Stanford

Carl Wieman

Cheriton Family Professor and Professor of Physics and of Education

Curriculum Vitae available Online

CONTACT INFORMATION

- **Administrative Contact**

  Linda J Kim

  Email lindaky@stanford.edu

Bio

BIO

Carl Wieman holds a joint appointment as Professor of Physics and of the Graduate School of Education. He has done extensive experimental research in atomic and optical physics. His current intellectual focus is now on undergraduate physics and science education. He has pioneered the use of experimental techniques to evaluate the effectiveness of various teaching strategies for physics and other sciences, and served as Associate Director for Science in the White House Office of Science and Technology Policy.

ACADEMIC APPOINTMENTS

- Professor, Physics
- Professor, Graduate School of Education

HONORS AND AWARDS

- Carnegie US University Professor of the Year, Carnegie Foundation for the Advancement of Teaching (2003)
- Nobel Prize in Physics 2001, Nobel Foundation (2001)

PROFESSIONAL EDUCATION

- Ph.D., Stanford University , Physics (1977)
- B.S., MIT , Physics (1973)

Research & Scholarship

RESEARCH INTERESTS

- Brain and Learning Sciences
- Higher Education
- Science Education
- Teachers and Teaching

CURRENT RESEARCH AND SCHOLARLY INTERESTS

The Wieman group's research generally focuses on the nature of expertise in science and engineering, particularly physics, and how that expertise is best learned, measured, and taught. This involves a range of approaches, including individual cognitive interviews, laboratory experiments, and classroom interventions with controls for comparisons. We are also looking at how different classroom practices impact the attitudes and learning of different demographic groups.

Some current projects include:

1. Investigating problem solving strategies. We are examining the detailed components in problem solving to determine how these combine to achieve problem solving success, and how the strengths and weaknesses of a learners strategy can be measured and then improved. This work involves physics based computer simulations where students decide what information to seek, how to interpret the information they get, and then how they choose to act on that information. The goals of this research are, primarily, to identify which aspects of problem solving strategies pave the way to expertise and how to teach these effectively.

2. Cognitive principles for instructional design

Although current "active learning" efforts have been shown to provide better learning outcomes than traditional instructional methods, there is currently little guidance on how to design such materials to best support learning. We are designing, implementing, and studying instructional materials that take into account findings on human cognition, such as the benefits of inventing from a series of contrasting cases (e.g. Schwartz et al., 2011). By studying the efficacy of these materials, we hope to provide instructors, curriculum developers, and researchers with new principles for designing effective instructional materials for typical classroom instruction. A particular focus at this time is the use and learning of mechanistic reasoning, a fundamental component of physic expertise, as well as many other sciences.

3. The assessment and learning of adaptive medical expertise. Although medical education focuses heavily on mastery factual information and procedures under carefully identified conditions, medical practice takes place in a much less controlled environment. There are many other possibly relevant and irrelevant factors a doctor must take into account. This calls for adaptive expertise, the capability to operate in new contexts and learn new things as needed. We are working on the better assessment of such adaptive expertise and ultimately on the improvement of medical teaching to better teach it.

Teaching

COURSES

2020-21

- Learning & Teaching of Science: EDUC 280, ENGR 295, MED 270, PHYSICS 295, VPTL 280 (Spr)
- Scientific Communication in Physics: PHYSICS 191 (Win)

2019-20

- Learning & Teaching of Science: EDUC 280, ENGR 295, PHYSICS 295, VPTL 280 (Spr)
- Mechanics, Concepts, Calculations, and Context: PHYSICS 41E (Win)

2018-19

- Learning & Teaching of Science: EDUC 280, ENGR 295, PHYSICS 295 (Spr)
- Mechanics, Concepts, Calculations, and Context: PHYSICS 41E (Win)

2017-18

- Foundations of Modern Physics: PHYSICS 70 (Aut)
- Learning & Teaching of Science: EDUC 280, ENGR 295, PHYSICS 295 (Win)
- Mechanics Concepts, Calculations, and Context: PHYSICS 41A (Win)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Amy Fritz

