

EDUCATION

Ph.D., Physics, University of Washington, Seattle, WA, June 2004.

Dissertation: Dynamics of Bose-Einstein Condensates in Optical Lattices.

Supervisor: Professor William Reinhardt.

M.S., Physics, University of Washington, Seattle, WA, June 2000.

B.A., Physics, Barnard College of Columbia University, New York, NY, February 1998.

Summa Cum Laude.

CURRENT PROJECTS

American Association of Physics Teachers

College Park, Maryland

Director: *PhysPort*, 2009-present.

Develop online resource to support physics faculty in using research-based teaching and assessment. Develop assessment data explorer for physics faculty and researchers to upload and analyze results of research-based assessments. Write content including expert recommendations and implementation guides to teaching methods and assessments. Conduct research on faculty implementation of research-based teaching methods and synthesis research on the results on research-based assessments.

Design and Development Director: *Living Physics Portal*, 2016-present.

Direct the design and development of online resource for faculty to discuss and share curricular materials for introductory physics for life sciences courses.

American Physical Society

College Park, Maryland

Editorial Director: *Effective Practices for Physics Programs*, 2016-present.

Serve as a member of the leadership team and lead the writing of a guide for self-assessment of undergraduate physics programs founded on documented best practices linked to measurable outcomes.

University of Colorado, Department of Physics

Boulder, Colorado

External Evaluator: *Research as a base to develop adaptable curricula bridging instructional paradigms in Quantum Mechanics*, 2016-present.

Evaluate project to develop, study, and disseminate quantum mechanics curricula.

Consultant: *PhET Interactive Simulations*, 2009-present.

Develop online resources to support teachers in using simulations for teaching and learning physics.

PREVIOUS PROJECTS

Augsburg College, Department of Physics

Minneapolis, Minnesota

Evaluator: *Modern Physics Laboratory Development*, 2009-2013.

Offer feedback on the development of innovative modern physics laboratory and conduct qualitative research to investigate the evolution of students' self-identity as scientists through research experiences.

Seattle Pacific University, Department of Physics

Seattle, Washington

Senior Researcher and Co-Director of Summer Research Institute: *Energy Project*, 2009-2013.

Conducted qualitative research on conceptual and pedagogical understanding of energy and assessment practices. Directed summer research institute where a multi-institution team of researcher-videographers document professional development courses and develop research collaborations.

University of Colorado, JILA

Boulder, Colorado

External Evaluator: *Investigating Instructional Influences on the Productivity of Clicker Discussions*, 2012-2016.

Sarah (Sam) McKagan

Evaluated project to analyze how instructors' directions influence productivity of clicker discussions.

Research Associate, 2005-2008.

Conducted research in physics education focusing on students' conceptual understanding of quantum mechanics, course reform, and design and use of instructional computer simulations. Developed computer simulations, modern physics curriculum, and the Quantum Mechanics Conceptual Survey.

University of Washington, Department of Physics

Seattle, Washington

Doctoral Thesis, 1998-2004.

Performed theoretical and computational analysis of Bose-Einstein condensates in optical lattices. Studied coherence properties and the breakdown of these properties with a focus on the fundamentals of quantum mechanics. Designed and wrote theoretical models and computer simulations of experiments.

Barnard College

New York, New York

Undergraduate Thesis, 1997-1998.

Developed computer models of biological evolution.

University of Washington and University of Rochester

Various locations

NSF Research Experiences for Undergraduates Program, 1995-1997.

Conducted research in experimental nuclear physics, computational astrophysics, and physics education.

