Forum on Education
American Physical Society

Summer 2020 Newsletter

Jennifer Docktor, Editor

In This Issue:

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From the Chair

Gerald Feldman, George Washington University

Well…unless you have been on a very long space voyage and been out of communication with Earth, or else if you have been living deep underground in a cave with no internet access, most of you reading this update will be aware that we have been in the midst of a major upheaval of our normal behavior patterns since mid-March of this year. The COVID-19 pandemic has affected all of our personal lives, and it extends profoundly into our professional activities as well. Of course, the Forum on Education (FEd) has also felt the repercussions of the recent health crisis.

For me, the first realization that something was amiss occurred while I was in Denver awaiting the start of the March APS meeting, at which FEd was sponsoring or co-sponsoring five invited sessions, including the prize session for the Reichert Award for Excellence in Advanced Laboratory Instruction. The award winner this year was Enrique Galvez, from Colgate University. The sudden announcement on Saturday February 29 that the March meeting was being cancelled came as a shock to many people, and it was a very bold move by APS – but in retrospect and in light of what has happened since then, it was very clearly the right move to make. Many meeting attendees (including myself) had to scramble to make new plans and figure out exit strategies, but everyone eventually got home, and for the most part, we have all been remaining at home ever since.

Following the cancellation of the March meeting, APS worked furiously on organizing a virtual platform for the April APS meeting, and the good news is that this meeting did take place as planned towards the end of April. At this meeting, FEd sponsored or co-sponsored seven invited sessions, and happily we were able to celebrate (albeit virtually) the winner of the Excellence in Physics Education Award, which was the Open Source Physics team. All of our scheduled invited sessions went off without a hitch, and the online attendance at these sessions was truly impressive. In the end, of course, we must gratefully acknowledge the heroic efforts of the APS staff for pulling the virtual April meeting together. Having served on the Program Committee for the March and April meetings this past year, I can say from direct experience that the tireless work of the APS staff made all the difference.

Other sessions planned by FEd have also been impacted, but have carried on (or will carry on) virtually. It has been our tradition to organize a special Physics Education session at the annual DAMOP meeting in June. In fact, this meeting did take place as an online event in early June, with a session entitled Quantum Quandries: How Can We Teach Quantum Mechanics Better, featuring invited speakers Carl Wieman, Chandralekha Singh, Enrique Galvez and Murray Holland. And finally, at the upcoming virtual AAPT Summer Meeting in July, we are sponsoring a special plenary session with Wolfgang Bauer speaking about green energy and Artemis Spyrou talking about nuclear physics and outreach at the Facility for Rare Isotope Beams (FRIB) located at Michigan State University.

During the APS April meeting, the FEd Executive Committee got together (online) for its annual business meeting and discussed various budgetary issues, in light of the fact that the bulk of our travel budget would remain unused this year due to major restrictions. We discussed several ways of putting our funds to good use during this particularly difficult period, and we came up with the idea of FEd Minigrants, which would be limited fund allocations to individuals or small groups who wanted to pursue a short-term project. The details of this solicitation were sent out to the entire FEd membership on June 9, so please check your e-mail inbox to find the details contained therein. If you have any questions, the person to contact is Laura Rios (lrios02@calpoly.edu), who is our FEd Secretary/Treasurer. We have set three interim deadlines (June 22, July 20 and August 24), and so even if the first one has passed by the time you read this Newsletter, the other deadlines will still be open.

As always, we want to remind all of you that the Forum on Education sponsors two major APS awards, and we encourage members to consider nominating your worthy colleagues for such honors in the coming year. The two FEd awards have already been mentioned above, but just to list them explicitly, here they are:

- **Reichert Award for Advanced Laboratory Instruction**
  To recognize and honor outstanding achievement in teaching, sustaining (for at least four years), and enhancing an advanced undergraduate laboratory course or courses at U.S. institutions.
- **Excellence in Physics Education Award**
  To recognize and honor a team or group of individuals (such as a collaboration) or, exceptionally, a single individual, who have exhibited a sustained commitment to excellence in physics education.

In addition, FEd works closely with the APS Committee on Education (COE), and there are two other related awards/prizes that are under the purview of COE:

- **Award for Improving Undergraduate Physics Education**
  To recognize physics departments and/or undergraduate-serving programs in physics that support best practices in education at the undergraduate level.
- **Prize for a Faculty Member for Research in an Undergraduate Institution**
  To honor a physicist whose research in an undergraduate setting has achieved wide recognition and contributed significantly to physics and who has contributed substantially to the professional development of undergraduate physics students.

In addition, we hope that all of you will recognize and honor our most accomplished FEd members by nominating our worthy colleagues for APS Fellowship. We have a long line of distinguished FEd APS Fellows spanning the history of the Forum on Education, dating back to 1993. Please consider the efforts of your colleagues and the people that they have worked with to see if you know someone who is deserving of this recognition – and if so, please take a few minutes to begin the nomination process. You can find more information at the following website:
aps.org/programs/honors/fellowships/

In the ongoing work of the FEd Executive Committee, I would like to mention that Catherine Crouch is leading the Program Committee for the March 2021 and April 2021 APS meetings, so if any of you have ideas or suggestions for education-related sessions at those meetings, please be sure to get in touch with Catherine. Also, Eric Brewe is heading the Nominations Committee this year, and he welcomes your recommendations for potential candidates for the leaders of the Forum on Education. This includes a new incoming Vice Chair, new Executive Committee members, and (for this coming year) a new Graduate Student representative. So please keep Eric in mind if you have any promising candidates to suggest to him.

Members of the FEd Executive Committee recently participated in a "brainstorming" session with the APS Committee on Education (COE) to explore issues pertaining to the recent push for online classes due to the global health situation and the possible inequities that can arise due to the pandemic. The discussion focused on how students have been impacted and the corresponding ramifications for student learning due to various demographic factors. This is an ongoing concern among educators across the country, and this is only the start of a much longer investigation. We welcome your input on this important subject, and on any other issues that are relevant to the imposed modifications in our educational pursuits.

In the ongoing cooperation between FEd and COE, one of the recent topics for discussion was put forward by Amy Flatten (APS Director of International Affairs). In November 2018, APS published a report from the Task Force on Expanding International Engagement.
aps.org/programs/international/upload/APS_TaskForceReport_AC.pdf

Through this study, APS is hoping to find ways to enhance its international profile and strengthen international partnerships. Through the COE, we focused our conversation on how to increase educational connections extending outside the domestic domain. This could pertain to attracting new international members to APS, or solidifying pedagogical collaborations through Physics Education Research, or increasing educational connections around the world through attendance at education-related conferences or teacher exchanges in the U.S. or abroad. If any of you have had enlightening or transformative educational experiences with international institutions or collaborators, either here in the U.S. or abroad, please let us know!

Finally, on a lighter note, for those of you who read the monthly *APS News* thoroughly, the Forum on Education has been featured in the recent June issue. Each month, an APS unit is highlighted, and this month it was our turn to be in the spotlight. So check out the article in the June 2020 issue of *APS News* that just recently appeared. In case you have not been checking your office mailbox very often these days, here is a link to the article:
aps.org/publications/apsnews/202006/fed-unit.cfm

In the end, while we still endure the trials of this very unusual period and we learn to adapt our daily lives to what has been termed the "new normal," we hope that you are all able to carry on and continue your professional activities related to research and teaching. As always, we welcome your input and your ideas to help further the mission of the Forum on Education. Here's hoping that we will be able to meet again in person very soon and get back to business.

Call for Invited Session Ideas for March and April 2021 Meetings

Catherine H. Crouch, FEd Chair-Elect and Program Committee Chair

We are eager to hear your ideas for Forum on Education-sponsored invited sessions at the American Physical Society's March and April meetings! We are seeking ideas for sessions (and potential invited speakers) that would be interesting and beneficial to the members of the American Physical Society, particularly undergraduate and graduate students and early-career members, whether or not they are members of FEd. We encourage ideas for sessions that might be co-organized by another APS unit (aps.org/membership/units/) or the APS Committee on Minorities or Committee on the Status of Women in Physics, which also have the ability to organize sessions.

In addition, we are eager for your feedback on the ideas generated so far by the Program Committee, including ideas for speakers on these topics. Our current ideas include:

Either meeting (or possibly both):

- Inclusive, equitable pedagogy and mentoring, and/or supporting diverse faculty (potentially co- organized with CSWP, COM, and/or other suitable APS units)
- The TEAM-UP report (potentially co-organized with COM and/or other units)
- Remote learning (potentially co-organized with GPER)

March Meeting:

- Examples of physicists contributing to solutions for COVID-19 and other public health challenges (co-organized with the Division of Biological Physics)
- Quantum Information throughout the curriculum (co-organized with the Division of Quantum Information)
- Computation throughout the curriculum (potentially co-organized with DCOMP, DMP, DSOFT, and GSNP)
- Data science education (co-sponsored with GDS)

April Meeting:

- Computation throughout the curriculum (potentially co-organized with DPF and DGRAV)
- Teaching gravitational physics (potentially co-organized with DGRAV)

Two of the sessions at the April meeting are co-organized with AAPT and the tentative plan is to offer one of those sessions on remote learning and one on some aspect of diversity, equity, and inclusion in physics education.