Postdoctoral Faculty Sponsor

Eric Burkholder

Doctoral (Program)

Candice Kim, Karen Wang

Publications

PUBLICATIONS

- **Expertise in University Teaching & the Implications for Teaching Effectiveness, Evaluation & Training** *DAEDALUS*
  Wieman, C.
  2019; 148 (4): 47–78
- **What do AP physics courses teach and the AP physics exam measure?** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Burkholder, E. W., Wieman, C. E.
  2019; 15 (2)
- **Demographic gaps or preparation gaps?: The large impact of incoming preparation on performance of students in introductory physics** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Salehi, S., Burkholder, E., Lepage, G., Pollock, S., Wieman, C.
  2019; 15 (2)
- **Improving How Universities Teach Science: Lessons from the Science Education Initiative**
  wieman, c. e.
  Harvard University Press.2017
- **Enhancing Diversity in Undergraduate Science: Self-Efficacy Drives Performance Gains with Active Learning.** *CBE life sciences education*
  Ballen, C. J., Wieman, C. n., Salehi, S. n., Searle, J. B., Zamudio, K. R.
  2017; 16 (4)
- **Measuring the impact of an instructional laboratory on the learning of introductory physics** *AMERICAN JOURNAL OF PHYSICS*
  Wieman, C., Holmes, N. G.
  2015; 83 (11): 972-978
- **Teaching critical thinking** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
  Holmes, N. G., Wieman, C. E., Bonn, D. A.
  2015; 112 (36): 11199-11204
- **Analyzing the many skills involved in solving complex physics problems** *AMERICAN JOURNAL OF PHYSICS*
  Adams, W. K., Wieman, C. E.
  2015; 83 (5): 459-467
- **The teaching practices inventory: a new tool for characterizing college and university teaching in mathematics and science.** *CBE life sciences education*
  Wieman, C., Gilbert, S.
  2014; 13 (3): 552-569
- **Large-scale comparison of science teaching methods sends clear message.** *Proceedings of the National Academy of Sciences of the United States of America*
  Wieman, C. E.
  2014; 111 (23): 8319-8320
- **Psychological insights for improved physics teaching** *PHYSICS TODAY*
  Aguilar, L., Walton, G., Wieman, C.

2014; 67 (5): 43-49

- **Use of research-based instructional strategies: How to avoid faculty quitting** *PHYSICAL REVIEW SPECIAL TOPICS-PHYSICS EDUCATION RESEARCH*
  Wieman, C., Deslauriers, L., Gilley, B.
  2013; 9 (2)
- **Validated diagnostic test for introductory physics course placement** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Burkholder, E., Wang, K., Wieman, C.
  2021; 17 (1)
- **Importance of math prerequisites for performance in introductory physics** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Burkholder, E. W., Murillo-Gonzalez, G., Wieman, C.
  2021; 17 (1)
- **Mixed results from a multiple regression analysis of supplemental instruction courses in introductory physics.** *PloS one*
  Burkholder, E., Salehi, S., Wieman, C. E.
  2021; 16 (4): e0249086
- **Characterizing the mathematical problem-solving strategies of transitioning novice physics students** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Burkholder, E., Blackmon, L., Wieman, C.
  2020; 16 (2)
- **Developing scientific decision making by structuring and supporting student agency** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Holmes, N. G., Keep, B., Wieman, C. E.
  2020; 16 (1)
- **What factors impact student performance in introductory physics?** *PloS one*
  Burkholder, E. n., Blackmon, L. n., Wieman, C. n.
  2020; 15 (12): e0244146
- **Exploring bias in mechanical engineering students' perceptions of classmates.** *PloS one*
  Salehi, S., Holmes, N. G., Wieman, C.
  2019; 14 (3): e0212477
- **Experiences in improving introductory physics labs Reply** *PHYSICS TODAY*
  Holmes, N. G., Wieman, C. E.
  2018; 71 (7): 13
- **Tools for Science Inquiry Learning: Tool Affordances, Experimentation Strategies, and Conceptual Understanding** *JOURNAL OF SCIENCE EDUCATION AND TECHNOLOGY*
  Bumbacher, E., Salehi, S., Wieman, C., Blikstein, P.
  2018; 27 (3): 215–35
- **Introductory physics labs: WE CAN DO BETTER** *PHYSICS TODAY*
  Holmes, N. G., Wieman, C. E.
  2018; 71 (1): 38–45
- **Enhancing Diversity in Undergraduate Science: Self-Efficacy Drives Performance Gains with Active Learning** *CBE-LIFE SCIENCES EDUCATION*
  Ballen, C. J., Wieman, C., Salehi, S., Searle, J. B., Zamudio, K. R.
  2017; 16 (4)
- **The Connection Between Teaching Methods and Attribution Errors** *EDUCATIONAL PSYCHOLOGY REVIEW*
  Wieman, C., Welsh, A.
  2016; 28 (3): 645-648
- **Examining and contrasting the cognitive activities engaged in undergraduate research experiences and lab courses** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Holmes, N. G., Wieman, C. E.
  2016; 12 (2)

