

N.G. Holmes

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Education

- PhD, Physics 2011-2014
University of British Columbia
Supervisor: Dr. Doug Bonn
Thesis: Structured quantitative inquiry labs: Developing critical thinking in the introductory physics laboratory
- MSc, Physics 2009-2011
University of British Columbia
Supervisor: Dr. Doug Bonn
Thesis: Creating better scientists: Using metacognitive scaffolding and intelligent tutoring systems to improve learning from invention
- BSc, Physics (Hons.) 2005-2009
University of Guelph

Research experience

- Postdoctoral Researcher Jan 2015 - Present
Department of Physics, Stanford University. Designing and testing an instrument to assess critical thinking; designing and evaluating physics and engineering lab curricula and pedagogy; exploring the relationship between lab courses and research experiences. (Supervisor: Dr. Carl E. Wieman)
- PhD Research Assistant Oct 2011 - Dec 2014
University of British Columbia. Developed and evaluated a new physics lab pedagogy for developing students' critical thinking and inquiry behaviours, understanding of measurement and uncertainty, and analytic data handling skills. Used mixed-methods analysis, primarily through coding of student lab books, to compare the effects of the course structure with previous years. (Supervisor: Dr. D.A. Bonn)
- MSc Research Assistant Sept 2009 - Oct 2011
University of British Columbia. Built a computer-based learning environment to deliver Invention Activities to students to develop analytic data handling skills, evaluated the impact of different metacognitive and self-regulated learning scaffolds on student behaviours and learning. (Supervisor: Dr. D.A. Bonn)
- Undergraduate Research Assistant May 2009 - Aug 2009
University of Guelph. Evaluated simulated planetary system evolution using Linux Operating Systems and C code to determine the parameters and processes required to produce Saturn and Jupiter's current positions and masses in our solar system. (Supervisor: Dr. E.Thommes)
- Undergraduate Research Assistant May 2008 - Aug 2008
University of Guelph. Evaluated the calibration of the Alpha-Particle X-ray Spectrometer for the Mars Exploration Rovers and Mars Science Lab, exploring the mineralogic effects on the calibration. (Supervisor: Dr. J.L. (Iain) Campbell)

Teaching experience

- Curricular Development Collaborator April 2015 - May 2015
Stanford University. Redesigned an advanced chemical engineering laboratory course sequence to teach critical thinking and experimentation skills required to characterize, evaluate, optimize, and design an engineered system. Worked with faculty members and graduate teaching assistants in chemical engineering to design

the learning goals, course schedule and structure, laboratory materials (pre-lab activities, lab protocols, and post-lab activities), interactive in-class sessions, and assessment materials.

Course Developer April 2015 - May 2015
Stanford University. Redesigned an introductory physics laboratory course to target learning goals about data and models in physics, including developing new pre-lab and in-lab activities. Trained 5 graduate teaching assistants to facilitate student learning in the lab. Consulted with the lecture course instructor to coordinate physics content goals.

Head Teaching Assistant Sept 2013 - May 2014
University of British Columbia. Developed and delivered course-specific training to the other teaching assistants in the undergrad physics laboratory through weekly training meetings to prepare teaching assistants for each lab session. Also participated in course material development, including preparing peer instruction questions (through Learning Catalytics), pencast videos, Invention activities, and lab experiments.

Physics Laboratory Teaching Assistant Sept 2010 - Dec 2014
University of British Columbia. Facilitated laboratory sections for 48 students in an introductory physics lab course, focusing on data analysis, critical thinking, and experimentation skills. Coordinated and supported student learning through Invention activities, peer instruction (using Learning Catalytics software), and worked examples.

Tutor - First Nations Longhouse Learning Center Oct 2011 - April 2012
University of British Columbia. Provided academic support and tutoring to students taking physics courses to help them plan and complete coursework and reach their academic goals.

Intro to Astronomy Teaching Assistant Sept 2009 - April 2010
University of British Columbia. Facilitated tutorials for 25 students in an astronomy course for non-science majors. Supported student learning through hands-on tutorial activities aimed at developing conceptual understanding and through individual tutoring during office hours.

