PHYS 1010 Course Redesign GEOC Proposal

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3. Currently existing course

4. PHYS 1010Q: Elements of Physics, Department of Physics

5. This proposed project responds to the General Education Oversight Committee (GEOC) course redesign grant competition. The purpose of this project is to implement anti-racist pedgaogoy (see Refs. [1], [2], [3]) and feminist standpoint theory (see Refs. [4], and [5]) into PHYS 1010Q (Elements of Physics) by weaving in a discussion about who conducts the science research and how these people shaped and contributed to the scientific endeavor. In our proposed project we brought together a team of scholars across two UConn campuses with expertise in physics, education, and psychology to redesign PHYS 1010Q.

Motivation: Upon completion of the General Education curriculum, students at the University of Connecticut should develop intellectual breadth, a consciousness of the diversity of human experience, and the processes to acquire and innovate knowledge within and towards the realities of our era and society. To this end, a broader aim of this proposal is to serve as a model through which other General Education courses might try to adopt.

Students of marginalized identities (e.g., disability status, socioeconomic status, nation of origin, educational background, age, native language, religion, and their intersections) face barriers to academic success when their experiences are inadequately considered inside and outside of the classroom. Several points of evidence show a problematic structure within the experience of the physics community. For example: physics content questions in introductory courses have been shown to have a gender bias against women [6]; physics textbooks include sexist examples [7] and have a history of gender and racial bias [8]; female faculty experience prejudice based on parental status which has been exacerbated by the COVID-19 pandemic [9]; women and Black and Indigenous People of Color (BIPOC) perceive the physics departmental climate to be worse than their male and white colleagues [10]; and undergraduate [11] and graduate [12] students experience sexual harassment and microagressions at high rates. Prior research has also highlighted issues the with climare of the physics community and barriers to access and participation for African American [13], women [14], Lesbian, Gay, Bisexual, Queer, and/or Transgender (LGBTQ+) [15], and/or disabled [16] people in the physics community.

We also see disparities when examining underrepresented students' semesterly achievement, persistence, and interest (e.g., Ref. [17], [18]), which are indicative of systemic issues in how STEM (Science, Technology, Engineering, and Mathematics) courses are designed and instructed. In response, there have also been calls for instructors to reflect on their privilege [19], utilize intersectional conscious collaborations in physics [20], and teach about the "who" of physics because it is an important aspect of teaching about racial equity [21]. To this last point, Russ (2017) states: "we must acknowledge that science teaching and learning does not take place in a vacuum. Science classrooms exist inside schools, which exist inside local communities, which exist inside these oppressive historical and political landscapes" [22].

Each discipline must reflect on how their field of study may have contributed to the critical issues faced by marginalized communities. Cultural and systemic change required to address these issues should not be viewed as a challenge to overcome, but as a reason to celebrate, because perspectives rooted in different backgrounds can contribute to new theories and scientific advances [23]. General Education courses should be platforms to highlight the contributions of researchers and philosophers of marginalized identities and the historical contexts in which these discoveries were created.

About PHYS 1010Q: In addition to systemic issues within the field of physics, we also have identified possible areas of improvement in the current PHYS 1010Q courses. The current instantiation of PHYS 1010Q is intended to be a survey course of general physics topics including motion, forces, energy, electricity, magnetism, optics, and modern physics. At the Storrs campus, the course is taught in a traditional lecture mode and students are assessed via weekly quizzes and two exams. At the Avery Point campus, the course has been modified to include active learning strategies such as in-class investigations (i.e., students work in groups to conduct a small experiment), hold discussions, and work through physics problems . Typically, non-STEM majors enroll in PHYS 1010Q to meet the lab-based science course requirement. This course is capped at 21 students per semester at Avery Point, 16 students at Hartford, 198 students at Storrs, and 22 students at Waterbury. This yields a total of 257 students per semester that can currently take PHYS 1010Q.