- **Toward instructional design principles: Inducing Faraday's law with contrasting cases** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Kuo, E., Wieman, C. E.
  2016; 12 (1)
- **Concepts First, Jargon Second Improves Student Articulation of Understanding** *BIOCHEMISTRY AND MOLECULAR BIOLOGY EDUCATION*
  McDonnell, L., Barker, M. K., Wieman, C.
  2016; 44 (1): 12-19
- **Seeking instructional specificity: An example from analogical instruction** *PHYSICAL REVIEW SPECIAL TOPICS-PHYSICS EDUCATION RESEARCH*
  Kuo, E., Wieman, C. E.
  2015; 11 (2)
- **Transforming a fourth year modern optics course using a deliberate practice framework** *PHYSICAL REVIEW SPECIAL TOPICS-PHYSICS EDUCATION RESEARCH*
  Jones, D. J., Madison, K. W., Wieman, C. E.
  2015; 11 (2)
- **Educational transformation in upper-division physics: The Science Education Initiative model, outcomes, and lessons learned** *PHYSICAL REVIEW SPECIAL TOPICS-PHYSICS EDUCATION RESEARCH*
  Chasteen, S. V., Wilcox, B., Caballero, M. D., Perkins, K. K., Pollock, S. J., Wieman, C. E.
  2015; 11 (2)
- **Comparative Cognitive Task Analyses of Experimental Science and Instructional Laboratory Courses** *PHYSICS TEACHER*
  Wieman, C.
  2015; 53 (6): 349-351
- **The Similarities Between Research in Education and Research in the Hard Sciences** *EDUCATIONAL RESEARCHER*
  Wieman, C. E.
  2014; 43 (1): 12-14
- **PRECISION-MEASUREMENT OF THE 1S LAMB SHIFT AND OF THE 1S-2S ISOTOPE SHIFT OF HYDROGEN AND DEUTERIUM** *PHYSICAL REVIEW A*
  Wieman, C., Hansch, T. W.
  1980; 22 (1): 192-205
- **DOPPLER-FREE LASER POLARIZATION SPECTROSCOPY** *PHYSICAL REVIEW LETTERS*
  Wieman, C., Hansch, T. W.
  1976; 36 (20): 1170-1173
- **HIGH-RESOLUTION MEASUREMENT OF RESPONSE OF AN ISOLATED BUBBLE-DOMAIN TO PULSED MAGNETIC-FIELDS** *IEEE TRANSACTIONS ON MAGNETICS*
  Brown, B. R., Henry, G. R., KOEPCKE, R. W., Wieman, C. E.
  1975; 11 (5): 1391-1393
- **DOPPLER-FREE 2-PHOTON SPECTROSCOPY OF HYDROGEN 1S-2S** *PHYSICAL REVIEW LETTERS*
  Hansch, T. W., Lee, S. A., Wallenstein, R., Wieman, C.
  1975; 34 (6): 307-309