Major awards and scholarships

Four Year Fellowship	The University of British Columbia	2012
Simons Foundation Doctoral Scholarship	The University of British Columbia	2011
Canadian Graduate Scholarship - Masters	National Sciences and Engineering Research Council	2009
Undergraduate Summer Research Award	National Sciences and Engineering Research Council	2009
Undergraduate Summer Research Award	National Sciences and Engineering Research Council	2008

Peer-reviewed publications

- 14 N.G. Holmes. Developing quantitative critical thinking in the introductory physics laboratory. In A.D. Churukian, D.L. Jones., and Lin Ding, editors, *Physics Education Research Conference 2015*, College Park, MD, July 29-30 2015
- 13 Carl E. Wieman and N.G. Holmes. Measuring the impact of introductory physics labs on learning and critical thinking. In A.D. Churukian, D.L. Jones., and Lin Ding, editors, *Physics Education Research Conference 2015*, College Park, MD, July 29-30 2015
- 12 N.G. Holmes and Carl E. Wieman. Assessing modeling in the lab: Uncertainty and measurement. In M. Eblen-Zayas, E. Behringer, and J. Kozminski, editors, *2015 BFY Proceedings*, College Park, MD, July 22-24 2015
- 11 N.G. Holmes, Carl E. Wieman, and D.A. Bonn. Teaching critical thinking. *PNAS*, 112(36):11199–11204, 2015
- 10 N.G. Holmes and D.A. Bonn. Quantitative Comparisons to Promote Inquiry in the Introductory Physics Lab. *The Physics Teacher*, 53(6):352–355, 2015
- 9 Carl E. Wieman and N.G. Holmes. Measuring the impact of an instructional laboratory on the learning of introductory physics. *American Journal of Physics*, 83(11):972–978, 2015

- 8 N.G. Holmes, Joss Ives, and D.A. Bonn. The impact of targeting scientific reasoning on student attitudes about experimental physics. In *Physics Education Research Conference 2014*, pages 119–122, Minneapolis, MN, July 30-31 2015
- 7 N.G. Holmes, Ido Roll, and D.A. Bonn. Participating in the physics lab: Does gender matter? *Physics in Canada*, 70(2):84, 2014
- 6 N.G. Holmes, James Day, Anthony H.K. Park, D.A. Bonn, and Ido Roll. Making the failure more productive: Scaffolding the invention process to improve inquiry behaviours and outcomes in productive failure activities. *Instructional Science*, 42(4):523–538, 2014
- 5 N.G. Holmes and D.A. Bonn. Doing science or doing a lab? engaging students with scientific reasoning during physics lab experiments. In P. V. Engelhardt, A. D. Churukian, and D. L. Jones., editors, *Physics Education Research Conference 2013*, pages 185–188, Portland, Or, July 17-18 2013
- 4 James Day, N.G. Holmes, Ido Roll, and D.A. Bonn. Finding evidence of transfer with invention activities: Teaching the concept of weighted average. In P. V. Engelhardt, A.D. Churukian, and D.L. Jones., editors, *Physics Education Research Conference 2013*, pages 117–120, Portland, OR, July 17-18 2013
- 3 N.G. Holmes, Matthew "Sandy" Martinuk, Joss Ives, and Mya Warren. Teaching assistant professional development by and for tas. *The Physics Teacher*, 51(4):218, 2013
- 2 Ido Roll, N.G. Holmes, James Day, and D.A. Bonn. Evaluating metacognitive scaffolding in guided invention activities. *Instructional Science*, 40(4):691–710, 2012
- 1 J.L. Campbell, M. Lee, B.N. Jones, S.M. Andrushenko, N.G. Holmes, J.A. Maxwell, and S.M. Taylor. A fundamental parameters approach to calibration of the mars exploration rover alpha particle x-ray spectrometer. *Journal of Geophysical Research*, 114:E04006, 2009

Publications in preparation

- 18 James Day, Jared Stang, N.G. Holmes, Dhaneesh Kumar, and D.A. Bonn. Gender gaps and gendered action in a first-year physics laboratory. (Accepted to Phys. Rev. ST-PER)
- 17 N.G. Holmes, Dhaneesh Kumar, and D.A. Bonn. Reasoning with tools: Inferentialism and critical thinking in undergraduate physics labs. (Submitted)
- 16 N.G. Holmes and Carl E. Wieman. Scaffolding experimentation: from cookbook labs to authentic research. (In preparation)
- 15 N.G. Holmes, Victoria Nguyen, and Carl E. Wieman. Teaching critical thinking in upper division chemical engineering. (In preparation)

