$390,000	\$450,000	\$1,680,000
Clerical/Support Personnel	\$28,365	\$29,216	\$30,093	\$30,996	\$31,926	\$150,596
Travel	\$5,000	\$5,150	\$5,305	\$5,465	\$5,629	\$26,549
Operations	\$5,000	\$5,150	\$5,305	\$5,465	\$5,629	\$26,549
Seminar	\$5,000	\$5,150	\$5,305	\$5,465	\$5,629	\$26,549
Equipment	\$3,000	\$3,090	\$3,183	\$3,279	\$3,378	\$15,930
Recruitment	\$4,000	\$4,120	\$4,244	\$4,372	\$4,504	\$21,240
Other	\$5,000	\$5,150	\$5,305	\$5,465	\$5,629	\$26,549
<b>TOTAL</b>	<b>\$576,335</b>	<b>\$616,408</b>	<b>\$686,805</b>	<b>\$757,515</b>	<b>\$828,543</b>	<b>\$3,465,606</b>
<b>SOURCES OF FINANCING BY YEAR</b>						
Reallocation of Existing Funds*	\$336,335	\$346,408	\$356,805	\$367,515	\$378,543	\$1,785,606
Tuition	\$66,016	\$74,268	\$90,772	\$107,276	\$123,276	\$461,608
Federal Funding**	\$173,984	\$195,732	\$239,228	\$282,724	\$326,724	\$1,218,392
<b>Total</b>	<b>\$576,335</b>	<b>\$616,408</b>	<b>\$686,805</b>	<b>\$757,515</b>	<b>\$828,543</b>	<b>\$3,465,606</b>

\* The proposal states that “at present \$60,000 per year is allocated in the departmental budget for graduate students. Tuition is based on total student enrollment at \$4162/semester.”

\*\* The proposal states that “the remaining graduate assistant budget will come from external federal grant sources. This funding estimate is predicated on continuous funding, however since the faculty have been successful already, we feel this projection is warranted. If funding sources are not available, we will not recruit graduate students for that year. Conversely, if our funding continues to rise, we will recruit more graduate students.”

According to the institution, these data show that if the projected student enrollments are met as they are shown in the proposal, the proposed program will be able to cover costs beginning in the first year and thereafter.

In summary, Clemson University is proposing a unique new program leading to the Doctor of Philosophy degree in Engineering and Science Education. The proposed program will draw its initial students from currently enrolled students and a realistic plan to increase enrollment numbers in the program is in place. There will be no new costs to the institution or state to implement this program.

### **Recommendation**

The Committee on Academic Affairs and Licensing commends favorably to the Commission the program leading to the Doctor of Philosophy degree in Engineering and Science Education to be implemented in Fall 2011, provided that no "unique cost" or other special state funding be required or requested.