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The STEP UP Project: A National and International Movement to Engage High School Teachers in Cultural Change

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Abstract. The STEP UP project (STEPUPphysics.org), based in the United States, includes physics teachers, researchers and professional societies who have collaborated to design high school physics lessons to empower teachers, create cultural change and inspire young women to pursue physics in college. Starting in 2017, the STEP UP project co-created and piloted a set of lessons that support cultural change in high school classrooms. Pilot and quasi-experimental studies on the lessons showed that the materials had a positive impact on students' self-perception of themselves as a "physics person" and increased interest in pursuing a physics degree in college. As of June 2021, around 1,600 teachers have signed on to the project, along with 1,900 other supporters (physics faculty, undergraduate students, and other community members). International expansions in 2020 and 2021 have brought STEP UP adaptations to Brazil and Canada and recruited teachers from more than 30 countries to the community.

BACKGROUND

The STEP UP project is a collaboration of two U.S. research institutions (Florida International University, Texas A&M University–Commerce) and two U.S. physics professional societies (American Physical Society, American Association of Physics Teachers). Starting in 2017, the team has co-created high school physics interventions with secondary school teachers to equip as many of the 26,000 U.S. secondary school teachers as possible with materials to support equity in the physics classroom. These materials have been freely available to download at STEPUPphysics.org since 2019, and the online community hosted there has grown to 1,600 teachers.

STEP UP focuses on the inspiring role that high school teachers play on the outcome of undergraduate majors [1] as a means of addressing the significant decline of female participation in physics from high school courses (47%) to incoming college majors (20%) [2]. Addressing this disparity would effectively shift the demographics of women in physics in the United States, as persistence in representation from undergraduate studies through career outcomes holds steady at 20%.

The power of working with high school teachers stems from the fact that approximately half the students (47%) in the United States who are taking at least one high school physics class identify as female (Fig. 1) [2]. This proportion drops immediately following high school, with national surveys of incoming university students showing that the proportion of female students among physics majors in the first year is only 20%. Notably, the largest proportions of female students who do continue to undergraduate physics programs cite their high school physics teacher as a primary motivation [1]. Addressing the lack of translation of high school interest in physics into college enrollment would help to shift the demographics in U.S. undergraduate physics to counter the as-yet unbreakable ceiling, that is persistent through academic stages, of a maximum of 20% of U.S. physicists being women [2].

The STEP UP materials are composed of two lessons, the *Career in Physics Lesson* and the *Women in Physics Lesson*, and a set of *Everyday Actions* to support an equitable classroom. The *Everyday Actions Guide* focuses on explicit steps that teachers can take to recruit students, reduce marginalization and promote recognition of their

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students as “physics people” throughout the year. It also includes a self-reflection survey that teachers can take to

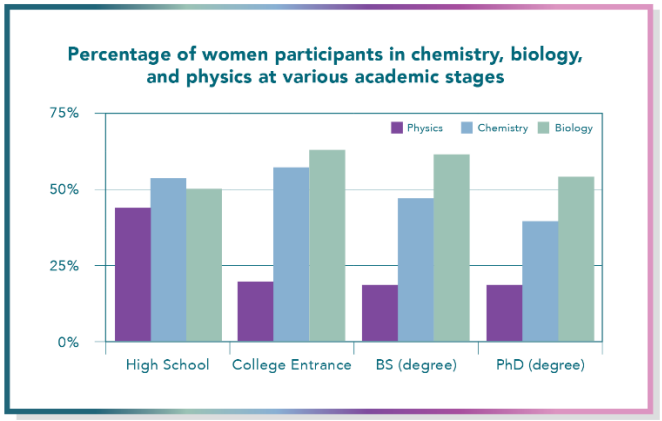

FIGURE 1. Chart showing the proportion of women in various stages of academic study, for physics, chemistry, and biology. Data drawn from American Institute of Physics (high school and professoriate data), Higher Education Resource Institute (college entrance), and U.S. Department of Education (degree data).

self-assess their progress. The *Careers in Physics Lesson* allows teachers to guide students through an exploration of what career pathways a physics degree can enable, from a researcher and professor to an engineer at NASA and a YouTube educator. The students are “matched” with a physicist through a simple two-question survey, and they then review background information of their “match” to further explore how the physicist ended up in their career. Through the lesson, students realize the breadth of available pathways and the specific ways that physics sets them up for success. The *Women in Physics Lesson* tackles critical issues related to the conditions for women in physics and the unconscious bias that is still present. The lesson includes reading about the experiences of historical women in physics and comparing and contrasting the experiences of more modern women. Students are also asked to share examples of bias that they have seen in their educational experiences and to reflect on how bias can be neutralized in the classroom, leading to a classroom agreement moving forward.