GRANTS

Collaborative Research: PhysPort's impact on teaching practice, NSF IUSE 1726113, \$2.4M, 2017-2022. (PI)

Workshop: Creating a Guide for Programmatic Assessment, Review, and Improvement in Undergraduate Physics Programs, NSF PHY 1738311, \$50K, 2017-2018. (co-PI)

Collaborative Research: Community Sourcing of Introductory Physics for the Life Sciences, NSF IUSE 1624185, \$3M, 2016-2020. (co-PI)

Collaborative Research: Community Implementation: WIDER: Data Explorer and Assessment Resources for Faculty, NSF WIDER 1347728, \$750K, 2013-2017. (PI)

Collaborative Research: WIDER: EAGER: Increasing Faculty Use of Formative and Summative Assessment through Online Resources and Faculty Development, NSF WIDER:EAGER 1256352, \$300K, 2012-2015. (PI)

Physics Education Research User's Guide: A Web Resource for Physics Educators, NSF TUES 1245490, \$200K, 2013-2015. (PI)

Physics Education Research User's Guide, NSF NSDL 0840853, \$150K, 2009-2012. (PI)

PUBLICATIONS

A. Madsen, **S. B. McKagan**, E. C. Sayre, and C. A. Paul, "Resource Letter: RBAI-2: Research-based assessment instruments: Beyond physics topics," *American Journal of Physics* (in press).

[<https://arxiv.org/abs/1811.02900>]

A. Madsen, **S. B. McKagan**, and E. Sayre, "Best Practices for Administering Concept Inventories," *The Physics Teacher* **55**, 530 (2017). [<https://doi.org/10.1119/1.5011826>]

A. Madsen, **S. B. McKagan**, and E. C. Sayre, "Resource Letter: RBAI-1: Research-based Assessment Instruments in Physics and Astronomy," *American Journal of Physics* **85**, 245 (2017).

[<http://dx.doi.org/10.1119/1.4977416>]

J. Von Korff, B. Archibeque, K. A. Gomez, T. Heckendorf, **S. B. McKagan**, E. C. Sayre, E. W. Schenk, C. Shepherd, and L. Sorell, "Secondary Analysis of Teaching Methods in Introductory

Physics: a 50k-Student Study,” *American Journal of Physics* **84** 969 (2016).

[<http://doi.org/10.1119/1.4964354>]

A. Madsen, **S. B. McKagan**, M. Martinuk, A. Bell, and E. C. Sayre, “Research-based assessment affordances and constraints: Perceptions of physics faculty,” *Physical Review Special Topics - Physics Education Research*, **12** (1) 010122 (2016).

[<http://dx.doi.org/10.1103/PhysRevPhysEducRes.12.010115>]

A. Madsen, **S. B. McKagan**, and E. C. Sayre, “How physics instruction impacts students’ beliefs about learning physics: A meta-analysis of 24 studies,” *Physical Review Special Topics - Physics Education Research* **11**(1), 010115 (2015). [<http://dx.doi.org/10.1103/PhysRevSTPER.11.010115>]

A. Madsen, **S. B. McKagan**, E. C. Sayre, M. Martinuk, and A. Bell, “Personas as a Powerful Methodology to Design Targeted Professional Development Resources”, pp. 1082-1086 in Polman, J. L., Kyza, E. A., O’Neill, D. K., Tabak, I., Penuel, W. R., Jurow, A. S., O’Connor, K., Lee, T., and D’Amico, L. (Eds.). *Learning and becoming in practice: The International Conference of the Learning Sciences (ICLS) 2014*, Volume 2. Boulder, CO: International Society of the Learning Sciences (2014). [<https://arxiv.org/ftp/arxiv/papers/1408/1408.1125.pdf>]

A. Madsen, **S. B. McKagan**, and E. C. Sayre, “Gender gap on concept inventories in physics: What is consistent, what is inconsistent, and what factors influence the gap?” *Physical Review Special Topics: PER* **9**, 020121 (2013). [<http://dx.doi.org/10.1103/PhysRevSTPER.9.020121>]

R. E. Scherr, H. G. Close, E. W. Close, V. J. Flood, **S. B. McKagan**, A. D. Robertson, L. Seeley, M. C. Wittmann, and S. Vokos, “Negotiating energy dynamics through embodied action in a materially structured environment,” *Physical Review Special Topics: PER* **9**, 020105 (2013).

R. E. Scherr, H. G. Close, **S. B. McKagan**, and S. Vokos, “Representing energy. I. Representing a substance ontology for energy,” *Physical Review Special Topics: PER* **8**, 020114 (2012).