Other publications

- 21 N.G. Holmes. *Structured Quantitative Inquiry Labs: Developing critical thinking in the introductory physics laboratory*. PhD thesis, University of British Columbia, Vancouver, BC, December 2014
- 20 Marjorie Gonzalez, Gabrielle Hodgson, N.G. Holmes, Chloe Malbrunot, Andrea Marshall, Janis McKenna, Trisha Roberson, and Tanya Roussy. Report on the second women in physics canada conference. *Physics in Canada*, 69(2):116–118, 2013
- 19 Natasha Holmes. The invention support environment: using metacognitive scaffolding and interactive learning environments to improve learning from invention. Master's thesis, University of British Columbia, Vancouver, 2011

Invited talks

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| 20 | Re-thinking intro physics labs: Teaching and assessing critical thinking
Department of Physics and Astronomy, University of New Mexico | Feb 2016 |
| 19 | Re-thinking intro physics labs: Teaching and assessing critical thinking
Physics Department, New Mexico Inst. of Mining and Technology | Feb 2016 |
| 18 | Re-thinking intro physics labs: Teaching and assessing critical thinking
Physics Colloquium Series, Department of Physics, New Mexico State University | Feb 2016 |

17	Re-thinking intro physics labs: Teaching and assessing critical thinking Department of Physics, Kansas State University	Feb 2016
16	Re-thinking intro physics labs: Teaching and assessing critical thinking Department of Physics and Science, Math, and Technology Education Program, Western Washington University	Feb 2016
15	Re-thinking intro physics labs: Teaching and assessing critical thinking Physics Colloquium, Department of Physics, University of Washington	Jan 2016
14	Re-thinking intro physics labs: Teaching and assessing critical thinking Physics Colloquium & Centre for Science Education, Aarhus Universitet, Aarhus, Denmark	Nov 2015
13	Developing & assessing quantitative critical thinking in the introductory physics laboratory Physics Education Research Seminar, University of Illinois - Urbana-Champaign, Champaign, IL	Oct 2015
12	Developing & assessing quantitative critical thinking in the introductory physics laboratory Physics Department Colloquium, University of Guelph, Guelph, ON	Oct 2015
11	Developing quantitative critical thinking in the introductory physics laboratory Plenary Speaker - Physics Education Research Conference, Baltimore, MD	July 2015
10	Developing quantitative critical thinking in the introductory physics laboratory Physics Education Research Group Presentation, University of Colorado - Boulder, Boulder, CO	June 2015
9	Throwing away the cookbook: Teaching & assessing experimentation skills in the intro science lab SJSU Science Education Seminar, San Jose State University, San Jose, CA	Feb 2015
8	Making comparisons: a strategy for teaching scientific reasoning in first year physics labs Department of Chemistry, University of British Columbia, Vancouver, BC	Dec 2014
7	Structured quantitative inquiry labs: developing critical thinking in the intro lab Simon Fraser University, Burnaby, BC	Sept 2014
6	Techniques for teaching critical thinking in a first year physics laboratory Stanford University, Stanford, CA	May 2014
5	Techniques for teaching critical thinking in a first year physics laboratory Physics and Astronomy Education Research Seminar, University of British Columbia, Vancouver, BC	May 2014
4	Techniques for teaching critical thinking in a first year physics laboratory Western Washington University, Bellingham, WA	Apr 2014
3	Student's t as a new epistemological framework for teaching measurement and uncertainty Department of Statistics Seminar, University of British Columbia, Vancouver, BC	Feb 2014
2	How do we get students to reflect and iterate? Physics Education Group Seminar, University of Washington, Seattle, WA	Jan 2014
1	Getting students to reflect or think in the lab Physics Education Group Seminar, Seattle Pacific University, Seattle, WA	Jan 2014

Media recognition

Sharing Science interview (2015, September 23). Science Education Research. *Interview with Sharing Science on CiTR radio*. Archive online at <http://www.citr.ca/radio/sharing-science/episode/20150923>

Choi, C.Q. (2015, August 17). How lab courses can teach more than science. *Inside Science*. Retrieved from <http://www.insidescience.org/content/how-lab-courses-can-teach-more-science/3126>

