Stanford



Carl Wieman

Cheriton Family Professor and Professor of Physics and of Education, Emeritus

Curriculum Vitae available Online

CONTACT INFORMATION

- **Admin Contact**

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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

- Emeritus Faculty, Acad Council, Physics
- Member, Wu Tsai Human Performance Alliance

HONORS AND AWARDS

- $4 M Yidan Prize for Education Research, Yidan Foundation (2020)
- 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

- Higher Education
- Learning Sciences
- Science Education
- Teacher Learning

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

2024-25

- Learning & Teaching of Science: CTL 280, EDUC 280, ENGR 295, PHYSICS 295 (Spr)

2023-24

- Mechanics, Concepts, Calculations, and Context: PHYSICS 41E (Win)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Alessandra Napoli

Publications

PUBLICATIONS

- **Deconstructing Expert Cognitive Skills and Knowledge.** *Gastrointestinal endoscopy clinics of North America*
  Wieman, C., Price, A.
  2026; 36 (3): 471-480

- **Teaching Medical Students to Reason like Skilled Physicians.** *Gastrointestinal endoscopy clinics of North America*
  Wieman, C., Price, A., Kim, C. J.
  2026; 36 (3): 453-461

- **Simulation supported directed self-guided learning of blended math-science sensemaking for historically marginalized STEM learners** *COMPUTERS & EDUCATION*
  Kaldaras, L., Wieman, C.
  2026; 251

- **Investigating blended math-science sensemaking with historically marginalized STEM learners** *INTERNATIONAL JOURNAL OF STEM EDUCATION*
  Kaldaras, L., Wieman, C.
  2025; 12 (1)

- **Scaffold or Crutch? Examining College Students' Use and Views of Generative AI Tools for STEM Education**
  Wang, K. D., Wu, Z., Tufts, L., Wieman, C., Salehi, S., Haber, N., IEEE
  IEEE.2025

- **Exploring Differences in Clinical Decisions Between Medical Students and Expert Clinicians.** *Advances in medical education and practice*
  Rojas, M., Price, A., Kim, C. J., Chen, S. F., Gutierrez, K., Wieman, C., Salehi, S.
  2024; 15: 1285-1297

- **Characterizing decision-making opportunities in undergraduate physics coursework** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Montgomery, B. J., Price, A. M., Wieman, C. E.
  2024; 20 (2)

- **Employing technology-enhanced feedback and scaffolding to support the development of deep science understanding using computer simulations** *INTERNATIONAL JOURNAL OF STEM EDUCATION*
  Kaldaras, L., Wang, K. D., Nardo, J. E., Price, A., Perkins, K., Wieman, C., Salehi, S.
  2024; 11 (1)

- **Exploring the learning experiences of neurodivergent college students in STEM courses** *JOURNAL OF RESEARCH IN SPECIAL EDUCATIONAL NEEDS*
  Wang, K. D., Mccool, J., Wieman, C.
  2024

- **Examining the potential and pitfalls of ChatGPT in science and engineering problem-solving** *FRONTIERS IN EDUCATION*
  Wang, K. D., Burkholder, E., Wieman, C., Salehi, S., Haber, N.
  2024; 8

- **Can Crowdsourcing Platforms Be Useful for Educational Research?**
  Wang, K. D., Chen, Z., Wieman, C., Assoc Computing Machinery
  ASSOC COMPUTING MACHINERY.2024: 416-425

- **Global perspectives of the impact of the COVID-19 pandemic on learning science in higher education.** *PloS one*
  Salehi, S., Ballen, C. J., Bolander Laksov, K., Ismayilova, K., Poronnik, P., Ross, P. M., Tzioumis, V., Wieman, C.
  2023; 18 (12): e0294821

- **Instructional model for teaching blended math-science sensemaking in undergraduate science, technology, engineering, and math courses using computer simulations** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Kaldaras, L., Wieman, C.

