PICUP

PARTNERSHIP FOR INTEGRATION OF COMPUTATION INTO UNDERGRADUATE PHYSICS

EXERCISE SETS, FACULTY COMMONS, AND RESOURCES OF THE PICUP WEBSITE

Todd Zimmerman
University of Wisconsin – Stout

Summer AAPT Meeting
July 12, 2022

Link to slides

Mission of PICUP

- Lower the barriers to integrating computation into classes
  - *Community*
  - *Training*
  - *Resources*

Computation in Physics - Definition

Having students work with simulations and/or algorithms, giving students pieces of code to complete on their own, and/or advising students on undergraduate research projects where they write code from scratch[1]

1. Caballero, Marcos D., and Laura Merner. "Prevalence and nature of computational instruction in undergraduate physics programs across the United States." *Physical Review Physics Education Research* 14.2 (2018): 020129.

A Brief History

- 2006 – Shodor Visioning Workshop – PICUP is born
- 2006 - Special issue on computation in physics in Computing in Science and Engineering
  - Fuller – "Numerical Computations in US Undergraduate Physics Courses"[1]
- 2008 – "Integrating computation into the undergraduate curriculum: A vision and guidelines for future developments"[2]
  - *AJP article by Chonacky and Winch*
- 2011-2013 – Development workshops
- 2013 – Present Workshops at various conferences
- 2015 – Two NSF proposals for PICUP funded
  - *M.D. Caballero, K. Roos, L. Engelhardt, M. Lopez, R. Hilborn, N. Chonacky*
- 2016 - First Faculty Development Workshop
  - *gopicup.org*
- 2018 – "On the Prevalence and Nature of Computational Instruction in Undergraduate Physics Programs across the United States"[3]
- 2020 First virtual workshop

Numerical Computations in US Undergraduate Physics Courses[1]

- Survey for faculty on importance and use of computation (N=187)
- Large fraction thought computation important
- <20% included computation in grades

1) Fuller, Robert G. "Numerical computations in US undergraduate physics courses." *Computing in science & engineering* 8.5 (2006): 16-21.

PICUP

On the Prevalence and Nature of Computational Instruction in Undergraduate Physics Programs across the United States[1]

- Response: 357 departments and 1246 faculty
- >50% of departments have 1 faculty teaching computation in intro and upper level courses
- >25% of departments have ½ of faculty teaching computation in intro and upper level courses

Related paper on barriers[2]

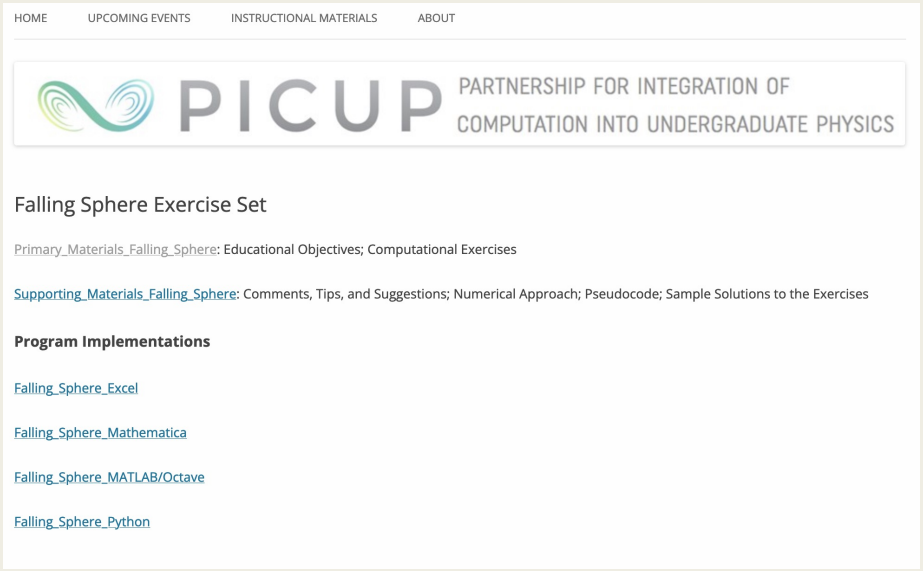
1. Caballero, Marcos D., and Laura Merner. "Prevalence and nature of computational instruction in undergraduate physics programs across the United States." *Physical Review Physics Education Research* 14.2 (2018): 020129.
2. Leary, Ashleigh, Irving, Paul W., and Caballero, Marcos D. The difficulties associated with integrating computation into undergraduate physics. *Proceedings of the Physics Education Research Conference* (2018).

