

- American Association of Physics Teachers, St Mary's College of Maryland (2015); A. Johnson et al., *Phys. Teach.* (in press).
4. P. W. Irving, E. C. Sayre, *Phys. Rev. ST Phys. Educ. Res.* **11**, 020120 (2015).
 5. C. L. Tesfaye, P. Mulvey, *Physics Bachelor's One Year After Degree*, American Institute of Physics (2014).

Erin De Pree

(ekdepree@smcm.edu)

Joshua M. Grossman

(jmgrossman@smcm.edu)

St Mary's College of Maryland
St Mary's City

► **Irving and Sayre reply:** We agree with many of the points raised by Erin De Pree and Joshua Grossman. Our PHYSICS TODAY article is not a treatise on identity in physics; instead, it is a succinct summation of two studies aimed at applying the theory of communities of practice to a specific physics context, which is not De Pree and Grossman's context. Nonetheless, many of their criticisms seem to stem from their misunderstanding the aims and methods of phenomenography.

For example, our statement that gender or race did not play a role in students' perceptions of their experiences was not an assertion that those things aren't important in students' identity as physicists. Our statement is based on our data, in which students did not highlight gender as playing an important role in how they perceived being a physicist. That perception is what phenomenography seeks to find. Is it problematic that students don't think of race or gender issues in physics? Absolutely! However, a critical examination of race and gender in undergraduate physics is a different study.

Similarly, De Pree and Grossman are concerned about our PHYSICS TODAY article's characterization of students by their attitude toward research. They're right that most physics students don't enter academic research careers, though that's not the only utility of research experiences. That theme in students' perceptions emerged from our data. We interpret it as a result of faculty messaging about the importance of research coupled to students' lack of awareness about the diversity of physics careers available. Our data highlight students' attitude toward research as a problem that needs to be addressed,¹ not an accepted norm.

More broadly, De Pree and Grossman wish our study had been completed in a

different context and a different way. There's a huge body of literature on the experiences of introductory students but comparatively little on upper-division students. In our study, we're interested in the experiences of upper-division students as they become physicists—whatever that means to them—not the experiences of first-year students as they become physics majors. We agree that the lens is narrow and limited by the demographics of physics majors at Kansas State University.

We're not quite as limited as De Pree and Grossman allege, particularly in terms of student retention. Of our 20 participants, 18 were still enrolled as physics majors or minors at the time of the final interview, yet only 7 persisted in our study. Maintaining persistent engagement in an interview-based study is a common problem for longitudinal qualitative research. The final interview was not during the final semester of their undergraduate career, and that was another limitation of our study. We would have loved to follow students from matriculation to graduation—and beyond—but that level of research is not part of our current funding.

We welcome additional research on the difficult problem of how students become physicists across a wide variety of contexts and experiences.

Reference

1. P. W. Irving, E. C. Sayre, *Cult. Stud. Sci. Educ.* **11**, 1155 (2016).

Paul W. Irving

(paul.w.irving@gmail.com)

Michigan State University

East Lansing

Eleanor C. Sayre

(esayre@ksu.edu)

Kansas State University

Manhattan

Standing on their shoulders

People like Dave Jackson come along only rarely (see his obituary in PHYSICS TODAY, October 2016, page 68). I was privileged to take his electrodynamics course at the University of Illinois, and along with many other aspir-

ing physics graduate students, I struggled with his "problems."

I write to share a personal interaction I had with Professor Jackson when I was attempting to understand special relativity's twin paradox. At a point of extreme frustration I went to his office and confessed my inability to get my head around the concept. He surprised me by saying that he didn't understand it either, and then the two of us worked together for a while to gain some understanding. The interaction is one I will never forget; it exposed me to a very special human being.

Allan R. Hoffman

(arh0531@gmail.com)

Reston, Virginia



Reading the obituary for Lev Okun (PHYSICS TODAY, May 2016, page 64), I realized that one very important contribution is omitted: Okun wrote an excellent PHYSICS TODAY article, "The concept of mass" (June 1989, page 31). Although there had been several related journal papers between the mid 1970s and the mid 1990s on speed-dependent mass being a misconception, Okun's article seems to have been the one that triggered the correction of high school and college physics textbooks that had favored it almost since the introduction of $E = mc^2$. (Actually, Einstein first introduced this concept as $\Delta m = \Delta E/c^2$.)

In the Soviet Union, Okun actually took up the problem two years before the PHYSICS TODAY article, when in 1987 the Ministry of Education sent him a new high school textbook for review. He hadn't been aware of the error before, and he failed to convince the ministry that there was a problem. He told the story of that controversy in *Energy and Mass in Relativity Theory* (World Scientific, Eng. trans. 2009).

The Commentary "The dangerous growth of pseudophysics" by Sadri Hassani, also in the May 2016 issue (page 10), touches on the misconception when discussing "spirit energy." Incidentally, Hassani did not mention that the laypeople who show interest in spirit energy relate positive energy with attractive personalities, whereas, as is well known, in physics it's just the opposite!

R. Ömür Akyüz

(akyuzo@gmail.com)

Boğaziçi University

Istanbul, Turkey