Please submit your ideas for sessions, as well as any input on the committee's ideas, to Catherine Crouch, APS FEd Chair-Elect and Program Chair for 2021, by email to ccrouch1@swarthmore.edu. Any ideas submitted will be considered by the Program Committee. The FEd is allocated a limited number of invited sessions at each meeting, based on FEd membership attendance at the previous year's meeting, so we may have to postpone good ideas to a later year.

The deadline for session ideas and feedback is July 24.

FEd also sponsors contributed sessions at both these meetings, and APS members are permitted to contribute a talk or poster to the education sessions (using the physics education sorting categories) in addition to one on a technical physics topic. We invite you to consider contributing to one of these two meetings.

From the Editor

Jennifer Docktor, University of Wisconsin – La Crosse

Many things have changed since our spring newsletter! The COVID-19 pandemic has significantly changed the way we live and work. During March many of us found ourselves thrust into "emergency remote teaching" with little or no training. The closure of schools and daycares have required parents (myself included) to juggle childcare responsibilities along with work. Conferences have been cancelled or converted to virtual meetings. More recently, events in the U.S. have brought issues of race and social justice to the forefront of our minds.

As we prepare for the uncertainty of the fall term, many instructors are wondering how to provide an inclusive, high-quality education experience for their students. In light of current events the focus of this newsletter is twofold: to highlight resources for teaching physics online and discuss important issues of diversity and systemic racism. The latter is addressed in the teacher preparation section edited by Alma Robinson.

I hope this newsletter inspires you to learn and grow as a physicist and physics educator. If you have ideas for future newsletter themes or an article you would like to contribute, please e-mail me at jdocktor@uwlax.edu. The deadline for the fall newsletter is October 1.

Resources to Help You Deliver Your Remote Courses

Beth A. Cunningham, AAPT Executive Officer

Many physics educators have had to make dramatic changes to their courses in March to convert them from face-to-face delivery to remote learning. For many faculty, this has been challenging since they only teach face-to-face with students and have no experience teaching remotely. Furthermore, many of our institutions have built success on close student-faculty interactions. This has left many faculty scrambling to provide a satisfactory learning experience for their students. The American Association of Physics Teachers (AAPT) and other physics and astronomy professional societies have shared resources to help physics educators during this challenging time. Below is a list of some of the most used resources.

PhysPort is a great source for ideas and resources that align with research-based pedagogical principles and research-validated resources for teaching online. It also has great ideas that can be use to make the online teaching process easier.

- For general information about teaching remotely: physport.org/recommendations/Entry.cfm?ID=119906
- For information about teaching labs in a remote setting: physport.org/recommendations/Entry.cfm?ID=119927
- For helping students continue to frame their "in-class" activity as sense-making: physport.org/recommendations/Entry.cfm?ID=119905

The Physics Teacher (TPT) and the *American Journal of Physics* (AJP) have compiled a collection of specialized articles that focus on remote learning. These articles highlight the use of smart phones for lab experiments as well as other activities that can be adapted for use by students at home. The articles have been made free to read, download and share for a limited time.
publishing.aip.org/publications/journals/covid-19/aapt/

ComPADRE (the Physics Digital Library) has many different resources such as Open Source Physics, Interactive Video Vignettes, and computational materials for physics classes that can be used to teach courses remotely. compadre.org

AAPT also has many discussion groups of active members and friends that allow the sharing of ideas, plans, activities, labs, lesson, etc. To join a discussion list use this link: aapt.org/Resources/lists.cfm?_zs=1tmEW&_zl=AtR22

AAPT's Committee on Physics in Two-Year Colleges has created a website that has many resources including grading papers online, taking good notes, remote clickers, recording classes or lectures using screen-capturing software, inserting quiz questions in the middle of presentations, and many more.
sites.google.com/a/aapt.org/comm/resources

AAPT's Digi Kits are vetted collections that include a hands-on, inquiry-driven activity inspired by articles from *The Physics Teacher* journal, digital resources that support student and teacher learning, and are aligned closely to the Framework for K-12 Science Education and NGSS performance expectations. Although these have been designed for K-12 physics educators, many can be used in higher education. aapt.org/K12/All-lessons.cfm

Physlets are over 800 ready-to-run interactive exercises for the teaching of the introductory physics sequence (kinematics through optics). This material uses a standard easy-to-understand interface designed with a sound use of pedagogy in mind.

- Physlet books online: compadre.org/physlets/ and compadre.org/pqp/
- Instructor Guide and Answer Key: physport.org/curricula/physlets/

PhET Interactive Simulations provides a collection of over 150 simulations, as well as sim-based lessons, labs and teacher resources. All are licensed as open (free) education resources. Tips for remote learning: See article in this newsletter.

- PhET physics simulations: phet.colorado.edu/en/simulations/filter?subjects=physics

Interactive Lecture Demonstrations (ILDs) are a great active learning tool that students can use at home. ILDs are designed to enhance conceptual learning of physics lectures through active engagement of students in the learning process. ILDs consist of pictures, videos, displays and real physics simulations that are available to substitute for hands-on experiments. pages.uoregon.edu/sokoloff/HomeAdaptedILDs.html

PERbites is a resource available to the physics education community. The purpose of PERbites is to connect physics research in all areas and make the results of physics education research meaningful and accessible to all. perbites.org/about/

Diagnoser Tools is a coordinated and coherent suite of free online tools that teachers use with their students to scaffold and monitor the development of deep understanding in science.
diagnoser.com

APS News April Back Page is "Moving Physics Courses Online on Short Notice" by Chandralekha Singh. This article includes links to a number of different resources. aps.org/publications/apsnews/202004/backpage.cfm
An article about physics smart phone apps: physics.aps.org/articles/v13/68

AAS has a website that lists a number of resources including AAS curated online teaching resources, community submitted online teaching resources, and Youtube videos on tools and tips of teaching astronomy online. aas.org/education/aas-responds-increased-online-instructional-needs

The American Sociological Association has a webinar on "Transitioning to Online Teaching in the Face of COVID-19" zoom.us/webinar/register/WN_Un66VwL8TjC2YTgWJ1JarQ

First published in the Council on Undergraduate Research Physics & Astronomy *Spring 2020 newsletter and updated for the FEd newsletter.*

Beth A. Cunningham is the Executive Officer of the American Association of Physics Teachers. She provides leadership on a number of physics education initiatives including the Physics and Astronomy SEA Change project that offers departments a self-assessment process to effect sustainable change with regard to diversity, equity, and inclusion, the eAlliance project supporting women physics and astronomy faculty members via peer-mentoring groups, and the NSF funded PhysTEC project (in partnership with APS) to increase the number and quality of high school physics teachers.

Strategies and Resources for Teaching Your Physics Course Remotely on Short Notice

Chandralekha Singh, University of Pittsburgh

Due to the COVID-19 pandemic, many of us teaching physics as well as those teaching other subjects in face-to-face brick-and-mortar classrooms have suddenly found themselves in an unprecedented situation: the rest of the term should immediately transition to a completely online format! Here I outline some strategies and resources that can help you and your colleagues in such a situation who have not had extensive time to think or plan for online instruction. It is important to recognize that everyone, including you and your students, is anxious and stressed by the circumstances, so being compassionate to yourself and your students is of paramount importance. I cannot emphasize enough that providing maximum flexibility to students is critical, particularly because they did not sign up for an online course and many of them may not have necessary resources, e.g., access to a computer with reliable internet connection or a quiet room at home or required time due to being sick or caring for a sick family member in order to complete all of the requirements of your online course. Everyone is trying to do their very best to salvage the situation, so whatever you and your students can accomplish is good. Communicating frequently and clearly with students is key.

There are many online resources, for example, Linda Strubbe and Sam McKagan's excellent crowd-sourced resources on PhysPort [1], that can be invaluable so you should definitely go over it in its entirety. Below, I summarize seven things to keep in mind while preparing for and executing your online physics courses, including labs:

1. **Keep the focus on the learning goals and objectives of your course.** For example, if your big picture goals are to help students learn to think like a physicist and help them develop problem solving, reasoning and meta-cognitive skills and become independent learners and excellent problem solvers, think carefully about strategies for how your online course will accomplish that [2-3]. Feel free to reduce the overall content coverage focusing on the central topics and effective approaches to engaging students and assessing their learning to meet your course goals in this online learning environment.
2. **For lecture-based courses, decide whether it is better to deliver your lectures synchronously or asynchronously.** Synchronous approach involves streaming your lectures live to students, e.g., via Zoom, BlueJeans, Skype or other platforms, and interacting with students during streaming similar in spirit to what you would do in a brick and mortar classroom. These types of platforms provide flexibility to record the streamed lecture that you can make available to students who could not join the live streaming. While the synchronous format gives students opportunity to ask questions and allows students to interact with each other and you, not requiring attendance during live stream and posting the recorded videos of live streamed sessions is essential to make sure students who do not have the resources or means to connect live are able to access relevant materials.
3. **Consider establishing virtual office hours** and have them at different times of the day so that students who are at home in different time zones can connect with you at a reasonable time. These live one-on-one or few-on-one sessions will give your students an opportunity to ask questions after they have had time to reflect on the material and work on homework. Moreover, it can be invaluable to have asynchronous discussion board on your learning management system, e.g., Blackboard or Canvas, where students and you can discuss what students are finding challenging and there is a record of those discussions for all students who may not be available at a

certain time. Also, being available to students for office hour via virtual chat (instead of video) may be particularly helpful for students whose internet connections do not reliably support video interface.

