

## **Applying the Scholarship of Teaching and Learning to Antennas and Propagation Education**

David G. Michelson and Ryan Manak

The University of British Columbia, Vancouver, Canada V6T 1Z4

For many years, engineering education practice was driven almost exclusively by a combination of institutional edict and instructor experience and intuition. During the 1990's, two fundamental shifts in thinking occurred. First, engineering accreditation boards began to take a more aggressive approach in challenging engineering schools to improving student outcomes. Second, the notion that teaching and learning could be subjected to scholarly research and inquiry took root and gave rise to the Scholarship of Teaching and Learning (SoTL) movement. Although SoTL has gathered a large following within the academic community in recent years, integration of SoTL into the engineering disciplines is still in its early stages. While many works have been devoted to SoTL as a scholarly process, relatively few have considered the institutional or discipline-specific context within which SoTL is practiced. Here, we consider how the principles of SoTL can be usefully applied to our own efforts to fundamentally improve the senior-level antennas and propagation course at UBC, and hopefully entice the best of them to consider pursuing graduate studies in this area.

During the most recent editions of our senior-level antennas and propagation course, we introduced various improvements to both the content and delivery of the course, and used SoTL techniques to assess the efficacy of the outcome from a learner perspective. First, we used smart antennas as the central theme of the course and highlighted the multidisciplinary nature of modern antenna engineering. As a result, the course modules progressed from a review of basic electromagnetics to radiation from simple antenna elements to antenna arrays to probability distributions to propagation models to direction of arrival estimation before bringing it all together to demonstrate the function and operation of a smart antenna. Second, we took a problem-based learning approach in order to more directly engage learners and placed particular emphasis on: 1) formulation and documentation of the problem-solving strategy as an intermediate step between giving the problem description and presenting the detailed mathematical solution, and 2) engineering communication skills, *i.e.*, use of free-hand sketches, bullet points, and mathematics to both aid in the problem-solving process and description of a problem and its solutions to others. Third, we introduced a series of lab assignments that gave students practical experience in spectrum and vector network analysis, and in realizing  $4 \times 4$  beamforming antenna arrays at 28 GHz.

We supplemented each chapter of the course text with a set of supplementary materials: 1) lecture slides that were used to introduce the concepts treated in greater detail in the textbook and supplementary materials, 2) a chapter brief which contained a list of performances (performance objectives) that the learners were expected to demonstrate upon course completion and detailed enabling objectives that were required to accomplish each performance, 3) a chapter supplement which surveyed the chapter, summarized the contents of each section, and offered commentary that either clarified certain points or raised issues or introduced references that had not been covered in the text but which the instructor felt was worth noting, and 4) a list of chapter review questions based on the textbook. In keeping with the problem-based learning approach, significant class time was devoted to in-class problem-solving in which learners could seek assistance from both colleagues and teaching staff. Both learner feedback and course results suggest that the improvements were effective in stimulating interest and encouraging mastery of the subject matter.