utility of the circuit they built. Unlike Neil, however, Liam suggests that experimentalists don't need to understand the broader theory of a research project: "Theorists just give me things to work on. They say 'I have a problem here, can you test it?' Like, sure I'll design something and work on it." Liam's description suggests that only theorists get access to the broader scientific purpose of experimental work.

Liam and Neil's experience demonstrates that LPP within a research lab can involve understanding narrow aspects of the scientific purpose—how it contributes to a given experiment—but not fully understanding the broader scientific purpose. We note differences in the peripheral nature of their engagement; Liam describes it as a *fixed* feature of doing experimental work, whereas Neil attributes it to his *currently* limited background knowledge and coursework. Applying the practices framework helps us explore these differences.

VI. DISCUSSION

We applied Ford's framework to illustrate the utility of attending to the *connectedness* and *purposefulness* of undergraduate researchers' engagement in scientific practices as a way to understand their LPP. While prior research on UREs measures engagement in different activities as independent outcomes, layering on Ford's practice framework gives a more holistic sense of students' participation in physics practices.

Methodologically, we also find value in this analysis of interviews. While surveys can capture the degree to which students view scientific practices as *purposeful* or *connected*, interviews allow us to characterize the nature of that *purposefulness* and *connectedness*. Consider the survey item "I understand the broader purpose of the experiments I am conducting." [12] Frank would likely agree with that item, but his survey response wouldn't allow us to examine how his participation in practices "hangs together" and the sensibility, plausibility, and coherence of the logic behind those practices. In a different vein, Liam and Neil might both disagree with that item, but for different reasons: Liam's response might reflect how he thinks theorists dictate experimental physics, whereas Neil might see himself as able to understand the broader purpose in the future. Analysis of interviews using Ford's framework lets us characterize these different forms of LPP.

This work also suggests features to foreground when supporting undergraduate researchers or developing courses such as the one in this study. We argue that URE mentors should attend to the ways in which scientific practices are meaningful with respect to one another and to a broader scientific purpose, and the logic behind how these aspects of practice are coordinated, from both the mentor's and the students' perspective. For example, mentors can design research experiences such that each activity informs the next. This can't all happen right from the beginning, of course, but it is important to think about how practices might come to be connected to one another and to a scientific purpose in coherent ways.

Given the preliminary nature of this study, future work will refine our classifications of connectedness and purposefulness in interview data. We will also continue to map out the different ways that students come to participate in connected, purposeful practice, and how their trajectories are impacted by mentors, subfields of physics, and structure of the URE. We will also explore the implications of the different forms of LPP in which students engage. For example, Neil suggested that he gained confidence from the fact that he didn't need to understand the broader research project. In contrast, Arthur described feeling overwhelmed by the amount of physics and math knowledge that he had to learn in a small amount of time. Together, these cases suggest that students' affect may be intertwined with their engagement in connected, purposeful practices in nuanced ways. In addition to characterizing different forms of LPP in research experiences, we plan to study how those forms impact students' future engagement in physics research.

ACKNOWLEDGEMENTS

The authors thank members of UMD PERG/Sci. Ed., Dimitri Dounas-Frazer, and Enrique Suarez for their thoughtful feedback. This work is supported by NSF DUE-1245590 and the UMD Physics Department.

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