

Timmerhaus Expansion Project: High School and University Collaboration

Project Summary: This project seeks to support high school teachers by bringing state of the art CU Boulder materials and pedagogies into their classrooms. Through a teacher facilitator program, some teachers will become teacher leaders and participate in a network of ambassadors supporting prospective teachers from CU Boulder as well as sharing experiences and knowledge with other teachers, their students, parents, and the community.

Introduction: Like scholars at the University of Colorado, K-12 teachers need time and space to innovate in ways that positively impact the lives of their students. The impact that teachers have often makes the difference between whether or not a student is able to realize their potential. When students have good experiences in school, there are enormous benefits to society, especially through the diversity of thought that emerges when students from traditionally underrepresented groups enter college and then have a voice in disciplinary communities. As a Chicana, first-generation college student, who grew up in New Mexico, working at the carnival and at her parent's grocery store, Professor Otero understands the experiences of underrepresented students first-hand. In her recent Ed Talk (Otero, 2022) she illustrates the vast impact of the messages that K-12 students receive in and out of the classroom. Otero's academic research agenda mostly involves institutional change at the college level through the Learning Assistant (LA) model. The LA model breaks down power structures in college classrooms by placing undergraduates as legitimate members of the instructional team. This gives more students voice in demonstrating not how much they already know, but how much they can achieve. Otero is trying to deploy a similar model in high schools in response to teachers' requests for help. There is a clear need for the re-professionalization of teaching by engaging teachers in the hard work of knowledge generation leading to educational innovation.

PEER Physics Professional Learning Community: Otero's PEER Physics program engages middle and high school teachers in a professional learning community that continually builds networks between CU and the K-12 communities. Teachers that participate can become leaders and serve as ambassadors for CU. In addition to Professor Otero, the PEER Physics team is led by two CU alumni (Shelly Belleau and Emily Quinty), who served as Learning Assistants (LAs) at CU Boulder and taught for many years in Colorado high schools. Seeking better curricular materials for their students in urban districts and more substantive intellectual opportunities for themselves, they began to collaborate with Otero to adapt her college-level physics curriculum for use in high schools and middle schools. This work led to the development of PEER Physics (Physics through Evidence, Empowerment through Reasoning) where students learn to advocate for themselves *through* physics rather than in spite of it. The idea is to cultivate students as *expert learners*, rather than solely as expert knowers. The PEER Physics professional learning community for teachers follows a similar approach, where teachers and the university faculty with whom they work, are valued as expert learners, in a community that continually generates educational innovation, growth, and better outcomes for students. These teachers and students can come to understand how knowledge is generated at universities by engaging in this generative process themselves. The PEER Physics lab materials and classroom posters are branded with CU's logo and students often remark that

they feel like a part of CU since they use CU materials. They boast that they are doing college-level physics and begin to identify with it.

This project is not funded by CU. It began as a part of a National Science Foundation Robert Noyce Master Teaching Fellows grant (NSF# 1340083) that was intended to build teacher leaders. It worked. Belleau and Quinty were working as teachers and became teacher leaders and now collaborate with Otero to build a mechanism for serving increasing numbers of teachers across Colorado and beyond. At its heart, the PEER Physics facilitator program is an ambassador model that establishes teachers as leaders who maintain connections between CU and the K-12 community. In some cases, the teachers work within their regions and in others the teachers work across the nation. We are currently working on a business model that could support teachers to continue to engage with CU. However, the funding model is currently based on district curriculum adoption funds. This leaves out a huge pool of solo teachers who can make a big difference in their own districts and beyond. These teachers do not have funds to join professional learning communities and obtain high quality curricular resources for their students. As Timmerhaus Ambassadors, we can establish a Teacher Facilitator Program, where teachers who participate can ultimately become PEER Physics facilitators, bringing in more teachers from urban and rural communities. In this way, teachers can become contractors for CU in a way that continually demonstrates CU's value for teachers, their students, and partnerships. By combining funding like Timmerhaus with district contracts, we can possibly set up a business model that can stand the test of time and maintain a strong connection between CU and the K-12 community.