4. **Consider using asynchronous pre-recorded lectures, created either by you or by others.** This way you can use all of the synchronous time with students for interactions, discussions and reflections. This approach is common in flipped mode [4] of teaching in which a large part of the meeting time with students is devoted to evidence-based active-engagement activities in the spirit of Just-in-time-teaching [5,6] and students interact with their peers and instructor after having gone over the pre-lectures and the corresponding pre-assessment tasks. In your online course, the actual meeting time will be virtual. Videoconferencing solutions such as Zoom have breakout rooms that allows you to assign students to different breakout rooms so that a smaller number of students in each breakout room can work with each other on the physics problems you assign using a virtual collaborative whiteboard for a certain length of time and then you can bring the students back into the same virtual room for a general discussion. In large classes, you may poll students by asking multiple-choice questions [7] that focus on your learning goals although it may be more difficult to engage students in peer interaction in this mode. Also, if you are pre-recording your own asynchronous lectures [8], make sure that you break your lecture into roughly 10-minute long sub-lectures and intersperse online assessments that you can grade students on, e.g., in the multiple-choice format, between each of these sub-lectures. This type of design is conducive to maintaining students' attention on each short sub-lecture and giving them an opportunity to assess their learning between different modules. Each of these pre-recorded sub-lectures can be e.g., voice over power point or similar to Khan Academy [9] (you will need a laptop or iPad with ability to write on it) and try to incorporate good visuals and if possible lecture demonstrations especially for introductory physics. If you are adopting asynchronous mode with pre-recorded video lectures, you can use the existing resources for introductory physics, e.g., FlipIt Physics [4], although it may cost money.

5. **For lab courses, take advantage of interactive virtual labs, simulations, and journal articles**. There are many such virtual labs (e.g., see [10-13], some of them are free while others may cost money beyond 30-day period). Articles in the *American Journal of Physics* (AJP) and *The Physics Teacher* (TPT) can be great resources in online teaching not only in lecture-based courses but particularly for your lab courses at all levels. For example, there are many experiments that have been discussed in a pedagogical manner in AJP and TPT. In these articles, e.g., instructors have often shared insights about classic experiments, e.g., single photon experiments for which video data are available as in this article [14], Millikan oil drop experiment [15], muon decay [16], and many others. You could ask students to read some of these articles about the experiments and then write about the aspects of those experimental set up that made them effective, how things evolved in that field and how trouble shooting was done, what the experimental errors were, their implications to physics in general and various other issues based upon your goals. You can also get together electronically with students and discuss what they got out of those papers and assess them on their writings and discussions. If possible, combine these tasks with students playing with related interactive simulations and analyzing data about these types of reflective assignments associated with journal articles. Similarly, in upper-level lecture classes, reading articles related to a topic that students would otherwise have learned via lecture would be an innovative approach to initiate a discussion via an electronic platform. For example, AJP and TPT articles often provide nice overview of the field including common student difficulties that can make it easier for students to understand the concepts in corresponding chapters in the textbook and issues associated with them. This pedagogical approach commensurate with your course goals can help students learn to read and reflect upon journal articles (good for becoming a lifelong learner) and enjoy the whole experience.

6. **Remind yourself that these are extraordinary circumstances and feel free to change assessment approach and be considerate**. It is ok to change assessment strategies as well as grading rubric and adjust the weight on the materials covered before and after going online. For example, it is ok for you to reduce the weight on the final exam or even eliminate the traditional final exam in favor of many low-stakes assessments, final projects and online presentations (that can be pre-recorded or can be synchronous so that students can field questions from their peers and you). You should consider giving students the opportunity to work in groups on these projects and online presentations since working with others can reduce isolation (otherwise, isolation can increase anxiety) and have students benefit from interactions. You can come up with novel group projects that meet the goals of your course in lieu of the final exam especially for your upper-level courses that require students to work in groups but have some individual accountability built into them (e.g., all students must present some part of their project individually and answer questions by peers and instructor). If you must give final exams that students will do at their own pace at home, use an honor code. Try to be extremely considerate to students since they may not have resources at home to take advantage of offering in the online learning environment. Be inclusive and think about whether it is appropriate and equitable to give students who cannot do the work due to constraints an incomplete so they can make up later or modify requirements for them commensurate with their constraints so that they can finish with everyone. Consider not giving a grade lower than what they would have gotten based upon their performance on the course thus far before going online

7. **Remember that technology is a tool and not the goal.** Make sure the focus is always on your students and their learning based upon your course goals and personalize learn-

ing as much as possible in this online environment so that students who are already disadvantaged in many ways are not penalized further. Share your ideas with your colleagues and help each other. We would have learned a lot about online learning at the end of this challenging period!

Chandralekha Singh is a professor in the Department of Physics and Astronomy at the University of Pittsburgh. She is a past chair of the APS Forum on Education and is currently the President of the American Association of Physics Teachers.

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From Lecture to Lab: Tips for Using PhET Simulations for Remote Teaching

Kathy Perkins, University of Colorado Boulder

Over many years, our physics education community has been creating, studying, and adopting new pedagogies to improve our students' experience and learning of physics. From Peer Instruction to Interactive Lecture Demos to Tutorials in Physics, we've increasingly used active-learning techniques, promoted making sense of concepts, and engaged students in science practices and ways of thinking. This spring, as schools transitioned to remote learning, we have faced the challenge of how to continue to actively engage students and address this broad set of learning goals. This fall, we will again be facing a good dose of remote learning.

From lecture to lab, interactive simulations are highly flexible tools that can support your transition to remote teaching and keep learning active. Since 2002, our PhET Interactive Simulations project at the University of Colorado Boulder has created 106 interactive simulations for teaching and learning physics, all open (free) educational resources which cover introductory physics, quantum, and some upper-division topics. Each PhET simulation creates an intuitive, game-like environment where students can learn through exploration, where dynamic visual representations build understanding, and where science and math concepts are connected to the real world. Many include measurement tools for data collection. With this open design approach, interactive simulations can be used in just about any part of a course, by the teacher or the students, synchronously or asynchronously, including pre-lab and lab activities, clicker questions, interactive lecture demonstrations, homework assignments, tutorials, pre-class just-in-time-teaching activity, etc.

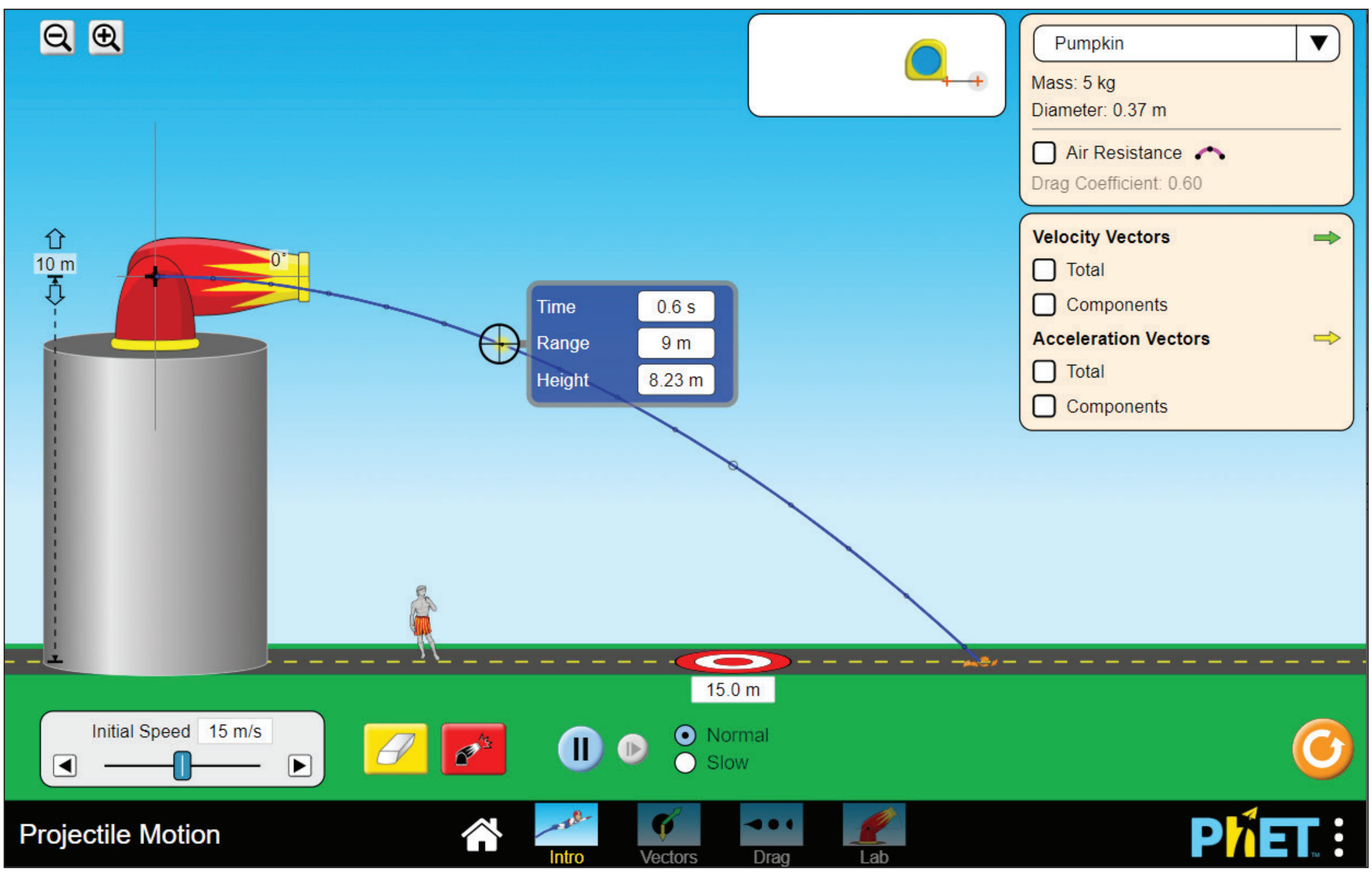
This spring, as learning moved online, our team worked to support educators' needs with **new resources and capabilities**. Visit the PhET website now and find:

- Late-stage prototype HTML5 simulations, including Circuit Construction Kit AC, Energy Skate Park (with new measure and graph screens), and Density. Prototypes of Collision Lab and Buoyancy are expected to be released this summer.
- New browser-compatible Java simulations! We partnered with Leaning Technologies to allow our legacy Java simulations to run in a web browser via a technology called CheerpJ. While their overall performance is slower, these "Java via CheerpJ" simulations enable popular legacy simulations to be once-again assigned for student-facing activities and labs.

- Remote learning activities and Google doc support. With the addition of a "remote learning" tag and support for Google doc formats, educators can more easily share and find remote learning activities and labs in our lesson database. Thirty PhET labs were updated for remote learning.
- Remote learning tips, including guidance for modifying lessons and activities for remote learning.

For remote live lecture or lecture capture, many simulations can serve the role of your traditional lecture demonstration equipment (waves, springs, projectiles, pendulums, circuits, etc.), and go well beyond, with options to show the invisible, layer on multiple representations, and modify hard-to-change parameters (like altitude). To infuse active learning, you can use simulation-based clicker questions or interactive lecture demonstrations, or engage students in more open whole-class inquiry. And with every student necessarily on a device, you can chat a link to a simulation and invite students to experiment with the simulation in class, and then share their screen and use the simulation to provide evidence in support of their reasoning. For larger classes, you can add short 5- to 10-minute experimentation sessions using breakout rooms where groups of 3-4 students collaborate on exploring a simulation. These student groups can complete a sim-based challenge question and record their observations, evidence, reasoning, and sim screenshots in a shared Google doc.

For physics labs and activities, simulations offer an opportunity to engage students in science practices – designing experiments, collecting, analyzing, and interpreting data, building mathematical models, justifying claims with evidence, and so on. Students can complete sim-based labs on their own from home, or better yet, work collaboratively with lab partners sharing screens online, e.g. in a Zoom breakout room. While many on the PhET team are experimentalists and value students working with real equipment, gaining experience with experimental and measurement uncertainty, and debugging and problem solving in experimental systems, simulations offer significant learning opportunities for the lab. Simulations create inviting, open, and exploratory environments; environments that enable student agency and rapid trials, visualize the conceptual models experts use to help their understanding (e.g. current, vectors, charges, particles, fields, etc.), and support qualitative and quantitative data collection. An early research study found that students who first learn using our *Circuit Construction Kit* simulation perform better at building and



PhET's Projectile Motion sim, redesigned in HTML5, includes new measurement tools and new Vector and Drag screens. (Image by PhET Interactive Simulations, University of Colorado Boulder, licensed under CC-BY 4.0) explaining a circuit using real equipment, compared to students who learned using the real equipment [1]. In working with the simulation, students benefit from the immediate cause-and-effect feedback to their interaction, the visualization of electron flow or current, and the ability to support multiple, rapid trials – all supporting the development of their conceptual model that they can then apply to building with real equipment.

Many of our newer HTML5 simulations have new screens and additional measurement opportunities. The *Projectile Motion* sim has a new data probe for capturing height, range, and time data. The *Gas Properties* sim has a new tool to measure wall collisions and a new screen for Ideal Gas Law measurements. The new *Diffusion* sim can be used to measure diffusion times vs a wide variety of properties. The *Energy Skate Park* prototype sim offers new *Measure* and *Graph* screens. The *Wave Interference* sim can be used to conduct the double-slit experiment. The list is long. If real experimental equipment or videos of real equipment are available, combining simulations and real equipment can also make for a great learning environment.

In crafting student labs and activities for remote learning, we offer a few recommendations to help scaffold your lesson and maintain student inquiry. First, begin with a short (5-10 minutes) of open play and exploration and have students record a few of their discoveries and observations. This approach promotes student agency, allowing them to become familiar with the simulation and mimics the broad exploration scientists will do as they explore the parameter space of a system. When designing the lab, maintain student inquiry by using challenge questions – as opposed to detailed directions – to create a structure that requires experimentation, data collection and analysis, but in ways that leverage the existing scaffolding in the simulation and continue to provide agency to students. Within the activity, open table structures and screenshots are good ways to provide some scaffolding for students working alone. And, if you are using an HTML5 sim, consider using the "?screens=" parameter on the end of your URL to start a PhET sim constrained to run just the screen(s) you want.

As you plan your simulation use, you need to be aware of **the device compatibility of the simulation**. Any of our HTML5 simulations will run on any device from full computers to Chromebooks to tablets and smartphones, supporting teacher use as well as student assignments. HTML5 simulations are also easily embeddable in any webpage and many homework systems. While we continue working to bring all PhET simulations to HTML5, over 60 legacy physics simulations still only exist in Java or Flash. If you are using simulations for teacher-led demos or discussions, we recommend using the Java and Flash versions on a full computer for best performance. The "Java via CheerpJ" sims can be assigned to students. Flash runs for now but Adobe is sunsetting the technology at the end of 2020. We are working to convert our simulations to HTML5, which is a resource and funding intensive activity.

As we face the teaching challenges of these times, we encourage you to **join the PhET community** and stay connected. If you are new to PhET, we invite you to visit the PhET website and explore the physics simulations. If you are already using PhET, we invite you to register for a free account and share your lessons and labs with other educators. If you are working on creating PhET labs this summer, we invite you to express your interest here; we will be connecting educators with shared needs and goals to each other for summer work.

Finally, we love to hear from our user community. We invite you to join the conversation on Twitter (@PhETsims). And if you want to report a bug, share an idea for a new simulation or an improvement, or just seek technical support, you can contact us at phethelp@colorado.edu.

Kathy Perkins directs the PhET Interactive Simulations project and is a faculty member in the Department of Physics at University of Colorado Boulder.

Endnote

1. *Finkelstein, N. D., Adams, W. K., Keller, C. J., Kohl, P. B., Perkins, K. K., Podolefsky, N. S., Reid, S., & LeMaster, R. When learning about the real world is better done virtually: A study of substituting computer simulations for laboratory equipment.* Physical Review Special Topics - Physics Education Research, **1***(1), 10103 (2005).*

Leveraging the Experience and Expertise of Learning Assistants in Remote Learning Spaces

Jennifer Avena[1], Mel Sabella[2], Aidan Barker[1], Susan Hendrickson[1], Laurie Langdon[1], Andrea Van Duzor[2], Valerie Otero[1]

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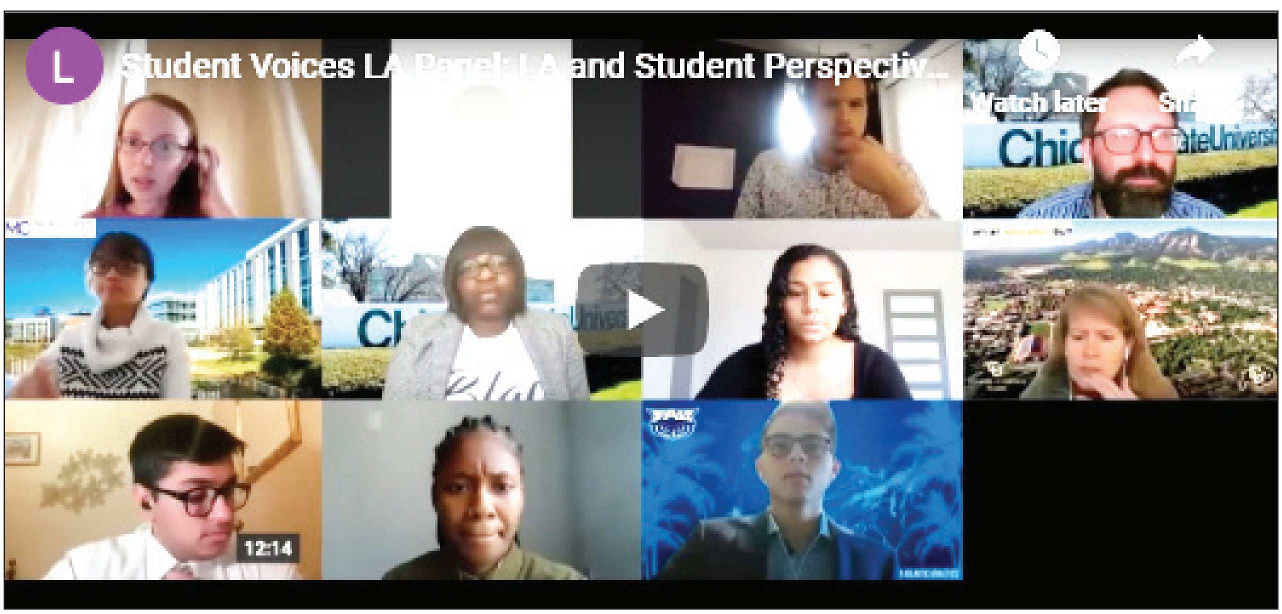
Supporting effective remote learning spaces