The **student learning objectives** for the proposed redesigned course are: 1) Evaluate the role of humans and the diversity of identities and experiences in the process and product of science.; 2) Identify a valid scientific argument and differentiate with pseudoscience.; 3) Justify inferences, predictions, and conclusions based upon data/evidence.; 4) Interpret graphical, diagrammatic, symbolic, and written representations of data.; 5) Understand and identify the relationship between physics and everyday experiences.; 6) Communicate scientifically through both written and oral formats.; and 7) Work together effectively on cooperative activities such as group problem-solving and group assessments.

While this is an important course that contributes to the general education curriculum, there are a few aspects of the course that could be improved. Firstly, the course does not emphasize that science is done by people and for people. People decide what science gets proposed, funded, conducted, and disseminated. Therefore, you cannot remove the people who were involved in the science from the science findings. There are also historic inequities in access, opportunities, support, and participation in science. Teaching a science course without highlighting the role of people in the scientific endeavor is only telling part of the story.

Secondly, the course is currently taught without emphasizing the connection between the physics content and the real world implications of the science. One reason funding agencies fund research is because of the real-world implications of the scientific findings. Science is done by people who are socialized within cultures. The culture in the United States is steeped in systems of oppression (e.g., racism, sexism, ableism, heteronormativity, etc.) that permeate into the science that gets done. Teaching a physics course without explicitly connecting the course content to the culture and the real world is missing an important aspect of the scientific process. Finally, the course is missing active learning strategies that the education research literature (e.g., [24]) show are better supportive of students' conceptual learning and attitudes and beliefs.

Making changes to these aspects of the course is important, because learning about the cultural and human aspect of the scientific process is just as important as learning about the science concepts. Similarly, Santos (2017) states: "Research shows that practices which point teachers' consideration to identity and empowerment within STEM (science, technology, engineering, and math) classrooms can address this gap in school performance by establishing positive outcomes for students." [25]

The **project objectives** are to: 1) Past: Weave a narrative of who has contributed to the current understanding of physics with emphasis on highlighting the diversity of identities, experiences, and roles of the people who contributed to the scientific endeavor.; 2) Present: Throughout the course, highlight ways in which systems of oppression are present within the current practices of physics.; 3) Future: Emphasize how physics can be used to address social justice issues and how physics can help move toward social justice aims.; and 4) Course sustainability: Curate a catalog of resources and create PHYS 1010Q course activities to support future instructors in preparing to implement the redesigned course with the goal of

reducing the barriers to implementing the redesigned course.

Project Timeline: In spring 2022 semester, we plan to: A) research and identify a more diverse group of physicists to highlight in the course; and B) engage in professional development about anti-racist pedagogy and feminist standpoint theory. In summer 2022, we plan to: A) create activities and course information about the more diverse group of physicists; B) write the "Who's Who" of physics project description; C) update course content and other projects; and D) apply for institutional review board (IRB) approval for the assessment plan. In fall 2022, we plan to: A) offer the redesigned PHYS 1010Q course; B) assess the implementation of the redesigned course; and C) submit a progress report to GEOC.

Broader Impacts: We intend for this project to impact students' understanding of the connection between physics and the real world, as well as the human side of physics. We hope these additions to the course will help to increase students' fluency with systems of oppression and will provide them a new scientific lens through which to view the world.

6. In addition to currently used assessments (i.e., in-class investigations, iClicker questions, final exams, and projects), we intend to use a three-pronged assessment strategy to collect multiple data sources to assess students' learning in the redesigned PHYS 1010Q course. The first assessment that we plan to use is currently in use at the Avery Point campus and is called the Epistemological Beliefs About Physical Science survey (EBAPS; <u>26</u>). This survey measures students' attitudes and beliefs about physical science. Secondly, we plan to use the Physics Inventory of Quantitative Literacy (PIQL; <u>27</u>) which assesses students' understanding of quantitative literacy in the physics domain. Since this is a Q-course, assessing students' quantitative literacy is paramount. Finally, we plan to create a new project for the course called The Who's Who of Physics project where students identify a scientist and describe their contributions to the field of physics and/or discuss a physics discovery that was enhanced due to the presence of a diverse team of scientists. For the third prong of our assessment strategy, we plan to collect students' project artifacts to assess their understanding of the connection between physics, culture, and the people who conduct the science.