Project Plan: The Timmerhaus award will directly support 10 teachers, with the expectation that some of them will become teacher leaders and facilitators who reach out to other teachers in the future. These funds will be used for teacher stipends and to purchase eBooks, print books, and laboratory materials for teachers to be successful in implementing state of the art instruction, developed at CU, that has research-based arguments about its effectiveness. Teachers who participate will visit each other's classrooms and similar classrooms at CU Boulder. They will have opportunities to discuss the transition from high school to college and the important role that inservice teachers can play in teacher preparation. Teachers will meet on Saturdays throughout the year as well as at a 3-day summer institute that will be headed by project staff and a teacher facilitator. The team, including participating teachers and students will hold events and give presentations for parents and school communities to display the effects of the partnership.

Our model for teacher engagement bundles professional learning with concrete curricular resources. Research shows that curricular materials can be leveraged to foster broader institutional change since they provide a road map along with a data-based argument that can help achieve desired learning outcomes (Ball & Cohen, 1996). Research also shows that professional development is more effective when supported with curricular resources (Penuel, Fishman, Yamaguchi & Gallagher, 2007). All PEER Physics professional development is relevant to the PEER Physics curriculum in principle, in pedagogy, and with respect to teachers' own practice. Second, our teacher facilitator model addresses the need for a large, national and

growing network of teaching professionals for providing professional development leading to more inclusive and accessible physics instruction. A teacher ambassador network is embedded within the PEER Physics professional community of teacher leaders/learners working on our own professional learning. This is necessary for teachers to continue to investigate solutions to unexpected problems of practice and to troubleshoot by circumstance in order to enact goals such as those brought on by the latest set of national and district-level standards. Also, community engagement provides desired professional and intellectual challenges for teachers. Third, district partnerships must be established whenever possible to ensure that district-level policies and practices are consistent with the reform-based classroom efforts of teachers (Lindsay, 2019). Teachers must be prepared and compensated to facilitate professional development and coaching at the district, state, and national scale to assist with teacher turnover, teachers teaching outside their disciplines, and to ensure seamless onboarding of new teachers within their own districts. District partnerships are not always possible, so our model features opportunities for individual teacher involvement and leadership, which subsidizes solo teachers with materials and supplies and for continual engagement in professional learning communities.

As mentioned, central to the model is the idea that as teachers continue to engage with the community, they have opportunities for continued intellectual growth by becoming a part of a facilitation team. A byproduct of this is a growing network of compensated teachers capable of reaching larger and larger numbers of teachers throughout the nation. Facilitator training will be headed by Quinty, Otero, and Belleau and will be an extension of the professional learning community but will focus more on *implementing* professional learning for other teachers. We will use the book titled, *The PD Book: 7 Habits that Transform Professional Development*, (Aguilar & Cohen, 2022). Of course, providing this opportunity for all teachers of physics will require staff who can reach out to districts and teachers thus some funding is built into this proposal for staff.

Research Findings Associated with the Program: Studies performed in PEER Physics learning environments suggest that PEER Physics courses support physics learning and foster positive shifts in student attitudes toward physics practices and the discipline of physics generally. Lindsay, Belleau, and Otero (2018) found that on average, students in PEER Physics courses had learning gain scores 9.9% higher than students in traditional classes on an assessment of conceptual physics knowledge. The difference in gain scores between students in PEER Physics and traditional courses was statistically significant, with $t(332) = 5.7$, $p < .001$. Cohen's d for gain scores equaled 0.61, indicating a moderate treatment effect for students in PEER Physics courses.