S. B. McKagan, R. E. Scherr, E. W. Close, and H. G. Close, “Criteria for Creating and Categorizing Forms of Energy,” *Proceedings of the Physics Education Research Conference 2011* (2011).

E. W. Close, R. E. Scherr, H. G. Close, and **S. B. McKagan**, “Development of Proximal Formative Assessment Skills in Video-based Teacher Professional Development,” *Proceedings of the Physics Education Research Conference 2011* (2011).

R. E. Scherr, H. G. Close, and **S. B. McKagan**, “Intuitive Ontologies for Energy in Physics,” *Proceedings of the Physics Education Research Conference 2011* (2011).

R. E. Scherr, H. G. Close, and **S. B. McKagan**, “Promoting Proximal Formative Assessment with Relational Discourse,” *Proceedings of the Physics Education Research Conference 2011* (2011).

E. W. Close, H. G. Close, **S. B. McKagan**, and R. E. Scherr, “Energy in action: The construction of ideas in multiple modes,” *Proceedings of the Physics Education Research Conference 2010* (2010).

H. G. Close, L. S. DeWater, E. W. Close, R. E. Scherr, and **S. B. McKagan**, “Using the Algebra Project method to regiment discourse in an energy course for teachers,” *Proceedings of the Physics Education Research Conference 2010* (2010).

R. E. Scherr, H. G. Close, **S. B. McKagan**, and E. W. Close, “‘Energy Theater’: Using the body symbolically to understand energy,” *Proceedings of the Physics Education Research Conference 2010* (2010).

S. B. McKagan, K. K. Perkins, and C. E. Wieman, “Design and validation of the Quantum Mechanics Conceptual Survey,” *Physical Review Special Topics: PER* **6**, 020121 (2010).

S. McKagan, “Laptops and Diesel Generators: Introducing PhET Simulations to Teachers in Uganda,” *The Physics Teacher* **48**, 63 (2010).

L. D. Carr and **S. B. McKagan**, “Graduate Quantum Mechanics Reform,” *American Journal of Physics* **77**, 308 (2009).

S. B. McKagan, W. Handley, K. K. Perkins, and C. E. Wieman, "A Research-Based Curriculum for Teaching the Photoelectric Effect," *American Journal of Physics* **77**, 87 (2009).

S. B. McKagan, K. K. Perkins, and C. E. Wieman, "A deeper look at student learning of quantum mechanics: the case of tunneling," *Physical Review Special Topics: PER* **4**, 020103 (2008).

S. B. McKagan, K. K. Perkins, M. Dubson, C. Malley, S. Reid, R. LeMaster, and C. E. Wieman, "Developing and Researching PhET simulations for Teaching Quantum Mechanics," *American Journal of Physics* **76** 406 (2008).

S. B. McKagan, K. K. Perkins, and C. E. Wieman, "Why we should teach the Bohr model and how to teach it effectively," *Physical Review Special Topics: PER* **4**, 010103 (2008).

W. K. Adams, S. Reid, R. LeMaster, **S. B. McKagan**, K. K. Perkins, and C. E. Wieman, "A Study of Educational Simulations Part II - Interface Design," *Journal of Interactive Learning and Research* **19** 551 (2008).

W. K. Adams, S. Reid, R. LeMaster, **S. B. McKagan**, K. K. Perkins, and C. E. Wieman, "A Study of Educational Simulations Part I - Engagement and Learning," *Journal of Interactive Learning and Research* **19** 397 (2008).

S. B. McKagan, K. K. Perkins, and C. E. Wieman, "Reforming a large lecture modern physics course for engineering majors using a PER-based design." *Proceedings of the Physics Education Research Conference 2006* (2007).

S. B. McKagan and C. E. Wieman, "Exploring Student Understanding of Energy through the Quantum Mechanics Conceptual Survey." *Proceedings of the Physics Education Research Conference 2005* (2006).

