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Can we build a more efficient airplane? Using applied questions to teach physics

AATISH BHATIA, Princeton University

For students and for the science-interested public, applied questions can serve as a hook to learn introductory physics. Can we radically improve the energy efficiency of modern day aircraft? Are solar planes like the Solar Impulse the future of travel? How do migratory birds like the alpine swift fly nonstop for nearly seven months? Using examples from aeronautical engineering and biology, I'll discuss how undergraduate physics can shed light on these questions about transport, and place fundamental constraints on the flight properties of flying machines, whether birds or planes. Education research has shown that learners are likely to forget vast content knowledge unless they get to apply this knowledge to novel and unfamiliar situations. By applying physics to real-life problems, students can learn to build and apply quantitative models, making use of skills such as order of magnitude estimates, dimensional analysis, and reasoning about uncertainty. This applied skillset allows students to transfer their knowledge outside the classroom, and helps build connections between traditionally distinct content areas. I'll also describe the results of an education experiment at Rutgers University where my colleagues and I redesigned a 100+ student introductory physics course for social science and humanities majors to address applied questions such as evaluating the energy cost of transport, and asking whether the United States could obtain all its energy from renewable sources.