As classes quickly moved online during Spring 2020, students, staff, and faculty in all types of institutions, at all levels, found themselves adapting to novel online learning spaces. Those who incorporate active learning in their classes, encourage group work, and promote conceptual sense making to engage communities of learners needed to be reflective, thoughtful, and creative in constructing these new spaces. The Learning Assistant Alliance (LAA) recognized that undergraduate Learning Assistants (LAs) were immediately providing crucial support for faculty and students in these new spaces, and leveraged its Alliance member expertise to develop a set of resources to assist in LA supported classes (sites.google.com/view/laa-elearning/).

LAs support student learning and persistence by engaging students and facilitating active learning and group work in many learning contexts. LAs, as key players of an instructional team, can play collaborative roles in identifying how we teach our courses, bringing in unique perspectives on what works and what does not work for their near peers. When LAs take on these leadership roles, they develop identity as science people, and the classes we offer improve along multiple dimensions - they become more supportive and interactive and better leverage student strengths and address student needs.

During the Spring 2020 term, LAs took on new collaborative roles and additional responsibilities as a result of moving online. To support the education community in using their LAs effectively in these new spaces, the University of Colorado Boulder and the LAA organized a series of Virtual LA Panels where the community could hear from experts: the LAs doing this work around the country. The LA panels were moderated by LAs and featured LAs from the humanities, social sciences, and science and math from Chicago State University, the University of Colorado Boulder, the University of Colorado Denver, Colorado State University, the Community College of Denver, Florida Atlantic University, Front Range Community College, Metropolitan State University of Denver, Montgomery College, and San José State University. This broad representation of colleges and disciplines provided a unique perspective on how LAs around the country were supporting their peers (sites.google.com/view/laa-elearning/virtual-la-panels).



International LA Panel from April 16, 2020: LA Panelists: An Dang (Montgomery College), Bailey Holifield (Chicago State University), Benjamin Tressler (Front Range Community College), Diane Hogan (Chicago State University), Gabrielle Jones-Hall (Chicago State University), Linnea Wolniewicz (University of Colorado Boulder), Nicholas Pizzo (Florida Atlantic University), Siya Bedi (San José State University)

Perspectives from Learning Assistants and Faculty

The national LAA LA Panel, held on April 16th, had about 70 participants from institutions around the world, in addition to our panelists. Three additional panels were held in April at institutions across Colorado, with an additional 55 participants. The community of panelists and participants provided both overarching ideas and specific techniques to effectively support students remotely.

Additionally, to learn more about the perspective of faculty working with LAs during the transition to remote learning, faculty at the University of Colorado (CU) Boulder were surveyed at the end of Spring 2020 and provided useful insight on the impact of LAs.

Keeping the community of learners engaged

While navigating this new space was challenging, there were elements that kept the LAs engaged in their work of supporting students. LA Diane Hogan cited the importance of ongoing interactions where students reached out to her with questions: "It lets me know that they are still willing to learn, and it makes me feel - being in this situation, it shows me that no one has given up." LA Linnea Wolniewicz mentioned that "something that has really helped me feel like I'm still part of the online classroom community is when I attend classes and everybody has their video on. It's like you're still attending the same lecture with the same people that you were before, and you might not be sitting next to them, but they're still there on the screen."

LAs cited the importance of checking in with students to see how they were doing. LA Siya Bedi mentioned "... one thing I've been trying … is … starting off by asking the students as an LA, something unrelated to the problem. So something like, 'how are you doing?' or how their day's going, so they feel more connected, and it's an easier transition to start a discussion."

LAs are a key source of student support, both academically as well as socially, during challenging times. One faculty member expressed in the Spring 2020 faculty survey, "The most valuable thing this semester is having the LAs continue their work during remote learning … They are really leading by example and giving students the message, 'hang in there, you can do it!'" Another faculty member shared, "As always, [LAs] are an approachable peer for students in the class, especially under stressful conditions."

Providing support and facilitating active engagement

LAs took on many roles during remote classes, including facilitating recitation sessions, holding office hours, facilitating discussions during synchronous lecture time with the faculty (in features such as chat and breakout rooms), as well as in promoting engagement in asynchronous discussions.

Three of the LAs, Linnea, Benjamin Tressler, and Nicholas Pizzo mentioned that more students were taking advantage of office hours and were being more "communicative." Benjamin stated that "one positive thing of the transition to online learning is just being more available, in the sense that people can just join office hours or whatever they need in the comfort of their homes." Online office hours via video conferencing at times that accommodate the complex schedules of our students can encourage more participation in these spaces. For some LAs, using video conferencing is new and provided some benefits that they did not have before through email communication. LA An Dang mentioned "I think [Zoom is a] super helpful tool, and it should be used as much as possible ... it's helpful to see and show the students how to do problems ... even when I'm at home ... it's very interactive - it's not like just through emails or through text messages."

LAs described the challenges of active engagement and group work in these settings but offered suggestions. Many LAs engaged with groups in Zoom breakout rooms. During group work, having a dedicated group member as the "screensharer," a new role in this setting, proved to be important to keep groups focused on a task. Group roles seem to take on additional importance in these settings. Nicholas mentioned how LAs used the WebEx whiteboard and chat features. "For our live lectures – at the second half of the lecture when the LAs are interacting with students while one of us is physically working on the whiteboard answering questions about problems and using their mic, the other two LAs in the class are answering questions in the chat." Chat features in video conferencing provide a unique space for LAs to support students as an instructor is discussing a particular topic. Responses by LAs in real time can help students not get lost during a lecture and keep them engaged. This is especially important in an online space where it can be more challenging to read the room.

When faculty at CU Boulder were asked how they thought the transition to online learning would have differed if they did not have LAs, faculty said that "Our students would have been less supported … and likely would have learned less" and "class would be less personal." An instructor of a large introductory course shared, "The LAs are absolutely critical … Without the LAs, I think we would have seen more student frustration about continuing to do active learning work during lecture." Several faculty also expressed that without LAs, smaller group discussions would have been challenging, because, as one faculty member stated, they "would have not been able to do class breakout sessions." Faculty valued LA input and feedback on how to promote student learning in a remote setting, such as improving student interaction in Zoom and providing "suggestions for making discussions in breakout rooms more engaging."

Facilitating technology adoption

In many classes, LAs supported the new technology needs of the course by helping faculty and students navigate new communication infrastructure. An mentioned, "Since it's not like a face-to-face class anymore, it might take more time for professors to respond to us through emails. And we overcome that by using GroupMe , which is like a chat service." Diane, a computer science major, used her computer skills and discussed how she was able to help students set up their online classes: "I help them go through the platform that they need to use to get to classes - so it's very positive for me because I am helping them with something that I already know."

Providing perspectives as students in remote learning settings

During the panels, LAs were able to provide both a learner perspective as well as an LA perspective. They understood the challenges of studying at home and staying focused and motivated and could often better relate to the experiences of their peers and convey this to instructors over the semester. Faculty valued the LA's unique student perspective and "appreciated [LA] feedback about how students are experiencing the transition."

Many students rely on college and university learning spaces to do their work. LA Bailey Holifield said, "One challenge is finding somewhere quiet to do my work. I have to sit down and be motivated, and it's hard for me to do that by myself sometimes." Diane mentioned that "most students that I have agree with me — it's the distractions at home … you have TV to watch, we got the kids, we got the dog, family members … it's a challenge mentally to not be in a learning environment." LAs are often in better positions to empathize with the students in these classes and what they might be struggling with in these new spaces.