7. Students will acquire a breadth of experiences and tools to understand and investigate the real-world impacts of science outside of the classroom. Science teaching that is conscious of its social and moral impacts will provide students a learning environment to engage with one's daily world critically. Furthermore, students will gain awareness of the historical contexts through which these theories were developed as well as exposure to significant figures in the field that are from backgrounds closer in representation to the demographics of today's society.

8. While we do not plan to have the course topics focus on anti-racism or decolonialism, we plan to implement anti-racist and feminist pedagogies in the course. We are also being anti-oppressive by expanding the discussion of diverse peoples and their role in science as well as discussing how science can be used to further social justice aims.

9. This course is currently taught within the department of physics. It is one of four general education courses within the physics department. At Storrs, it is the largest physics gen ed course (capped at 198 students in person and over 200 online). At Avery Point, it is currently one of two general education courses offered within the physics department and it has a significantly higher enrollment than the other course in the past few years. The department plans to continue to offer this course for the foreseeable future and it is a means for the department to provide a service to the university.

10. This course already has a Q competency and is aligned with CA3 - Science and technology. We do not propose to change the competency nor the content area. We plan to integrate topics of the culture of science and the role of people in the process and product of science. We also will focus on the history and value of a diversity of perspectives, identities, and experiences to the scientific endeavor. The people and the cultural context of science ARE part of science.

11. The current offering of this course is taught as a science survey course. Assorted topics in physics are briefly covered over the semester, in the process glorifying the straight white able-bodied men who contributed to science. Across the general education courses offered in the physics department, there is little discussion about the people who made those discoveries nor the cultural context. The curricular changes proposed will provide a more holistic picture of how science is done and by whom, in addition to the physics content.

12. The project team is uniquely qualified to implement the activities and evaluation plan of this project to reach the objectives due to their experience and expertise in physics, teaching physics and PHYS 1010Q, feminist standpoint theory and anti-racist pedagogy, and interrogating the people who are commonly cited as contributors to science. This team also is cross-disciplinary (i.e., physics, physics education, and psychology) as well as spans the Storrs and Avery Point campuses and includes: <u>Dr. Erin Scanlon</u> (PI) is an Assistant Professor in Residence (APiR) in the Physics Department at University of Connecticut, Avery Point. She is a physics education researcher who works to assess and increase the equity of physics courses and community; <u>Dr. Matthew Guthrie</u> (Co-PI) is an APiR in the Physics Department at University of Connecticut, Storrs (starting January 2022). He is a physics education researcher who works to understand the effectiveness of instructional materials and design more effective physics curricula; <u>Dr. Kenneth A. Pérez</u> (Consultant) is a social psychologist and APiR at Avery Point who researches the impacts of emotional experiences on individual judgment, decision-making, and psychological well-being. He also explores the mechanisms for improving health and academic outcomes for students of marginalized communities.

PI Scanlon and Co-PI Guthrie have taught PHYS 1010Q at the Avery Point and Storrs campuses, respectively and are physics education researchers and have experience with curriculum writing, and assessment. Drs. Scanlon and Pérez also have experience in social justice work through service on Avery Point's Diversity, Equity, and Inclusion committee. Dr. Pérez also serves on CLAS's Diversity, Equity, and Inclusion committee and led the Avery Point DEI subcommittee which identified directions in Scholarship (i.e., examining current course offerings, and inquiring on future courses to develop). The project team spans a range of identities and experiences including gender identities, race/ethnicities, ability statuses, experience with physics, primarily disciplines, and campuses.

To further our understanding and expand our expertise about the intersection of physics, systems of oppression, and anti-racist pedagogy and feminist standpoint theory, we will engage in professional development by following the learning progression outlined by Ref. [28]. We will engage with physics-specific curated lists of articles such as in Refs. [29] and [30], and we will engage with general resources about anti-racist pedagogy [31].

13. We intend for this course to be a pilot for how other physics courses could include anti-racist pedagogy and feminist standpoint theory in their course and how STEM courses can take up diversity, equity, and inclusion ideas. We believe that talking about the human side of science is critically important; and thus, this project could also be a pilot for how to treat the discussion of the people of science to other STEM courses across the general education curriculum. The aims of our proposal are to redevelop an individual course, but it is also important to emphasize that initiatives at the departmental level can have substantial influence on the experience of undergraduates in STEM education [18].