S. B. McKagan, D. L. Feder, and W. P. Reinhardt, "Mean-field effects may mimic number squeezing in Bose-Einstein condensates in optical lattices," *Physical Review A* **74**, 013612 (2006).

D. Masiello, **S. B. McKagan**, and W. P. Reinhardt, "Multiconfigurational Hartree-Fock theory for identical bosons in a double well," *Physical Review A* **72**, 063624 (2005).

S. McKinney (now McKagan), "Dynamics of a Bose-Einstein Condensate in an Optical Lattice: Coherence and Fragmentation," *Doctoral Thesis* (2004).

W. P. Reinhardt and **S. B. McKinney** (now McKagan), "Dynamical and Wave Chaos in the Bose-Einstein Condensate," *Physica Scripta* **T90**, 202-211 (2001).

INVITED TALKS

"PhysPort: Supporting Physics Teaching with Research-based Resources," American Association of Physics Teachers National Meeting, College Park, MD, July 2015.

"Introducción a PhysPort: Recursos basados en investigación para mejorar la enseñanza de la física en tu aula y departamento," AAPT-MX, Guanajuato, MX, November 2014.

"Research-based Assessment Resources to Improve Teaching in Your Classroom and Department," American Association of Physics Teachers National Meeting, Minneapolis, MN, July 2014.

"Top 10 results of Physics Education Research that every physics instructor should know," Physics Colloquium, Rochester Institute of Technology, Rochester, NY, June 2013.

"Top 10 results of Physics Education Research that every physics instructor should know," Physics Colloquium, Kansas State University, Manhattan, KS, February 2013.

"Teachers engaging in the production of scientific knowledge: Lessons from the Energy Project," Mathematics Colloquium, Augsburg College, Minneapolis, MN, November 2011.

"Using the PER User's Guide and Adopting/Adapting Course Materials," Integrating Science and Mathematics Education Research into Teaching National Conference, University of Maine, Orono,

June 2010.

“Development of the PER User’s Guide: Identifying key features of research-based teaching methods for effective implementation” Carl Wieman Science Education Initiative, University of British Columbia, May 2010.

“Embodied Learning Activities: Using the body symbolically to solve a physics problem,” University of Maryland, College Park, MD, February 2010.

“Developing and Researching PhET Simulations for Teaching Quantum Mechanics,” University of Washington, Seattle, WA, January 2010.

“Developing and Researching PhET Simulations for Teaching Quantum Mechanics,” Cal Poly Pomona, Pomona, CA, April 2009.

“Student Understanding of Potential Energy Diagrams in Quantum Mechanics,” Colorado School of Mines, Golden, CO, October 2007.

“What every dance teacher should know about education research,” Swing Dance Teachers' Get-together, May 2007.

“Using the methods of science to teach science: Examining student learning of atomic models,” DePaul University, Chicago, IL, February 2007.

“Using the methods of science to teach science: Examining student learning of atomic models,” Evergreen State College, Olympia, WA, February 2007.

WORKSHOPS ORGANIZED

“Explore your assessment data with the PhysPort Data Explorer,” S. McKagan, A. Madsen, E. Sayre, American Association of Physics Teachers National Meeting, Cincinnati, OH, July 2017.

“Introducción a PhysPort: Recursos basados en investigación para mejorar la enseñanza de la física en tu aula y departamento,” S. McKagan, A. Madsen, E. Sayre, AAPT-MX, Guanajuato, MX, November 2014.

“Improving Assessment in your Courses Using Tools from the PER User's Guide,” A. Madsen, S. McKagan, E. Sayre, American Association of Physics Teachers National Meeting, Minneapolis, MN, July 2014.

“Embodied Learning Activities: using bodily experiences to build and share understanding of abstract science concepts,” S. McKagan, H. Close, E. Close, R. Scherr, Integrating Science and Mathematics Education Research into Teaching National Conference, University of Maine, Orono, June 2010.

“PhET Simulations and their Effect on Science Learning,” S. McKagan and M. Dubson, King Saud University, Riyadh, Saudi Arabia, May 2010.

