

Recent Research in Science Teaching and Learning

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Shernoff, D. J., Ruzek, E. A., & Sinha, S. (2017). The influence of the high school classroom environment on learning as mediated by student engagement. *School Psychology International*, 38(2), 201–218. <https://journals.sagepub.com/doi/abs/10.1177/0143034316666413>

Many of us assume that student engagement in class impacts student learning, but few studies document this relationship. In this study, Shernoff and colleagues test both the impact of student engagement on learning, and how the classroom environment affects student engagement. The authors characterized the classroom environment along two dimensions that they refer to as environmental challenge and environmental support. Environmental challenge refers to the challenges, tasks, and expectations an instructor uses to guide student thinking. Measurable elements of environmental challenge include whether activities are at the appropriate difficulty level or whether educational goals are clear to students. Environmental support is the help available to students as they navigate the challenges. This includes features such as whether an activity appeals to student interests and the quality of relationships in the classroom (peer to peer and instructor to student).

The units of analysis in the study are the “instructional episodes”: a 25-minute interval of class. At the end of each episode, students reported three measures of engagement: how interested they were during the episode, how hard they concentrated, and how much they enjoyed it. Students also reported how much they learned in that episode. Although there is much skepticism about self-reported learning measures, Shernoff and colleagues demonstrated the specific measure they used predicted course grades in an unpublished prior study (Shernoff *et al.*, 2016). These measures were taken for each of 23 instructional episodes measured from the perspective of multiple students. Finally, each instructional episode was recorded, and two coders used a classroom observation tool to characterize the classroom environment in terms of 10 subdimensions related to either environmental challenge or environmental support. Because data in this study were collected at both the student level (engagement, perceived learning) and at the level of the episode (classroom environment), the authors used multilevel path analyses to test whether engagement mediates the impact of classroom environment on learning.

Shernoff and colleagues found that student engagement significantly predicted self-reported learning. Engagement was, in turn, impacted by the classroom environment, specifically by the dimension of environmental support. They identified two of the five dimensions within the environmental support scale that significantly and positively predicted engagement: positive relationships and motivation. Educational episodes that raters coded as high for motivation were responsive to student backgrounds and their goals, interests, and needs. Coders rated educational episodes high for positive relationships when they observed the instructor demonstrating respect for the students and when praise, empathy and encouragement were communicated in the classroom.

The authors warn the reader not to conclude from this work that environmental challenge is not important for student engagement and learning. Instead, they speculate that when environmental challenge is present, having environmental support

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becomes even more critical for encouraging students to engage in the challenge and, through that engagement, learn. Two key components for supporting student engagement and learning seem to be communicating with students in ways that motivate them and building a collaborative and supportive classroom environment.

Bettinger, E. P., Long, B. T., & Taylor, E. S. (2016). When inputs are outputs: The case of graduate student instructors. *Economics of Education Review*, 52, 63–76. www.sciencedirect.com/science/article/pii/S027277571630036X

The use of graduate students as instructors is a common practice at many institutions of higher education. However, neither the impacts of graduate student instructors on undergraduate outcomes nor the impacts of teaching opportunities on outcomes for graduate students are well understood. To explore these questions, Bettinger and colleagues used a large extant data set from 12 Ohio public 4-year colleges and universities containing data from more than 40,000 first-time, full-time freshmen and approximately 2,600 graduate students.

A challenge in using these data is accounting for confounding factors—such as choice and the distribution of resources—in determining which graduate students teach and which undergraduates have graduate students rather than faculty as instructors. Bettinger and colleagues used an extensive set of control variables to account for this nonrandomness, which drastically changed the results from less well-controlled models. They also used a statistical method called an instrumental variable approach that accounts for potential nonrandom influences.

Bettinger and colleagues identified the courses taken by first-year students and then measured their subsequent course-taking behaviors. They found that undergraduates taking an initial course in a subject area with a graduate student as the instructor of record were 9.6% more likely to major in that area than if taught by full-time faculty. Undergraduates also took 2.3 times more courses in that subject if their initial course was taught by a graduate student, a quarter of a SD increase above baseline. However, if these analyses were limited to only students' courses in their first term of college, then there was no significant impact of instructor type. Taken together, these data suggest that having a graduate student instructor for a course does not harm undergraduates and may offer some benefit.

For graduate students, there also appears to be a small benefit in teaching. Every semester a graduate student taught increased his or her chance of graduating within 6 years by 2.1% across all disciplines. This effect was particularly notable in the humanities and math: a 13% increase for each additional term a graduate student taught. In addition, each term a graduate student taught increased the chance of employment at a Ohio college or university within 6 years of entering graduate school by 1.4% for each term a graduate student taught. The authors do caution that these results cannot be assumed to be causal, and other factors could play a role, such as selection of only the best graduate students as instructors of record.

In summary, Bettinger and colleagues find that having graduate student instruction does not reduce the likelihood that students will pursue additional courses in a discipline and may, in fact, somewhat encourage them to take more courses

in a discipline. In addition, teaching may have direct benefits for graduate students themselves.