- 14. No.
- 15. Unsure.
- 16. No.
- 17. No.

18. We do not believe that additional funding would be required for PHYS 1010Q. Instead, we hope that our course could be a model for how to engage in DEI work in a physics Q-course.

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PHYS 1010Q: Elements of Physics Syllabus

Course and Information

Course Description

Basic concepts and applications of physics for the non-science major. Scientific principles and quantitative relationships involving mechanics, energy, heat and temperature, waves, electricity and magnetism, and the theory of the atom are covered. A laboratory provides hands-on experience with the principles of physics.

Course Materials

- Textbook: OpenStax Physics; ISBN: 978-1-951693-21-3.
 - This is a free textbook available online: https://openstax.org/details/books/physics.
- Lab Manual: Available for purchase through the UConn Bookstore.

Course Goals and Learning Objectives

Science is done by people for people. This course will familiarize you with the process of how scientific concepts are developed and the role of people in the process of science, as well as to provide you with an appreciation of the laws of physics and their implications for events in your daily lives. The course will also increase your ability for critical, abstract, and analytical thinking and help you to understand the workings of modern science and technology and how science can be used to make the world more inclusive and accessible to all.

On completion of this course, students will be able:

- 1. Evaluate the role of people and the diversity of identities and experiences in the process and product of science.
- 2. Identify a valid scientific argument and differentiate with pseudoscience.
- 3. Justify inferences, predictions, and conclusions based upon data/evidence.
- 4. Interpret graphical, diagrammatic, symbolic, and verbal representations of data.
- 5. Understand and identify the relationship between physics and everyday experiences.
- 6. Communicate scientifically through both written and oral formats.
- 7. Work together effectively on cooperative activities such as group problem-solving and group assessments.

Course Structure

This course will be taught in person synchronously. Additionally, the lab component of the course will be held synchronously and in person. The synchronous class periods will be spent with a brief summary of course content, time for students to ask questions, and investigations of course content. It is essential that you read the assigned sections before coming to class

because each class section will involve active learning. During class you will be expected to work in groups on investigations of the course content.

Assessments

In-Class Investigations

Students are expected to actively participate during the class periods. Active participation means interacting with peers in your breakout groups, discussing problems/conceptual questions and course content, contributing to the investigations, etc. If the instructor notices a student not participating during class (e.g., not contributing to group discussion, excessive off-topic discussions), the student will not receive full credit for the day.

Students will be graded on their understanding of the in-class investigations via their responses to i-Clicker questions after the investigations. The i-Clicker questions will be focused on the content covered in the in-class investigations.

We will be using the iClicker Reef classroom polling system in order to make our class time more engaging. This will help me understand what you know, give everyone a chance to participate, and increase how much you learn when we are in class together. This will also provide you with feedback on how well you are comprehending course concepts, help you master challenging concepts, and allow you to review material after class. You will find the iClicker Reef course registration information in the iClicker Reef Information tab on HuskyCT.

You are required to have a device to participate in the iClicker sessions during class. I will be allowing participation with the iClicker Reef app on a smartphone, tablet, or laptop. It is your responsibility to set up your iClicker Reef account in a timely fashion and follow the steps below to properly register in my iClicker course. It is also your responsibility to regularly check your iClicker records for any discrepancies and bring them to my attention within 48 hours.

iClicker activities fall under the provisions of our campus academic honesty policy. Students must not engage in academic dishonesty while participating in iClicker activities. This includes but is not limited to having another person check you into class.

Clicker scoring is as follows: Incorrect answers to questions are given 1 point for participation. Correct answers are given an additional 1 point, for a total of 2 points. Students answering all but one of the questions during each session are given an additional 1 participation point for the day. To allow for flexibility in these uncertain times, grading will be based on a maximum of 80% of the maximum accumulated score. Late iClicker submissions will not be accepted.