Balma, C. (2015, August 17). UBC physics class drops 'by-rote' experiments to boost critical thinking. *UBC Science*. Retrieved from <http://http://science.ubc.ca/news/ubc-physics-class-drops-'rote'-experiments-boost-critical-thinking>

Carey, B. (2015, August 17). Stanford research shows how to improve students' critical thinking about scientific evidence. *Stanford News*. Retrieved from <http://http://news.stanford.edu/news/2015/august/thinking-holmes-wieman-081715.html>

Flaherty, C. (2015, August 18). Teaching long-term critical thinking. *Inside Higher Ed*. Retrieved from <https://www.insidehighered.com/quicktakes/2015/08/18/teaching-long-term-critical-thinking>

Johnson, S.K. (2015, August 18). A successful strategy to get college students thinking critically. *ars technica*. Retrieved from <http://arstechnica.com/science/2015/08/a-successful-strategy-to-get-college-students-thinking-critically/>

Ellerton, P. (2015, August 18). Teaching how to think is just as important as teaching anything else. *The Conversation*. Retrieved from <http://theconversation.com/teaching-how-to-think-is-just-as-important-as-teaching-anything-else-46073>

Beekhuis, D.M. (2015, August 19). Hoe je studenten 12 keer beter kritisch leert nadenken [How students learn 12 times better with critical thinking]. *BNR Nieuwsradio*. Retrieved from <http://www.bnr.nl/radio/bnr-spitsuur/wetenschap-vandaag/326773-1508/hoje-studenten-12-keer-beter-kritisch-leert-nadenken>

Chandler, L. (2015, August 22). Study: There are instructions for teaching critical thinking. *big think*. Retrieved from <http://bigthink.com/ideafeed/can-you-be-taught-how-to-think-better>

Moura, P. (2015, September 4). Cientistas desenvolvem modelo para ajudar alunos a pensar de forma critica [Scientists develop model to help students to think critically]. *Universo On Line*. Retrieved from <http://noticias.uol.com.br/ciencia/ultimas-noticias/redacao/2015/09/04/cientistas-desenvolvem-modelo-para-ajudar-alunos-a-pensar-de-forma-critica.htm>

Other professional activities

Committees

Physics Education Research Local Organizing Committee Member January 2015 - present

Elected member of PERLOC, a team of 8 elected members who serve as the representative body for community decision-making with the PER Topical Group within the American Association of Physics Teachers.

Reviewer

Physical Review Special Topics: Physics Education Research December 2014 - present

The Physics Teacher August 2015 - present

The American Journal of Physics September 2015 - present

Workshop coordination and facilitation

American Association of Physics Teachers July 2015

Developed and facilitation a workshop for physics faculty and instructors about teaching and learning in introductory physics lab courses.

Office of the Vice Provost for Teaching and Learning April 2015

Stanford University. Developed and facilitated a workshop for graduate teaching assistants across various disciplines about teaching with effective questions.

Program Coordinator - Teaching Assistant Professional Development March 2010 - May 2012

University of British Columbia. Developed modules for training new TAs during a core training workshop, facilitated Mentor TA and Course-Specific training programs, applied for funding from UBC TA Training program for a \$25,000 budget, coordinated a hiring process for new mentors and facilitators.

Conference organization

Women in Physics Canada Conference (Organizer) August 2011 - August 2012

University of British Columbia. Volunteered as a conference organizer, awarding travel grant to students, developing and organizing the conference program, inviting speakers, booking presentation rooms, coordinating accommodations for participants, and planning a conference banquet.

STEM Conference (Volunteer) July 2014

University of British Columbia. Assisted conference organizers in pre-conference set up and with registering participants and running information booths during the conference.

Science outreach activities

Executive Coordinator - Let's Talk Science September 2012 - September 2014

University of British Columbia. Coordinated a team of 7 assistant coordinators and over 300 active volunteers to deliver hands-on, minds-on science activities to over 10,000 children and youth from across BC and the Yukon each year. Awarded runner-up for national Let's Talk Science Coordinator of the Year award.

Stanford Splash! April 2015

Stanford University. Co-organized and delivered a hands-on astronomy workshop to youth about understanding the scale of the solar system.

Physics and Astronomy Outreach Program September 2009 - December 2014

University of British Columbia. Participated in numerous outreach events, including the Experience Science Day and Physics Olympics each year, delivering hands-on physics activities and demonstrations to youth.