An investigation of a high school PEER Physics course found that female students whose native language was not English exhibited the greatest learning gains and the most frequent use of model-based thinking, suggesting that the course's curricular structures provide accessible and inclusive physics instruction (Belleau and Otero, 2013). Another peer-reviewed study was conducted by high school teachers who used the PEER Physics materials. They analyzed student conceptual gains from multiple PEER Physics courses found that student learning gains did not differ across gender, language proficiency, race/ethnicity, or even identified learning disability (as

is traditionally documented), further supporting the claim that these learning environments were providing opportunities for traditionally underserved students to thrive (Keil, Schrode, and Stober, 2018).

Students' attitudes about science and sense of empowerment are also impacted by the learning environments thus described. One student in a study said, "We used to be gullible before this class, but now evidence has our backs." Another said, "If she had just told us the answer, I think you lose that sense of wonder, so it kind of taught me to be more resourceful of myself and not always depending on other sources" (Ross and Otero, 2013). To investigate qualitative effects such as these, the Colorado Learning Attitudes about Science Survey (CLASS) was applied in 15 high school PEER Physics courses. Comparisons of student opinions about science before and after their course experience suggested that they came to see science as more connected to the real world, while also demonstrating decreased negative attitudes towards problem-solving and conceptual understanding. These shifts in opinion were greater for female students in comparison with male students and greater for students in traditionally underrepresented groups in comparison to students from majority groups (Belleau, 2022).

Teacher learning in PEER Physics has also been the focus of research investigation. An independent study found that participation in the PEER Physics professional learning community resulted in greater learning gains in participating teachers' classrooms. Significantly, for each session attended by teachers, there was a 1.46% increase in learning gains among their students, after controlling for various potentially confounding teacher characteristics (Lindsay, Widman, and Garcia, 2019). Additionally, PEER Physics teachers who engaged in several years of PEER Physics professional learning and in Facilitator Training recently published a book entitled, *Honoring teachers as professionals: Stories and pathways for growth in your classroom and career*, that highlights their experiences becoming leaders and better teachers through the professional learning experiences they had in the program (Grimes, Schrode, Stober, and Wachowski, 2021).

Anticipated outcomes of the project: This project seeks to accomplish multiple related goals: (1) improve learning outcomes and science identities for a greater diversity of students in high school physics classrooms, (2) enhance the connection between experienced high school teachers and CU Boulder's prospective teachers who are in the CU Teach program, (3) create a network of teacher ambassadors and CU Boulder faculty to regularly offer information sessions and events informing students, district leaders, parents and the general public of the close collaboration between CU Boulder and local schools.

Budget

Title: Timmerhaus Ambassadors Expansion Project						
Principal Investigator: Valerie Otero						
					<i>Base</i>	Year 1
A. Salaries and Wages						
Senior Personnel (CU instructor/former HS teacher)						
	20 % time, 12 months				92,000	18,400
Total Salaries and Wages						18,400
B. Fringe Benefits (using current FY21 rates)						
RA: 37.7%						6,937
Total Fringe Benefits						6,937
C. Other Direct Costs						
5) Operating Expenses			150			150
6) Participant Support		# teachers	stipend	materials	Professional Learning	
	10 Teachers	10	500	1,000	800	23,000
	Teacher facilitator	1	1,500			1,500
Total Other Direct Costs						24,650
D. Total Direct Costs						49,987
E. Total Costs						49,987

Budget Justification:

- A. A total of 20% time is requested for project management--10% for Quinty and 10% for Belleau to assist in the recruitment, support, and professional development of teachers. This team, along with PI Otero will support teachers, run a facilitator program, and assist in public events and presentations.
- B. Fringe benefits are calculated on requested salary per the University's federally negotiated Rate Agreement with the Department of Health and Human Services (DHHS). The rate used for Research Assistants is 37.7%.
- C1. Participant support is requested for 10 teachers, for a stipend of \$500, plus \$1000 of materials and eBooks for each teacher and the cost of professional learning program of \$800 per teacher.
- C2. One teacher facilitator will assist with the summer institute and other ongoing teacher professional development opportunities.

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