Example 1: If the maximum number of available clicker points is 267, 80% of this is 213.6. Anyone with an accumulated score \geq 213.6 will receive 100% credit on clickers.

Example 2: A person with an accumulated score of 190 in the same course would receive (190/213.6)% = 88.95% credit on clickers.

Laboratory

Laboratory is an essential part of the course. Additional information about the laboratory can be found in the laboratory syllabus.

Projects

In this course students will be evaluated through projects instead of weekly homework assignments.

Movie Physics Project

For the Movie Physics project students will work in groups of 2-3 and will select a movie clip and analyze the physics displayed in the clip. Your group will create a video presentation describing the movie clip, the physics displayed in the clip, and your argument of why the physics displayed is accurate and/or inaccurate.

Physics Photo Journal Project

For the Physics Photo Journal project students will write 3 blog posts describing how physics is present in everyday phenomenon. Students will identify a piece of source material (e.g., photo, newspaper article, social media video, piece of art, etc.) and discuss how it highlights and/or is governed by physics.

The Who's Who of Physics Project

For the Who's Who of Physics project students will dive deeper into the fact that science is done by people for people. Students will have the choice of either: 1) identifying a physicist and discussing their contributions to physics; or 2) identifying a physics topic and how our understanding of that topic was enhanced/furthered by a diverse team of researchers. Students will write a 1-2 page letter to a family member describing their topic.

Final Exam

There will be one final exam in this course. The final exam will be cumulative and will be scheduled by the <u>University's registrar</u>. More information about the exams will be given during the semester. Late exam submissions will not be accepted.

Tentative Course Schedule

You are expected to read the relevant sections of the textbook before class. This will allow us to spend our time during the class periods to focus on question/answer time and working on the investigations. The tentative schedule (which is subject to change) is available in a separate document.

Physics 1010 Schedule

Day Topic	Investigation	Possible Physcists to Highlight	
1 Intro. to Course and Scientific Method	None	Science is done by people, for people	
2 Units and Orders of Magnitude	Scale Drawings of Campus	Laura Bassi [1]	
- No Class - Labor Day			
3 Motion: Position and Velocity	Graphing Motion 1		
4 Motion: Acceleratoin	Graphing Motion 2		
5 Falling Bodies	Red Bull Space Jump Video Analysis		
6 Intro. to Forces	Identifying Forces		
7 Newton's Laws	Media Activity	Ibn Sina [2]	
8 Momentum	Rollerblade Momentum		
9 Physics of Cars	Car Crash Video Analysis		
10 Gravitation, Star Death, Black Holes	Spandex Spacetime		
11 Work and Energy	Work Done by a Spring		
12 Energy Conservation and Transformations	Energy Skatepark PhET	Fred Begay [3]	
13 Efficiency and Power	Media Activity	Eunice Foote [4]	
14 Static Electricity	Pulling Apart Tape		
15 Moving Charges	Intro. to Circuits PhET		
16 Circuits	Lightbulb Circuits		
17 Magnetism	Magnetism Experiments	Inge Lehmann [5]	
18 Electromagnetism	Electromagnetic Motor	Abdus Salam [6]	
19 Waves	Slinky Waves	Hertha Ayrton [7]	
20 Light: Waves	Diffraction of Light		
21 Light: Reflection and Refraction	Lens Reflection and Refraction	Anthony Johnson [8]	
22 Electromagnetic Spectrum	Media Activity	Elmer Imes [9], Margaret Huggins [10]	
23 Sound	Tuning Forks Beats		
No Class - Thanksgiving			
No Class - Thanksgiving			
24 Special Relativity and Black Holes	Gedanken Experiments	Subrahmanyan Chandrasekhar [11]	
25 Big Bang	Fermi Estimates	Wanda Diaz-Merced [12]	
26 Dark Matter and Dark Energy	Media Activity	Vera Rubin [13]	
27 Final Exam Review	Jeopardy		