“Introduction to Inquiry-Based Teaching and PhET's Web-Based Interactive Simulations,” Sam McKagan, Pilgrim Inc., Soroti, Uganda, Jan.-Feb. 2008.

“Exploring Easy and Effective Ways to Use PhET’s Web-Based Interactive Simulations,” Kathy Perkins, Wendy Adams, Sam McKagan, and Carl Wieman, AAPT National Meetings, 2006-2007.

“What every dance teacher should know about education research,” S. McKagan, Swing dance teachers get-together, Sacramento, May 2007.

“Multiple Methods of Analyzing Reasoning About Quantum Tunneling,” S. McKagan and M. Wittmann, Physics Education Research Conference 2006.

“Are your students learning the main concepts? Defining learning goals and assessing as you go,” C. Wieman, K. Perkins, S. McKagan, L. Koch, and J. Knight, University of Colorado Faculty Teaching Excellence Program, 2006-2007.

TEACHING EXPERIENCE

University of Colorado, Department of Physics

Boulder, Colorado

Co-Instructor and Curriculum Designer, Modern Physics for Engineering Majors, 2005-2007.

Directed course reform and developed lectures, exam questions, and homework questions for a class of 150-200 students, oversaw hand-off of course material to new professor.

Private Employment

Seattle, Washington

Tutor for Modern Physics, 2004.

Tutored student in modern physics ten hours per week. Helped her address physics anxiety.

Home School Physics Instructor, 2000-2002.

Taught physics class for four children, ages 8-14. Designed and implemented lessons and experiments based on students' interests and learning styles. Topics included gravity, light and color, astronomy, density and buoyancy, and measurement and uncertainty.

University of Washington, Department of Physics

Seattle, Washington

Lecturer, Calculus-Based Introductory Electromagnetism, 2002.

Primary instructor for class of 150 students. Wrote and presented three lectures per week, wrote exams, and assigned homework. Incorporated interactive lecture techniques.

Curriculum Developer and Instructor in Charge of Waves and Optics Labs, January-September 2001.

Revised existing labs and designed new curriculum, wrote manuals to assist TAs in teaching these labs. Primary instructor in charge of labs during summer of 2001, overseeing course administration and supervising TAs.

Organizer and Co-Leader of Reading Courses, 2000-2002.

Organized informal reading courses for graduate students on the interpretation of quantum mechanics and on quantum computation. Wrote syllabus, assigned homework, gave talks, and led discussions.

Teaching Assistant, University of Washington, 1998-2003.

Taught and graded introductory physics labs, tutorials and exams. Led recitation sections.

Instructor, NSF Summer Institute for K-12 Teachers in Physics and Physical Science, 1996.

Instructed in laboratory-based course for K-12 teachers, using method of Physics by Inquiry. Analyzed and evaluated effectiveness of teaching methods.

Barnard College

New York, New York

Peer Tutor, Barnard College Writing Fellows Program, 1995-1998.

Completed training program and tutored peers in academic writing. Hosted peer tutor conferences.

PhET INTERACTIVE COMPUTER SIMULATIONS

Designer, researcher, and curriculum developer for Physics Education Technology Project:

<http://phet.colorado.edu>, 2005-2008.

Lead Designer for the following simulations:

Rutherford Scattering: <https://phet.colorado.edu/en/simulation/rutherford-scattering>

Models of the Hydrogen Atom: <https://phet.colorado.edu/en/simulation/hydrogen-atom>

Stern Gerlach Experiment: <https://phet.colorado.edu/en/simulation/stern-gerlach>

Quantum Bound States: <https://phet.colorado.edu/en/simulation/bound-states>

Quantum Tunneling: <https://phet.colorado.edu/en/simulation/quantum-tunneling>

Quantum Wave Interference: <https://phet.colorado.edu/en/simulation/quantum-wave-interference>

Davisson Germer: Electron Diffraction: <https://phet.colorado.edu/en/simulation/davisson-germer>

Fourier: Making Waves: <https://phet.colorado.edu/en/simulation/fourier>

Optical Quantum Control: <https://phet.colorado.edu/en/simulation/optical-quantum-control>

