

# Curriculum, program, and infrastructure development for Bachelor of Science in Optical Science and Engineering (Invited Paper)

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## Summary

The faculty of the Department of Electrical and Computer Engineering (EECE) in the School of Engineering, the Department of Physics and Astronomy in the College of Arts and Sciences, the Department of Educational Specialties in the College of Education, and the Department of Individual, Family, and Community Education in the College of Education at the University of New Mexico (UNM) have jointly developed a comprehensive plan for a new B.S. degree in Optical Science and Engineering, with emphasis on education in the field of photonics, accompanied by teacher training and enhancement of K-12 optics education initially at the high- and middle-school levels, and eventually reaching down to the elementary school level in the implementation stage of this program. Specifically, the plan incorporates development of a new college degree curriculum, creation of new laboratories, development of courses training K-12 teachers in optical science and engineering, creation of outreach programs, identification and activation of sources of support for minority students, and involvement of local and national industry and government laboratories.

Through the incorporation of current pedagogical learning theories concerning instructional design and assessment, the new degree curriculum will support a new model that will be available for use by other engineering programs at UNM's School of Engineering and nationwide. Most importantly, the new degree will bridge the last remaining gap in the unique hierarchy of photonics educational programs in New Mexico, starting with the Photonics Academy at West Mesa High School supported by the Sandia National Laboratories that feeds into the Photonics Technology Associate Degree program at the Albuquerque Technical Vocational Institute, and ending with the M.S. and Ph.D. programs in Optical Science and Engineering offered at UNM. The comprehensive line-up of educational and career options in optics and photonics that would be enabled by the planned B.S. degree will permit New Mexico industry to fill its photonics-centered positions at all levels, from the technician to the advanced researcher, from a workforce trained locally. The planned degree will, more generally, help meet the emerging workforce and educational needs of the entire US industry.

There is critical need for a new approach in undergraduate engineering education, and this is particularly true for a cross-disciplinary field like optical science and engineering. A major emphasis in the planning process is placed on enhancement of the quality of learning that can result from collaborative interactions between the optics and education faculty. These are expected to create conditions in which cognitive science research will be actively conducted and applied to optics and photonics education. We further expect that this unique environment will result in the creation of the first normative model of optics and photonics professional education.

We plan to utilize the positive experience of NSF-funded Engineering Education Coalitions (EECs), where even the first-year students learn engineering within a connected intellectual and social context. Significantly improved retention among students who elect to take the first-year engineering courses at the universities participating in the EECs shows that early offering of subject-oriented courses is very effective in building community and social support that are vital as students go through a challenging curriculum. Based on these data, we plan to develop an innovative first-year optical science and engineering curriculum incorporating the pedagogical theories of the Foundation Coalition.

The proposed program will aim at increasing the number of web-based and ITV course offerings, especially at the lower-end (first two years) of the curriculum. Development of an undergraduate curriculum with a strong distance learning component is particularly important for UNM with some of its branch campuses extending as far as 150 miles away from the main campus.

We plan to organize an Optics and Photonics Education Summit that will be devoted to further strengthening of optics and photonics education in New Mexico at all levels of the educational ladder. Based on the educational as well as socioeconomic issues identified at the Summit, we plan to organize a smaller, more focused follow-on workshop at UNM, concentrating on the new B.S. program. The main purpose of this workshop will be to develop actual strategies and tactics to fold in the entire range of such mostly external, often highly interdependent factors into a viable plan for the new degree program.