Although LAs cited the importance of synchronous interactions in providing community and some sense of normalcy in these spaces, they also provided a student perspective on issues of access, citing the importance of also providing asynchronous materials. Asynchronous materials provide students the opportunity to review materials and also mitigate certain circumstances that students faced during the semester. For example, Benjamin said, "I have a 10-hour time difference. I traveled back home … So there's some lectures that I have that end at 4am, and well, that's not that's not nice when you live with your family. And so there are classes where …[I] wake up in the morning and watch the recorded lecture of what happened at 4am … and that's why making it an asynchronous activity gives the opportunity for students who couldn't appear in person or online to do it in their own time." LA Kyle Tayman also commented on the value of recorded lectures:"say you know you missed something that the professor said, instead of just being lost for the rest of the lecture, you can just rewind it"

Learning from this experience and moving forward

Many institutions are now developing plans for remote learning or hybrid spaces for the Fall 2020 semester. While the situation with COVID-19 remains challenging for students, LAs, staff, and faculty, there are lessons learned from our LAs that we can take into Fall 2020 and beyond. Aidan Barker, the LA Panel Moderator and LA at CU Boulder, challenged the LAs to describe what they have learned from this experience - items that they see as useful in remote learning and in in-person settings.

LAs found that the virtual videoconferencing format, at flexible times, allowed for interactive opportunities with students that may not have occurred in a face-to-face setting. As we transition back to in-person coursework, classes might also provide virtual spaces for discussion, such as sessions that can be implemented via Zoom breakout rooms. These can happen at times convenient for students, such as the evenings, with LAs moderating the sessions.

Creating personal connections with students was also highlighted as an important feature that should continue regardless of the instructional setting. Benjamin mentioned that "a good thing would be for professors to maintain a kind of personal relationship with students … try and get to know them a bit, maybe kind of personally invest in students a bit more, as you are in online classes … I'm sure students would appreciate to see that more once we get back to classes." He went on to say "I'm sure we'd all like to see a bit of personal connection between a mentor, a professor, and the student."

LAs also felt that the sense of flexibility and accommodation should also move forward as we transition back to more traditional learning spaces. Linnea commented that "I think it's wonderful that faculty are being more understanding of the extenuating circumstances, and things like that, and like deadlines, and it would be wonderful if we could carry that sense of connectedness and, like, caring for each other beyond the classroom." An mentioned that she was proud of her institution for its diverse support of students, stating that her institution "has been helping us with, like, emergency aids, and renting out laptops without fees, so that's one very big support from our college, and I am very ...proud.." LAs on the panels cite the importance and attention to empathy and compassion continuing beyond COVID-19. These statements echo what Valerie Otero describes on how LAs are "leading the charge of creating meaningful, compassionate online experiences for students during the COVID-19 crisis."

As we move forward, LA Gabrielle Jones Hall reminded the participants attending the virtual LA Panel to "take this abrupt transition as a wake-up call – really pay attention to STEM education research … learn about pedagogy, take Learning Assistants serious, because we're here to help."

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Chicago State University: Mel S. Sabella is a professor of physics and Andrea G. Van Duzor is a professor of chemistry, both at Chicago State University where they are co directors of the CSU Learning Assistant Program. Additionally, Mel S. Sabella is Past-President of the American Association of Physics Teachers.

University of Colorado Boulder: Jennifer S. Avena is an Instructor in Biology and the Learning Assistant (LA) Program, Aidan Barker is a former undergraduate LA, LA Mentor, and recent graduate and is also a member of the Learning Assistant Alliance Leadership Council, Susan Hendrickson is a Teaching Professor in Chemistry and a Departmental Coordinator for the LA Program, Laurie Langdon is Director of the LA Program, Valerie Otero is a Professor in the School of Education and Executive Director and founder of the LA Program.

Endnotes

1. *To find out more about the Learning Assistant Model, see learningassistantalliance.org and Otero, V. K. (2015). Nationally scaled model for leveraging course transformation with physics teacher preparation.* Recruiting, and Educating Future Physics Teachers: Case Studies, and Effective Practices*, 107-127.*

2. *Sabella, M., Van Duzor, A., & Davenport, F. (2016, July 20-21).* Leveraging the expertise of the urban STEM student in developing an effective LA Program: LA and Instructor Partnerships*. Paper presented at Physics Education Research Conference 2016, Sacramento, CA.*

3. *Close, E. W., Conn, J., & Close, H. G. (2016). Becoming physics people: Development of integrated physics identity through the Learning Assistant experience.* Physical Review Physics Education Research*,* **12***(1), 010109.*

4. *groupme.com*

5. *tinyurl.com/LAsCompassionateLeadership2020, retrieved 5-26-2020*

Physics Teacher Education Coalition

Section on Teacher Preparation

Teacher Preparation

Alma Robinson, Virginia Tech

Physics, as a discipline, continues to suffer from an underrepresentation of traditionally marginalized groups. This issue of the Teacher Preparation Section discusses ways that we, as educators of future physicists and physics teachers, can help to address this lack of diversity. Although the following articles had already been planned to be published in the Summer 2020 newsletter, the recent murders of George Floyd, Breonna Taylor, Ahmaud Arbery, Dominique "Rem'mie" Fells, Riah Milton, among others, alongside the ensuing public outrage have made the neccesity for all of us to combat systemic racism even more urgent.

Danny Doucette and Johan Tabora describe the Underrepresentation Curriculum, a collection of lessons, with accompanying teacher guides, that has students engage in conversations about inclusion and equity in physics. The lessons are organized in a modular fashion, giving instructors (ranging from middle school to college) the ability to adopt a lesson, a unit, or multiple units to fit their particular needs.

Eleanor Close and Xandria Quichocho illustrate how the Physics Learning Assistant (LA) Program at Texas State University has been successful in fostering positive physics identities among the LAs. By normalizing mistakes and having the LAs help each other during the LA Prep meetings, the LAs develop a deeper understanding of physics and an increased confidence in their physics ability.

Talking about Equity in Physics Classes

Danny Doucette, University of Pittsburgh and Johan Tabora, University of Illinois-Chicago

When we were asked last month to write about the Underrepresentation Curriculum for the FEd newsletter, we were honored and excited to share our approach to teaching about systemic racism in physics classes. Since then, the murders of George Floyd, Breonna Taylor, Ahmaud Arbery and others have provoked such a strong and urgent national response that talking about racial justice in physics class has become both inevitable and necessary. Black lives matter. As educators, we strongly decry the endemic systemic racism and white supremacy that have continually oppressed Black lives and commit to uprooting these discriminatory structures through our teaching.

For teachers who need resources to have conversations about systemic racism and other systemic social injustices in the classroom tomorrow, we have some recommendations.[1] On the other hand, if you are looking to incorporate anti-racist pedagogy into your science curriculum, we offer to you the Underrepresentation Curriculum.

In "A Framework for K-12 Science Education", the National Research Council calls for concerns about equity to be placed at the forefront of our efforts to develop and deliver science instruction in the 21st century.[2] In past newsletters, articles in the FEd Teacher Preparation Section have addressed how instructors can adopt inclusive teaching practices that address curricular topics, like multiple representations and sense-making, as well as sociocultural aspects of education like identity, belonging, and affect. This article introduces a complementary approach that seeks to help students understand the nature of essential social issues as they pertain to science by examining the underrepresentation of racial, ethnic, gender, and other social groups in physics. Underrepresentation acts as the starting point for the curriculum, which uses discussions, reflections, and other activities to help students learn about the importance and complicated reality of equity and inclusion in both physics and the modern world, while also helping students better understand themselves and their own various identities.

The Underrepresentation Curriculum builds on more than a decade of development by physics teacher Moses Rifkin and others. A team of volunteer high school and college educators develops and refines curriculum modules, runs workshops, cultivates resources and community, and conducts research on the curriculum. Over time, the curriculum has been adopted and used by middle school, high school, and college teachers around the world.

The curriculum starts by asking students to do a bit of research about the life of a physicist from a traditionally marginalized group. This leads to the question that will guide our discussions, supported by historical data from APS and AIP: "Why are there so few Black (or women, or Latinx, or LGBT, or disabled) physicists?" Students tackle this question using scientific tools and modes of thought: proposing hypotheses and seeking falsifying evidence, obtaining and plotting data, developing explanatory models, and negotiating understandings collaboratively with their peers. Along the way, we ask students to attend to an assumption that lies at the heart of scientific practice: is science objective, subjective, or somewhere in between? They also seek to answer the question posed by Chief Justice Roberts, "What unique perspective does a minority student bring to a physics class?"[3] By studying topics that involve the intersection of social issues and science, students not only realize the utility of the relevant scientific skills they have already developed, but also come to appreciate the interwoven nature of society and science.

After this introduction to key topics, teachers who use the Underrepresentation Curriculum choose from a variety of specific topics to explore next, including stereotype threat, meritocracy, systemic racism/sexism, racial privilege, implicit bias, intersectionality, and the concept of a model minority. For each, the curriculum provides a flexible set of activities and prompts for guided reflection. The curriculum wraps up by calling on students to take action based on what they've learned. In the past, students have embraced this opportunity by creating posters, podcasts, videos, reflective texts, poetry, songs, or other forms of expression, and also by going into their schools and communities to learn more.