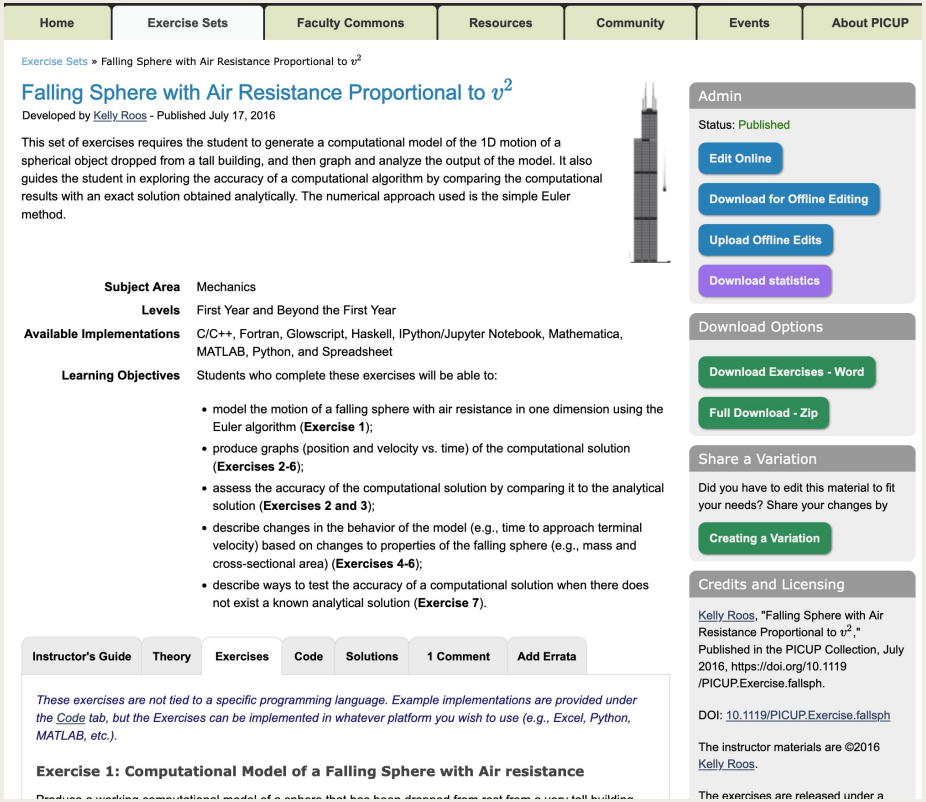
PICUP

- Website:
  - *Exercise Sets*
  - *Faculty Commons*
  - *Resources Tab*
  - *Community and Events*
- Training:
  - *FDW*
  - *Regional Workshops*
  - *Virtual Workshops*
  - *Site Visits*
  - *Webinars*
- Community
  - *Webinars and Workshops*
  - *Slack Channel*

PICUP

- Website:
  - *Exercise Sets*
    - Peer-reviewed activities
  - *Faculty Commons*
    - All other curricular material
  - *Resources Tab*
    - Tips and best practices
  - *Community and Events*
    - Stay connected, get help





Then and Now

Old site: https://picupsite.wordpress.com/

Exercise Sets (ES)