Member of Design Team for the following simulations:

Lasers: <https://phet.colorado.edu/en/simulation/lasers>

Sarah (Sam) McKagan

Photoelectric Effect: <https://phet.colorado.edu/en/simulation/photoelectric>
Discharge Lamps: <https://phet.colorado.edu/en/simulation/discharge-lamps>
Nuclear Fission: <https://phet.colorado.edu/en/simulation/nuclear-fission>
Simplified MRI: <https://phet.colorado.edu/en/simulation/mri>
Conductivity: <https://phet.colorado.edu/en/simulation/conductivity>
Semiconductors: <https://phet.colorado.edu/en/simulation/semiconductor>

PROFESSIONAL SERVICE AND DEVELOPMENT

Co-Founder and Co-Organizer, Foundations and Frontiers of Physics Education Research: Puget Sound Conference, 2009-2014.

Organized bi-annual conference on physics education research in the northwest region.

Member, Research in Physics Education Committee, 2010-2013.

Planned physics education research activities for American Association of Physics Teachers.

Advisor, Science Education Initiative, 2006-2008.

Served in an advisory role for science teaching fellows who work on course reform at the University of Colorado in departments ranging from Chemistry to Geology.

Co-instructor, physics of trapeze class, 2005-2006.

Worked with the Frequent Flyers, an aerial dance troupe in Boulder, to teach a physics of trapeze class for local high school students.

Graduate Student Representative to 12X Committee, 2002-2004.

Served on committee that oversees policies for introductory physics classes. Participated in textbook review and selection. Researched and wrote proposal for improvements to Physics Study Center.

Founding Member, Physics Graduate Student Council, 2002-2004.

Helped draft letter outlining graduate student concerns that led to major departmental reforms, participated on student council.

Presenter, Expanding Your Horizons Conference, 2002.

Led workshops on at conference to encourage middle school girls to explore science and math.

Mentor, Seattle Girls' School, 2001-2002.

Served as mentor for middle school student and taught dance class for students and mentors.

Co-Organizer, University of Washington Interdisciplinary Graduate Student Symposium, 1998-1999.

Organized and presented at interdisciplinary conference for graduate students.

ADVISEES

Linda Strubbe, postdoctoral researcher, 2018-present.

Remy Dou, postdoctoral researcher, 2017.

Brian Danielak, postdoctoral researcher, 2014-2015.

Adrian Madsen, postdoctoral researcher, 2013-2014.

Hannah Sabo, undergraduate student assistant, 2013-2016.

Clarissa Lovegren, undergraduate student assistant, 2012-2013.

Ward Handley, undergraduate Noyce Fellowship student, 2006-2007.

FELLOWSHIPS AND AWARDS

Fellow of the American Physical Society, 2018.

Homer L. Dodge Award for Distinguished Service to the American Association of Physics Teachers, 2013.

PhET Project, 1st place in Interactive Media Category, NSF Science and Engineering Visualization Challenge, 2007.

American Association of University Women Fellowship, July 2003 - June 2004.

Sarah (Sam) McKagan

American Association of Physics Teachers Outstanding Teaching Assistant Award, 2001.

Baumgartner Fellowship, University of Washington Physics Department, October 1998 - June 1999.

Graduate and Professional Student Senate Distinguished Service Award, 1998-1999.

Grace Potter Rice Fellowship for graduating Barnard senior who shows promise of distinction in natural sciences or mathematics, May 1998. (declined)

Henry A. Boorse Prize for a graduating Barnard senior whose record in physics shows promise of distinction in a scientific career, May 1998.

Dean's List for Academic Excellence, Barnard College, 1994-1997.

REFERENCES

Dr. Adrian Madsen
(Former postoc and now collaborator)
American Association of Physics Teachers
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Professor Carl Wieman
(Postdoctoral advisor)
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Professor William Reinhardt
(Doctoral thesis advisor)
Retired
Santa Fe, NM
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(Collaborator)
329 Cardwell Hall
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(Postdoctoral co-advisor)
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(Collaborator)
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