# Practice Space Prepares Teachers for Hands-On Physics

The Lab, a practice space designed for teaching assistants in physics laboratory classes, sprung out of my own personal experiences as a student and teaching assistant in MIT's Junior Lab. These experiences informed the design and the goals of the practice space.

As a student, I was attracted to Junior Lab's goal of fully simulating the experience of being a real practicing physicist, communicated through open-ended lab protocols and authentic experiments and equipment. The lab experience, although frequently intense, left me with a deep appreciation for simulation as a tool for learning and also, of course, physics as a whole. This experience led me to return to Junior Lab as a teaching assistant.

As a teaching assistant, I realized that I knew a great deal about the physics of the labs, and could easily sit down and fix a student's malfunctioning equipment. However, I was much less adept at communicating my knowledge. I had all the answers, but I had no practice in guiding students to the right solution without giving everything away. The brief orientation for teaching assistants at the start of the class urged us to avoid giving answers or doing things for students, but provided no practice in these areas.

Other existing professional development solutions across the advanced physics lab community, such as the ALPhA series of conferences and workshops, tend to assume that lab instructors are coming from a teaching background, and devote their time and energy towards increasing technical knowledge.

Meanwhile, practice spaces for teacher training, such as the MIT Teaching Systems Lab's ELK (Eliciting Learner Knowledge), simulate a traditional classroom that bears little resemblance to the hectic environment of a lab. Lab teachers must juggle equipment and protocols in addition to managing students, watching for safety hazards and knowing exactly when to intervene.

In response to these issues and specific gaps in the existing work, I developed a new teacher practice space, designed to prepare new teaching assistants to prioritize conceptual learning over equipment-fixing and answer-giving when faced with a complex lab environment. This practice space has three primary components: roleplay personas, authentic lab equipment, and mechanics for representing student misconceptions. These components are general enough that this practice space could easily extend beyond the physics lab context.

Roleplay personas help to replicate the drama and tense interactions that can take place in lab. One player takes the role of the teacher and receives a sheet summarizing their basic teaching philosophy. The other player takes the role of a student and receives a sheet summarizing their (problematic) attitude to the lab class. For playtesting, I gave student players the task of playing as a student who thinks they know everything about the lab and has no interest in talking to the teaching assistant.

Authentic lab equipment increases the immersion and accuracy of the simulation. In particular, teacher players must learn how to watch what students are physically doing on the lab equipment, balancing this with note-taking or consulting the protocol. The physical equipment is fun, but also increases cognitive load on the players in ways that match reality. For playtesting, I gave players the modules pictured below, allowing players to flip switches, plug in cables, and turn dials.


Mechanics for representing student misconceptions keep the players from having to remember their own misconceptions. Each player receives a labeled diagram of the lab equipment, along with notes on the lab protocol that say both what steps to take and why to take them. Differences in these diagrams and protocols between the student and the teacher represent what the student has misunderstood. Both players have an interest in these differences: the teacher wants to find as many differences as possible, especially conceptual misunderstandings, while the student just wants their apparatus to match the final lab solutions and doesn't care about intervening steps and misconceptions.

A playtest with these essential game components revealed a wide variety of playstyles and approaches to the game. One playtest had mechanics-focused players who collaborated to find all of the non-conceptual misconceptions, efficiently reaching the correct setup by the end of the lab. In this run, the teacher forgot to ask conceptual questions entirely and only realized

their mistake when presented with the full list of misconceptions after the game was over. This is a successful outcome as far as the learning objective: the teacher was given the opportunity to reflect on their default approach. The other playtest had roleplay-focused players who generated a great deal of tension and drama. The student player took their character sheet extremely seriously and refused to speak to the teacher at all. The teacher got increasingly frustrated, reaching out to use the equipment themselves and chastising the student for “setting themselves on fire.” This is also a successful outcome for the learning objective: it’s much better for teaching assistants to practice dealing with frustration in a controlled environment.

Overall, the playtest shows that players approach the basic mechanics of the game in a wide variety of ways. I think that this variation is a good thing for the game: there are new things to learn from every configuration of players. Going forward, I plan to expand the number of student profiles and look into ways of increasing the number of people that can play at once. One avenue suggested at a public presentation of this work was to have two student players and one teacher player, simulating the existence of lab partners and increasing the number of playstyles in the game.

Next semester, I plan to act as a teaching assistant for Junior Lab again. Ideally, I’ll implement my practice space for the benefit of all of the teaching assistants. Over the course of interviewing permanent Junior Lab staff for the design of this game, I started to publicize the practice space, making implementation into a possible reality. Either way, though, I have still learned a great deal about my own teaching from watching the playtests and implementing the game.

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