The first question we always hear when we explain the curriculum is, "when do you have time for all that?" It's a fair question. As educators, the editors of the Underrepresentation Curriculum are intimately familiar with the time pressure associated with teaching in a high school or college. We wrote the curriculum to be flexible: a brief implementation can be done in as little as 90 minutes, or a full course of study can productively fill two weeks of classes. Some instructors implement the Underrepresentation Curriculum during the last class before winter break, following AP exams, during the class after a difficult assessment, or dispersed throughout the year. The curriculum is most effective after teachers have had an opportunity to establish norms and develop a community of respect in their classrooms. Being able to have respectful, productive discussions is an essential prerequisite to teaching the Underrepresentation Curriculum since much of the curriculum is built on small and large group discussions around sensitive topics.

Talking with students about race, gender, disability, or other social issues can be intimidating. For that reason, the Underrepresentation Curriculum is flexible enough to be adapted to a variety of different settings and implementations. There is scope for instructors to discuss their own experiences, welcome the voices of outside experts (or experts within the classroom), or simply rely on well-articulated perspectives from readings. In general, teachers who use the Underrepresentation Curriculum tend to acknowledge their own identity and potential biases and then focus on promoting productive and respectful discussions amongst students, acting as a guide rather than an authority. The goal is to help students learn how to frame and talk about these issues in an engaged and productive way, not to advocate for any particular political opinion. Rather than adopt a "both sides" approach, we encourage students to consider as broad a range of perspectives as possible, including those that may be unfamiliar to them.

The response from students has been powerful. They quickly see that "there's really no class that would be better to talk about [equity]," and that "our race affects almost every aspect of our lives." Following the curriculum, students are less likely to view science as a strictly objective enterprise, more likely to describe their race as important to their lives, and more likely to believe that equity is important in science.

If you work with future physics teachers, or if you are a physics instructor yourself, and would like to take a look at the Underrepresentation Curriculum, visit our website at underrep.com. We are currently asking that new users fill out a short survey before accessing the curriculum materials so we can understand who is using the curriculum, provide support and community, and track our impact. For some background on the curriculum, and discussion of its positive impact on students, papers by Moses Rifkin[4] and Abigail Daane and collaborators[5] explain how the curriculum has been implemented at the high school and college levels. Abigail Daane has also published research on the impact of the curriculum on college learners[6]. We welcome correspondence at underrepstem@gmail.com, and look forward to hearing from you!

Danny Doucette is a PhD student in Physics Education Research at the University of Pittsburgh and a former high school teacher. Johan Tabora is a PhD student in Science Education at the University of Illinois-Chicago and a high school physics teacher with the Chicago Public Schools.

Endnotes

1 *tolerance.org/magazine/fall-2016/dont-say-nothing*
npr.org/2020/06/04/868600478/q-a-how-to-talk-to-kids-about-george-floyd

2 *nap.edu/read/13165/chapter/16*

3 *aps.org/publications/apsnews/201602/supreme.cfm*

4 *aapt.scitation.org/doi/full/10.1119/1.4940167*

5 *aapt.scitation.org/doi/full/10.1119/1.4999724*

6 *compadre.org/per/items/detail.cfm?ID=14200, compadre.org/per/items/detail.cfm?ID=14580, compadre.org/per/items/detail.cfm?ID=15247*

Cultivating an Inclusive Culture in the Physics Department through a Learning Assistant Program

Eleanor Close and Xandria Quichocho, Texas State University

Physics lags almost all other STEM disciplines in our lack of diversity[1]. Gendered and racialized stereotypes of physicists as brilliant geniuses permeate American culture and create barriers for many students before their first physics course. To counter these enculturated biases, we are working to create a department culture that supports collaborative student community, recognizes many different strengths as valuable, and acknowledges and addresses bias. In the physics department at Texas State University, we have created a Learning Assistant (LA) Program with structures specifically designed to promote inclusive community among students. In this article we will describe some specific elements of our LA Program and share some of our research on how participation in the program impacts our LAs.

In the LA Model[2], undergraduate LAs meet weekly with faculty to prepare for instruction. In our implementation, all LAs and LA-supported faculty meet together each week, creating opportunities for students to get to know each other and to meet faculty in an informal setting. One of the community norms we promote is that LAs will continue to learn physics as they prepare for and assist in the introductory courses. This also means we expect LAs to make mistakes while working through material in weekly LA Prep meetings, and we work to normalize this. During LA Prep, we discuss ways of supporting student learning as well as identify the content we hope they will learn, and we encourage LAs to share their own struggles with the material as guidance for what to expect in the classroom.

As part of an ongoing study of physics identity development, we collect video data during LA Prep. These videos can give us insight into the kinds of discourse LAs engage in with each other, and the community norms they express and enact. In our analysis of these episodes, we find that discussions about teaching often merge seamlessly into new content learning for LAs. For example, in a preparation session early in the semester, Dustin (pseudonym), a new LA in introductory mechanics, asks the experienced LAs at his table how to explain a concept to students:

> *So how would you explain, though, ... "how is the direction of the change of velocity vector related to the direction." Like, I know they're the same, I'm just trying to figure out how I would explain that to them. Other than just be, like, "it just is."*

Ava, a physics major in her third semester of LAing, walks through an explanation using the equation for average acceleration. At the end of her explanation, Dustin responds: "*That makes sense. ... I'm probably going to get more out of that than any student would ...I've already learned a lot more than I thought I would.*" Beau, a second-semester LA, replies "*Oh, you learn SO much more doing this*." No one in the group seems either surprised or disconcerted that Dustin is learning more physics as they are preparing for the next week's class; in fact, Beau affirms that this is a valued part of the experience.

The experienced LAs preparing with Dustin are not only able to help him better understand the physics concept at hand; they're also reinforcing the idea that the practice of learning physics is more than immediately finding the right answer. Using a theoretical framework drawn from Communities of Practice[3] and Physics Identity[4], we understand these interactions as both providing recognition to the experienced LAs and creating a body of shared experience that can support a sense of community membership. The community practice of valuing and affirming ongoing physics learning also reinforces the idea that it is "okay to be wrong", which challenges the idea of physicists being natural geniuses and creates a more accessible and accepting environment.

This environment has helped students from multiple minoritized groups gain confidence in their physics knowledge and reconcile their multiple identities. In another research project, we use intersectionality[1,6,7], body performance[8], and the Critical Physics Identity framework[9] as lenses to understand the personal narratives of women of color and LGBTQ+ women who study physics. Many of the women interviewed had participated in the LA program, and describe it as an important factor contributing to their success during their studies.

For example, one interviewee—Nadya, who identifies herself as a Guatemalan, White, and straight woman—told us how being an LA helped her build her confidence. In response to the question "*Do you see yourself as a physics person or a physicist?*" Nadya first described how her answer to that question had changed over her time as a student, then reflected on what helped her develop her identity as a physicist:

> *...even doing Pedagogy- like that helped to- becoming in L.A., oh my God, that helped me so much with gaining my confidence—because I really lacked confidence in my skills, because I just didn't- I didn't do well in intro levels, because I was just so, like, not focused [on] school and I was going through a hard time. But, um, it- being an L.A. made me more confident in myself, and ... it helped me define how I see myself as a physicist—and how I can be able to say like, "I'm a physicist."*

Nadya's response shows that the community practices and norms of the LA Program not only support collaboration and continued learning, but also, through these, opportunities to gain competence in physics content and strengthen physics identity.

Nadya and other interviewees often talk about the LA Pedagogy course (required of all first-time LAs) and its impact on their physics experience. At Texas State this course is an upper-division physics elective, described by another interviewee, Autumn, as a "crash course on...how you learn." Autumn identifies herself as a White and bisexual woman. This piece of Autumn's narrative was part of her response to the interviewer's question *"How did you get into physics?"* which generated the follow-up question *"Can you talk about that, the psychological educational aspect of the department?"* Autumn replied:

> *I feel really strongly that I wouldn't have done as well, or as been as successful ...at a different university that doesn't do the LAs or- doesn't have the kind of supportive, um - like, all the professors are on your side... I just feel like the kind of person that I am is that I am really shy and timid and have a lot of fear of failure. So being in an environment where it was kinda- maybe more cut-throat—I feel like that might affect me more than somewhere like here. And the fact that they pretty much give you a crash course of what, how you learn, and the psychology behind that. And I think that really opens your mind up to- to kind of believing in yourself.*

In a program with a more competitive environment, Autumn's "fear of failure" might have been a stumbling block towards development of positive physics identity. However, in her physics community with practices that normalize making mistakes and prioritize collaboration and continued learning, Autumn was supported and encouraged to embrace the "wrong" ideas as a tool for learning and to work with her peers to develop a deeper understanding of the material.

Our LA program creates an inclusive environment in ways both planned and emergent. We hope this description of the structures that have proven successful for supporting our students will help other departments discover new ways to foster inclusion.

Eleanor Close is an Associate Professor of Physics at Texas State University. She is the Director of the TXST Physics Learning Assistant Program and teaches the LA Pedagogy course most semesters. She is a member of the Leadership Council of the National Learning Assistant Alliance (LAA), and is grateful to be part of thriving, supportive communities in the LAA and at Texas State.

Xandria Quichocho is a student in the Texas State Physics program, doing Physics Education Research work on intersectional identity development of marginalized women. She is currently the Associate Director of the TXST Physics Learning Assistant Program. She served as an LA for three semesters, two of them in the LA Pedagogy course. She will be beginning her graduate studies at Michigan State University in the Physics Ph.D. program in the Fall 2020 semester.