RESEARCH

The lessons were examined by the research team through pilot and quasi-experimental studies [3], which showed positive results of the materials on students’ self-perception of themselves as a “physics person” and increased interest in pursuing a physics degree in college (Fig. 2) [4]. The measures indicate a difference between pre- and post-testing of one particular metric, the self-declared interest to pursue a physics degree after high school. Combined, the two studies examined the effects of STEP UP lessons in 20 classrooms over 10 states over two academic years, representing diverse school contexts (urban, suburban and rural) and school demographics. A total of 1,448 students received pre- and post-surveys related to their physics intentions, including questions on their future pursuit of a physics degree. Forty-nine percent of the students self-identified as female and 54% belonged to a racial/ethnic group underrepresented in physics. Overall, the gains were significant for all students, but especially so for these two groups.

PROPAGATION

Primary efforts to build the STEP UP community of high school physics teachers and to share the STEP UP interventions were launched in 2019 and focused on recruiting as many of the 26,000 teachers across the United States as possible into the movement. The “propagation framework” relied on early engagement with stakeholders, co-creation of materials, and grassroots engagement of a broad community [5]. Through various efforts (Fig. 3), a total of 3,478 community members were recruited and then registered to the database managed by the American Physical Society (APS) (as of June 2021). These community members included 1,558 high school teachers and other supporters, such as undergraduate students recruited from APS’s Conferences for Undergraduate Women in Physics (CUWiP), faculty members who are committed to gender equity in physics and other community members who wanted to join

the cause. The gender demographics of our teachers (60% female, 38% male, 2% no response) does not match the national demographics (around 66% male), so future work is targeted at efforts to engage male allies.

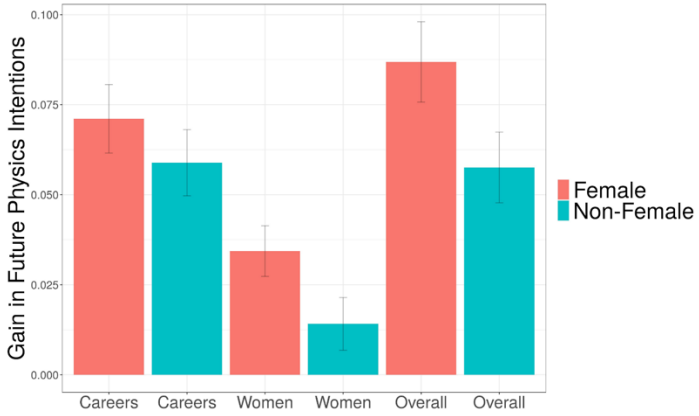

FIGURE 2. Gains in future physics intentions of students, shown by a percent improvement in the score from pre- to post-lesson tests, after either the *Careers in Physics Lesson* (Careers), the *Women in Physics Lesson* (Women), or Overall.