2023; 19 (2)

- **Cognitive framework for blended mathematical sensemaking in science** *INTERNATIONAL JOURNAL OF STEM EDUCATION*
  Kaldaras, L., Wieman, C.
  2023; 10 (1)
- **Impact of Prompting Engineering Undergraduates to Reflect on Their Problem-Solving Skills** *INTERNATIONAL JOURNAL OF ENGINEERING EDUCATION*
  Salehi, S., Wang, K. D., Flynn, M., Wieman, C.
  2023; 39 (2): 653-667
- **How traditional physics coursework limits problem-solving opportunities**
  Montgomery, B. J., Price, A. M., Wieman, C. E.
  edited by Jones, D., Ryan, Q., Pawl, A.
  AMER ASSOC PHYSICS TEACHERS.2023: 230-235
- **Equitable approach to introductory calculus-based physics courses focused on problem solving** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Burkholder, E., Salehi, S., Sackeyfio, S., Mohamed-Hinds, N., Wieman, C.
  2022; 18 (2)
- **How to become a successful physicist** *PHYSICS TODAY*
  Wieman, C.
  2022; 75 (9): 46-52
- **An accurate and practical method for assessing science and engineering problem-solving expertise** *INTERNATIONAL JOURNAL OF SCIENCE EDUCATION*
  Price, A., Salehi, S., Burkholder, E., Kim, C., Isava, V., Flynn, M., Wieman, C.
  2022
- **Absence of a COVID-induced academic drop in high-school physics learning** *PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH*
  Burkholder, E. W., Wieman, C. E.
  2022; 18 (2)
- **Perspectives on Active Learning: Challenges for Equitable Active Learning Implementation br** *JOURNAL OF CHEMICAL EDUCATION*
  Nardo, J., Chapman, N. C., Shi, E., Wieman, C., Salehi, S.
  2022; 99 (4): 1691-1699
- **Perspectives on Active Learning: Challenges for Equitable Active Learning Implementation** *JOURNAL OF CHEMICAL EDUCATION*
  Nardo, J., Chapman, N. C., Shi, E., Wieman, C., Salehi, S.
  2022
- **Inclusive Instructional Practices: Course Design, Implementation, and Discourse** *FRONTIERS IN EDUCATION*
  Salehi, S., Ballen, C. J., Trujillo, G., Wieman, C.
  2021; 6
- **Evidence-Based Principles for Worksheet Design** *PHYSICS TEACHER*
  Burkholder, E., Mohamed-Hinds, N., Wieman, C.
  2021; 59 (6): 402-403
- **A Detailed Characterization of the Expert Problem-Solving Process in Science and Engineering: Guidance for Teaching and Assessment.** *CBE life sciences education*
  Price, A. M., Kim, C. J., Burkholder, E. W., Fritz, A. V., Wieman, C. E.
  2021; 20 (3): ar43
- **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
- **Impact of Decision-Making in Capstone Design Courses on Students' Ability to Solve Authentic Problems** *INTERNATIONAL JOURNAL OF ENGINEERING EDUCATION*
  Burkholder, E., Wieman, C.
  2021; 37 (3): 650-662
- **Examining the Links between Log Data and Reflective Problem-solving Practices in An Interactive Task**
  Wang, K., Nair, K., Wieman, C., Assoc Comp Machinery
  ASSOC COMPUTING MACHINERY.2021: 525-532
- **Response to "Interpret with Caution: COPUS Instructional Styles May Not Differ in Terms of Practices That Support Student Learning," by Melody McConnell, Jeffrey Boyer, Lisa M. Montplaisir, Jessie B. Arneson, Rachel L. S. Harding, Brian Farlow, and Erika G. Offerdahl.** *CBE life sciences education*
  Wieman, C.
  2021; 20 (3): le1
- **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
- **Comparing problem-solving across capstone design courses in chemical engineering**
  Burkholder, E., Wieman, C., IEEE
  IEEE.2020
- **Evaluating the problem-solving skills of graduating chemical engineering students** *Education for Chemical Engineers*
  Burkholder, E., Hwang, L. Y., Wieman, C.
  2020; 34: 68-77
- **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)
- **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)
- **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)
- **Improving How Universities Teach Science: Lessons from the Science Education Initiative**
  wieman, c. e.
  Harvard University Press.2017
- **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)
- **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
- **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)

- **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
- **Comparative Cognitive Task Analyses of Experimental Science and Instructional Laboratory Courses** *PHYSICS TEACHER*
  Wieman, C.
  2015; 53 (6): 349-351
- **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
- **The Similarities Between Research in Education and Research in the Hard Sciences** *EDUCATIONAL RESEARCHER*
  Wieman, C. E.
  2014; 43 (1): 12-14
- **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)
- **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