Endnotes

1 *Quichocho, X. R., Conn, J., Schipull, E. M., and Close, E. W. (2019). Who does physics? Understanding the composition of physicists through the lens of women of color and LGBTQ+ women physicists. In* 2019 PERC Proceedings *[Provo, UT, July 24-25, 2019], edited by Y. Cao, S. Wolf, and M. B. Bennett,* doi:10.1119/perc.2019.pr.Quichocho.

2 *Otero, V. K. (2015). Nationally scaled model for leveraging course transformation with physics teacher preparation. In C. Sandifer & E. Brewe (Eds.),* Recruiting and Educating Future Physics Teachers: Case Studies and Effective Practices *(pp. 107–127). American Physical Society.*

3 *Wenger, E. (1998).* Communities of Practice: Learning, Meaning, and Identity. *(Cambridge University Press, New York, NY.*

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5 *Close, E. W., Conn, J., & Close, H. G. (2016). Becoming physics people: Development of integrated physics identity through the Learning Assistant experience.* Physical Review Physics Education Research*,* **12***(1), 010109.* doi.org/10.1103/PhysRevPhysEducRes.12.010109

6 *Crenshaw, K. (1989).* Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory, and Antiracist Policies*. University of Chicago Legal Forum, 1989(1), 39–52.*

7 *Schipull, E. M., Quichocho, X. R., and Close, E. W. (2019). "Success Together": Physics departmental practices supporting LGBTQ+ women and women of color. In* 2019 PERC Proceedings *[Provo, UT, July 24-25, 2019], edited by Y. Cao, S. Wolf, and M. B. Bennett,* doi:10.1119/perc.2019.pr.Schipull.

8 *Ong, M. (2005).* Body Projects of Young Women of Color in Physics: Intersections of Gender, Race, and Science. Social Problems*, 52(4), 593–617.* doi.org/10.1525/sp.2005.52.4.593

9 *Hyater-Adams, S., Fracchiolla, C., Williams, T., Finkelstein, N., & Hinko, K. (2019). Deconstructing Black physics identity: Linking individual and social constructs using the critical physics identity framework. Physical Review Physics Education Research, 15(2), 20115.* doi.org/10.1103/PhysRevPhysEducRes.15.020115

Browsing the Journals

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- An article on page 101 of the February 2020 issue of *The Physics Teacher* (aapt.scitation.org/journal/pte) experimentally investigates the lift on a drone in a variety of different gases at various pressures for future applications in planetary explorations. On page 113 of the same issue, Georgios Horsch compares theory and experiment for the flow of water out of a hole in the side of a vessel including corrections for the size and shape of the orifice, and on page 119 Marc Frodyma compares motion due to a constant force in Newtonian and relativistic mechanics. In the March issue, I took note of a thermodynamic study of air in a vacuum food cylinder on page 186, and a short look at why a nearly empty shampoo bottle is so much easier to knock over than a full one on page 220. Vincent Coletta on page 244 of the April issue shows that students choose to sleep longer before final exams when shown data that doing so improves scores. Finally, a comprehensive experimental study of how a handblender immersed in a glass of water can be used to lift it is reported on page 308 of the May issue and corrects my previous hypothesis about the effect. Much of the May issue is devoted to articles dealing with gender issues in physics education.

- Mark Denny provides an overall method of solution for all falling chain problems (sliding through a hole in a table or onto a floor, a folded chain released from one end, and chain fountains) on page 94 of the February 2020 issue of the *American Journal of Physics* (aapt.scitation.org/journal/ajp). John Milsom discusses a charging capacitor in relation to the conduction and displacement currents on page 194 of the March issue. The June issue has an article on page 475 that treats the steady-state shape of the free surface of water spinning in containers of various shapes. Also Robert Ross presents a simulation of Mermin's three-switch two-light EPR quantum apparatus on page 483 of the same issue.

- The flapping motion of a coin placed over the opening of a frozen bottle is analyzed in article 025105 of the March 2020 issue of the *European Journal of Physics*. Douglas Mundarain considers how to renormalize away the infinities that appear in the electrostatic potential of infinite wires and disks in article 035205 of the May issue. Article 035804 of the same issue models a frying pan with a lid as a Helmholtz resonator to explain the change in the frying sound as the lid is opened and closed. The journal can be accessed online starting at iopscience.iop.org/journalList.

- The geyser produced when Mentos candies are dropped into a bottle of Diet Coke is investigated at various altitudes above sea level on page 980 of the April 2020 issue of the *Journal of Chemical Education*. An article on page 1026 of the same issue discusses an Excel spreadsheet to solve the time-dependent Schrödinger equation using a finite-difference algorithm, and another on page 1195 investigates the demonstration of placing an inverted beaker over a burning candle standing in a container of water. The journal archives are at pubs.acs.org/loi/jceda8.

- Article 4307 in the December 2019 issue of the *Latin-American Journal of Physics Education* (lajpe.org/) presents a comprehensive analysis of the oscillations of Newton's cradle, including stress-strain relations, viscoelastic dissipation, air drag, and other effects.

- The October–December 2019 issue of *Physics Education* (India) at physedu.in/ has an article discussing the possibilities for interstellar travel. After reviewing the history of space exploration, relativistic acceleration, and the rocket equation, various concepts are proposed such as chemical, nuclear, anti-matter, hydrogen scoop, solar sail, particle beam, and bomb propulsion mechanisms.

- The wanderings of earth's magnetic poles are discussed on page 363 of the March 2020 issue of *Resonance.* Using the angle of minimum deviation to measure refractive index is reviewed on page 579 of the April issue. These articles can be freely accessed at ias.ac.in/listing/issues/reso.

- Article 010112 in *Physical Review Physics Education Research* at journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.16.010112 investigates student difficulties with noninertial frames of reference as they try to predict the trajectory of a ball rolling on a rotating disk. Article 013101 at journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.16.013101 suggests that students may learn more from online than live lecture demonstrations, in part because contrasting cases can be quickly shown back-to-back, slow motion is more easily displayed, and whiteboarding explanations can be presented and animated.

Web Watch

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- The *New Yorker* had the article Did Benjamin Franklin Fly That Kite? at bit.ly/36RtcBu.
- A Mac tool for drawing electric fields and equipotentials is Franklin at highcliffsoftware.com/.
- Beneath the Waves at museum.wa.gov.au/btw/ is an interactive look at one of Australia's magnificent marine environments.
- A free online tool for drawing chemistry apparatus is chemix.org/. It has lots of items such as beakers, balances, jacks, syringes, and other things that physicists also use.
- *Nature* had an interesting pair of columns recently: Thirteen tips for a biologist engaging with physicists at nature.com/articles/d41586-019-03960-z and Twelve tips for a physicist engaging with biologists at nature.com/articles/d41586-019-03961-y.
- The Cheese Science Toolkit at cheesescience.org/ provides a deep dive into the science behind cheesemaking.
- If you have a Mac, you probably use Time Machine to do backups. Occasionally it has issues. An in-depth examination of everything about this program starts at eclecticlight.co/2019/12/03/time-machine-1-how-it-works-or-fails-to/.
- I recently read Eileen Pollack's book about why there are so few women in physics. A *NYT* article she wrote is at nytimes.com/2013/10/06/magazine/why-are-there-still-so-few-women-in-science.html?
- Statistics related to women in STEM are discussed at catalyst.org/research/women-in-science-technology-engineering-and-mathematics-stem/.
- In these days of online courses, screencasting is a valuable tool. Some video recording and editing tools can be found at screencast-o-matic.com/.
- Socrative is an online clicker system with various plans (starting with a good free one) available at socrative.com/plans/.
- If you use Google Forms, the timing and assessment tools at timify.me/ may prove helpful.
- A site devoted to real world physics problems for the intro courses is real-world-physics-problems.com/.
- The current trend is against standardized testing but IQ tests can nevertheless be fun, such as at iqtestprep.com/.
- A visual examination of water stress across the USA is online at thewatercrisis.us/.
- Is it possible to make panels that generate electricity at night? Consider the anti-solar panels discussed at inverse.com/innovation/researchers-have-a-counterintuitive-concept-for-solar-panels-that-work-at-night.
- Harvard maintains a rich science blog at sitn.hms.harvard.edu/.
- A mathematical proof of the universal scaling law of turbulence is considered at quantamagazine.org/mathematicians-prove-batchelors-law-of-turbulence-20200204/.
- DIY Science Activities are presented at carnegiestemgirls.org/stem-activities/activities/.
- JoVE physics education videos are online at jove.com/science-education-library/29/physics-ii.
- 1001 Arabic inventions are graphically presented at 1001inventions.com/.
- The principle of least action is explored at cleonis.nl/physics/phys256/least_action.php.
- Resources to integrate argumentation into K-12 science classes are available at argumentationtoolkit.org/.
- New Zealand has the Science Learning Hub online at sciencelearn.org.nz/topics.

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Upcoming newsletter deadlines:

Fall 2020: October 1, 2020
Spring 2021: January 15, 2021