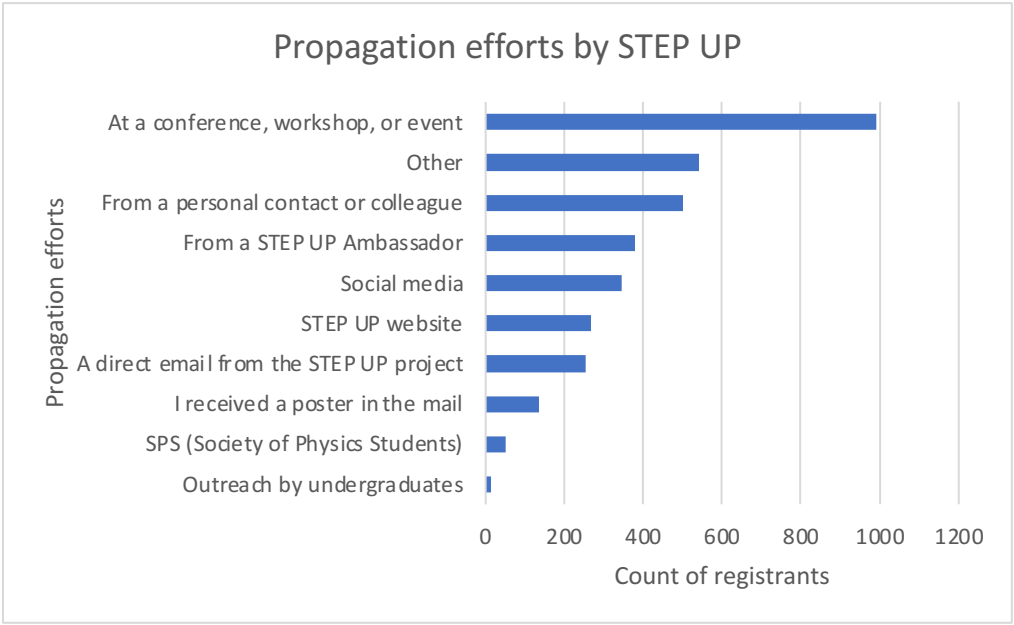

FIGURE 3. Efforts to propagate the lessons and the resulting registrants.

A hallmark program in the suite of propagation efforts is the STEP UP Ambassador program, which was launched in 2019. The first cohort of 45 teacher leaders were trained in the STEP UP materials and then led workshops related to the program to recruit other teachers interested in implementing the STEP UP curriculum. The second cohort, active in the 2020–2021 academic year, had a total of 80 ambassadors adding to the total number of workshops and bringing it to more than 350 run throughout the country. This second cohort also included our first international expansion, with teacher leaders in Brazil and Canada creating country-specific materials and recruiting from local teacher groups to share their version of STEP UP.

The third and current iteration of the Ambassador program has focused on recruiting teacher implementers, with 187 ambassadors acting as teacher "advocates" and directly interacting with students in the classroom (Fig. 4). This altered focus, from recruitment to direct lesson implementation, reflects the needs of our large and evolved community of teachers looking to make a difference with their students. In additional to the U.S. advocates, there are international advocates from 10 countries.

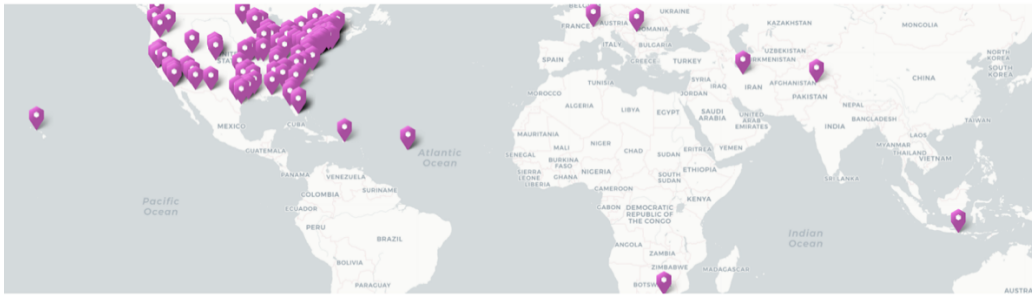

FIGURE 4. Map showing the distribution of 2021–2022 STEP UP ambassadors.

Research and evaluation on the propagation efforts is ongoing, with a leadership survey on teacher agency focused on the ambassadors, an implementation survey for high school teachers around the country, and ongoing formative feedback from interviews with ambassadors and community members.

CONCLUSION

The STEP UP project is a novel, research-driven and research-proven intervention to promote gender equity in physics in the United States. The international expansion projects are in their infancy, but ripe for collaboration from like-minded organizations abroad. Further information can be found at STEPUPphysics.org, and the project seeks like-minded partners to expand and enhance the movement.

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