Let's Talk Science September 2009 - April 2012

University of British Columbia. Delivered hands-on, minds-on science, technology, engineering, and math activities to youth across British Columbia through classroom visits, community events, and trips to rural and remote communities.

Creative Encounters with Science May 2006 - June 2009

University of Guelph. Developed and delivered science, technology, and engineering activities to youth through classroom workshops, community events, and week-long summer day camps. Also participated in outreach to rural and remote communities, aboriginal communities, and programs for girls in science.

Contributed conference presentations

Talks

Student's t as a new epistemological framework for teaching measurement and uncertainty July 2014

American Association of Physics Teachers Summer Meeting, Minneapolis, MN

A case for integrating peer instruction and Learning Catalytics in the introductory physics lab July 2014

Science, Technology, Engineering, and Math in Education Conference, Vancouver, BC

Techniques for teaching critical thinking in a first year physics laboratory May 2014

American Physical Society - North West Division Meeting, Seattle, WA

Reflection and evaluation in physics labs: Can it be done? July 2013

American Association of Physics Teachers Summer Meeting, Portland, OR

Developing analysis skills through invention May 2013

Canadian Association of Physicists Congress, Montreal, QC

The Invention Support Environment: The effect of task structure on student reasoning during invention activities Apr 2013

American Educational Research Association Annual Meeting, San Francisco, CA

Developing analysis skills through invention Oct 2012

American Association of Physics Teachers Washington Section Meeting, Bellingham, WA

Developing analysis skills through invention Aug 2012

Women in Physics Canada, Vancouver, BC

Developing analysis skills through invention July 2012

American Association of Physics Teachers Summer Meeting, Philadelphia, PA

The Invention Lab: Helping students become better scientists Women in Physics Canada, Waterloo, ON	July 2011
Posters	
Measuring the impact of introductory physics labs on the learning Physics Education Research Conference, College Park, MD	July 2015
What Are Students Learning In Your Lab Class? A New Tool to Find Out American Association of Physics Teachers Summer Meeting, College Park, MD	July 2015
Assessing modeling behaviors in the lab Beyond First Labs Conference II, College Park, MD	July 2015
A new instrument to assess modeling in the lab Foundations & Frontiers in Physics Education Research Conference, Bar Harbor, ME	June 2015
The impact of targeted learning goals on student attitudes about experimental physics Physics Education Research Conference, Minneapolis, MN	July 2014
Using Student's <i>t</i> -scores to teach measurement, uncertainty, and experimentation skills American Association of Physics Teachers Summer Meeting, Minneapolis, MN	July 2014
Doing science or doing a lab? Engaging students with scientific reasoning during physics lab experiments Physics Education Research Conference, Portland, OR	July 2013
The Invention Support Environment: Where do we go from here? Foundations and Frontiers in Physics Education Research – Puget Sound, Burlington, WA	June 2012
On guided invention activities that support scientific reasoning and domain learning Foundations and Frontiers in Physics Education Research – Puget Sound, Olympic Peninsula, WA	Mar 2011
Examining invention task support to improve student acquisition of scientific reasoning skills inter-Science of Learning Center Conference, Boston University, Boston, MA	May 2010

Other awards and scholarships

Graduate Entrance Scholarship	2009
Faculty of Science Graduate Award	2009
College of Physical and Engineering Sciences Society of Excellence	2009
E.B. McNaughton Scholarship	2008
College of Physical and Engineering Sciences Dean's Honours List Scholarship	2008,2007,2006
Copernicus Scholarship	2007
Undergraduate Entrance Scholarship	2005

Professional references

Dr. Carl Wieman (current postdoc advisor), Professor, Physics Department and Graduate School of Education
Stanford University, 382 Via Pueblo Mall, Stanford University, Stanford, CA 94305-4060
Email: cwieman@stanford.edu; Phone: 650-497-3491

Dr. Douglas Bonn (PhD advisor), Professor, Department of Physics and Astronomy
University of British Columbia, 6224 Agricultural Road, Vancouver, BC, V6T 1Z1 Canada
Email: bonn@phas.ubc.ca; Phone: 604-822-1997

Dr. Heather Lewandowski (Collaborator), Associate Professor, Physics Department and Fellow, JILA
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