- [1] https://www.aip.org/history-programs/physics-history/teaching-guides-women-minorities/laura-bassis-school-experimental
- [2] https://www.aip.org/history-programs/physics-history/teaching-guides/on-shoulders-giants-inertia
- [3] <u>https://www.aip.org/history-programs/physics-history/teaching-guides/fred-begay-physicist-3-names</u>
- [4] https://www.aip.org/history-programs/physics-history/teaching-guides/fred-begay-physicist-3-names
- [5] <u>https://www.aip.org/history-programs/physics-history/teaching-guides/inge-lehmann-danish-seismologist</u>
- [6] <u>https://www.aip.org/history-programs/physics-history/teaching-guides/heritage-all-mankind</u>
- [7] <u>https://www.aip.org/history-programs/physics-history/teaching-guides/hertha-ayrton-and-seashore-waves</u>
- [8] https://www.aip.org/history-programs/physics-history/teaching-guides/optics-and-anthony-johnson
- [9] https://www.aip.org/history-programs/physics-history/teaching-guides/physicist-activist-dr-elmer-imes-and-civil-rights
- [10] https://www.aip.org/history-programs/physics-history/teaching-guides/optics-and-anthony-johnson
- [11] https://www.aip.org/history-programs/physics-history/teaching-guides/black-holes-and-telescopes
- [12] https://www.aip.org/history-programs/physics-history/teaching-guides/wanda-diaz-merced-hearing-stars
- [13] https://www.nature.com/articles/d41586-021-00734-4

2021-2022 GENERAL EDUCATION ENHANCEMENT GRANT COMPETITION

Proposer Name (s): Erin Scanlon, Matthew Guthrie, and Kenneth Perez

Course Proposal Title: PHYS 1010Q: Elements of Physics

Email Address of Department Fiscal Manager: Jack Potter (jack.potter@uconn.edu)

Fiscal Year 2022	Amount Requested	Fringe for Summer Salary *	Total
Faculty Salary (calculate a fringe rate of 25.8%)	\$2,231 (Scanlon) \$2,231 (Guthrie) \$1,500 (Perez)	\$1,538	\$7,500
Student Labor (calculate a fringe rate of 18% for Grads)	\$0	\$0	\$0
Supplies	\$0	N/A	\$0
Travel	\$0	N/A	\$0
Research (Faculty Account)	\$0	N/A	\$0
Other	\$0	N/A	\$0
Total	\$5,951		\$7,500

Justification:

Please explain how the expenditure of all funds will support this proposal (100-400 words). Proposers should explain how any expenses, especially travel, will benefit the COURSE, not necessarily the professional development of the proposer.

Summer salary support is proposed for PI Scanlon, Co-PI Guthrie, and Consultant Perez for summer 2022. Dr. Scanlon will lead, and Dr. Guthrie will assist with the course redesign and process to identify connections between the physics content and the people who conducted the experiments to provide evidence for the content. Dr. Perez will serve as a consultant for the

project and will play a more limited role in the project; which is why Dr. Perez's requested summer salary support is less than for Drs. Scanlon and Guthrie. Dr. Perez will routinely meet with the project PI and Co-PI to provide expertise insight about weaving the "who" of physics into the course as well as about anti-racist and feminist pedagogies. The requested summer salary funding will allow the project team to focus their attention on: 1) identifying a more diverse group of physicists to highlight within the course and what their contributions were to the physics content of the course; 2) develop a course project about who does the physics research that lead to the content discussed in the course; and 3) redesigning the course to include anti-racist and feminist pedagogies as well as including active learning in the form of in-class investigations.

Phys 1010Q

Wells, Barrett <barrett.wells@uconn.edu>

Thu 12/2/2021 10:52 PM To: Provost's Office - Geoc <geoc@uconn.edu> Cc: Scanlon, Erin <erin.scanlon@uconn.edu>

To whom it may concern,

I support the enhancement of Phys 1010Q as proposed by Profs. Erin Scanlon, Matthew Guthrie, and Kenneth Perez, and I affirm that the course is in line with the curricula and courses of the department's strategic vision. Upon completion of the project, I will make every effort for the course to be offered every, or every other year at the typical class size for the duration of at least five years.

Sincerely, Barrett Wells

Barrett O. Wells Professor and Head, Department of Physics Member, Institute of Materials Science University of Connecticut Storrs, CT 06269-3046 USA

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