Yee, A. (2016). The unwritten rules of engagement: Social class differences in undergraduates' academic strategies. *Journal of Higher Education*, 87(6), 831–858. www.tandfonline.com/doi/abs/10.1080/00221546.2016.11780889

Academic strategies used by students drive their college success. However, these strategies may be culturally based, with some student groups more likely to employ them than others. This becomes an issue when college norms are based on the practices of one culture more than another, thus rewarding the strategies of particular cultural groups. This institutional basis could explain disparities between different cultural groups in college, such as between continuing-generation and first-generation students.

In this multimethod qualitative study, Yee uses more than 800 hours of direct observations and interviews to characterize the academic practices of continuing-generation ($n = 15$) and first-generation ($n = 19$) students at a public, comprehensive university. She finds that both groups use a core set of academic strategies, but differ in one key aspect. Although both continuing-generation and first-generation students took notes in class, studied hard, and completed assignments, continuing-generation students interacted more frequently with their professors and tutors. This difference may set them up to be more successful in college than first-generation students.

Continuing-generation students engaged with faculty when they had difficulty in a course, but also proactively established connections to their advantage. These students understood that faculty would be less available to them than their high school teachers, that they would have to be proactive to get faculty help, that they would have to initiate the interactions, and that they were supposed to do this. These students accrued multiple advantages, including help on difficult content, hints on upcoming exam questions, clarification of expectations for assignments, reassurance that they belonged in the class even if they struggled, special accommodations for absences, and a closer relationship with faculty that was useful for letters of recommendation.

First-generation students also knew faculty would be less available than high school teachers, but interpreted this as needing to be more independent, learning on their own, and being responsible for their own success. Thus, they worked hard but without the additional insights that continuing-generation students were receiving from faculty. Typically, if they did reach out to faculty, it was only under dire circumstances and too late for useful help. Some first-generation students recognized the importance of establishing relationships with faculty but did not know how to go about it. Thus, first-generation students missed out on the advice and advantages continuing-generation students received by pre-emptively interacting with faculty.

Yee points out that this difference in engagement with faculty also colors how faculty view students. Because higher education values student engagement with faculty, tutors, and support staff, students who engage interactively rather than work independently are perceived as trying harder and are rewarded for this strategy. In contrast, the independent efforts

of first-generation students are not recognized and rewarded in the same way. Thus, interactive engagement as an institutional value, favors the success of continuing-generation students over first-generation students.

Yee notes several implications of this work. First, if instructors wish to level the playing field, they should consider proactive practices like interactive teaching methods and structured opportunities to meet with students. She also strongly recommends enlarging the definition of what an “engaged student” looks like to include students working independently, as well as validating this value and equipping students to be successful at learning how to learn on their own.

Thoman, D. B., Muragishi, G. A., & Smith, J. L. (2017). Research microcultures as socialization contexts for underrepresented science students. *Psychological Science*, 28(6), 760–773.

The benefits of undergraduate research experiences are well documented but tend to focus on development of academic and professional skills. In this study, Thoman and colleagues explore apprentice-like research experiences as exposure to science microcultures that socialize students into specific beliefs about the practice of science. Using a longitudinal study design, the authors explore how the culture in a lab around the role of prosocial goals in science research, such as helping other people, impacts an undergraduate researcher’s interest in the lab’s research and his or her own sense of the role of prosocial beliefs in science and interest in pursuing a science career.

The authors surveyed 522 undergraduate research assistants in 41 biomedical research labs at five institutions with at least two and up to 30 (median = 8) undergraduate researchers in each lab. Students were surveyed seven times across 2 years. At each time point, students reported their beliefs about the ability of the lab’s research to fulfill prosocial goals, their interest in the lab’s research, and their interest in pursuing a scientific research career. Thoman and colleagues then averaged the beliefs about

the lab’s ability to fulfill prosocial goals of all the undergraduate researchers in a particular lab as a measure of the lab culture for each academic term. They used a longitudinal multilevel model to then look at how this lab-level measure impacted student-level outcomes such as interest and intent to pursue a research goal and whether this varied by student underrepresented minority (URM) status.

Lab mate’s prosocial beliefs, measured the semester before, predicted an undergraduate researcher’s own prosocial beliefs at the current time point, even after controlling for their personal beliefs in the prior semester. Thus, the culture around undergraduate researchers can influence their beliefs about science. The less the lab culture reflected prosocial beliefs, the less interested URM students became in the lab’s research over time; a similar but significantly smaller impact was seen for white and Asian students. The lab culture also predicted the interest of URM students in pursuing a scientific research career; but if a lab did not support prosocial goals, these students became less interested in science careers over the course of their lab experiences.

Thoman and colleagues conclude that efforts to broaden participation in science need to not only explore the skills and academic experiences students receive, but also the cultures of science they are exposed to as they progress through their undergraduate training.

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