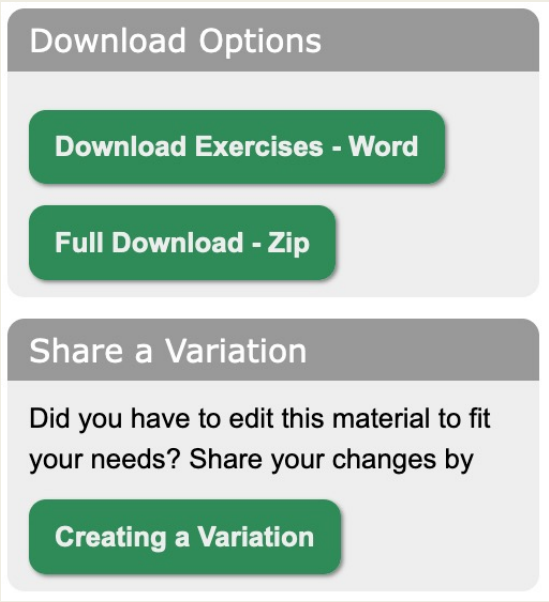
- An Exercise Set is a set of peer-reviewed material that contains the following:
  - *A brief description of the physics and computation*
  - *A list of learning objectives for the set*
  - *An instructor's guide and theory section for background*
  - *A series of activities and questions (the exercises)*
  - *Code template and solutions in at least one programming language*
  - *Solutions*
- All Exercise Sets are peer-reviewed through semi-automated process
  - *Collaborative peer-review*

Peer Review

- Emails auto-generated
- Due dates/reminder emails handled by server

1. Author submits Exercise Set (ES) material
2. Editor take responsibility for ES
3. Editor emails potential reviewers
4. Reviewers submit reviews
5. Editor contacts author for possible changes
6. Author submits changes
7. Published!

Why are ES special?



- Complete package
- Easy to download and modify
- Can upload variants
- Language agnostic
  - *Templates and solutions available in one or more platforms*
- Peer-reviewed

Multiple authors, non-faculty authors

Study of rectilinear motion with a smartphone: Elevators and Slides

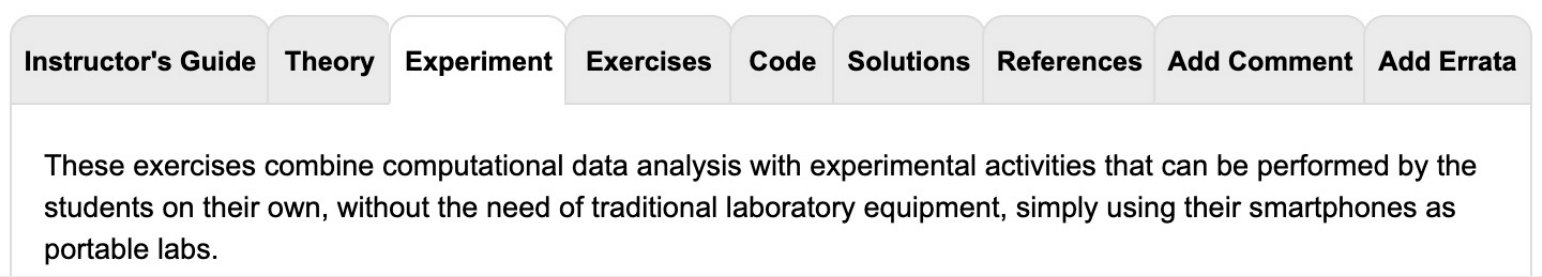
Developed by Amador García Fuente, María Rita Sierra Sánchez, Maria Velez, and Maria Rosario Diaz Crespo - Published May 21, 2018

- Exercise sets can now have multiple authors

- Students can be included as authors
  - *Select "Non-Faculty Verification" on Registration page*

Experiments

- Exercise sets can combine experiments with computation



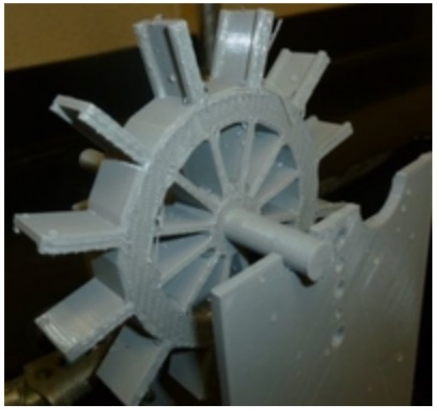
3D Printing

- Can find 3D files under Additional Resources on the Code tab

Efficiency of a Water Turbine (3D Printing Lab)

Developed by Deva O'Neil, Benjamin Hancock, and Benjamin Hanks - Published June 7, 2021

This Exercise Set describes one way to incorporate 3D printing into lab sessions in Physics I: Students design and print a water-wheel, and measure its efficiency in lifting a load. An optional exercise at the end uses video analysis to verify that the system is approximately in equilibrium for almost all of the lift process. Concepts applied include power, energy, and efficiency.

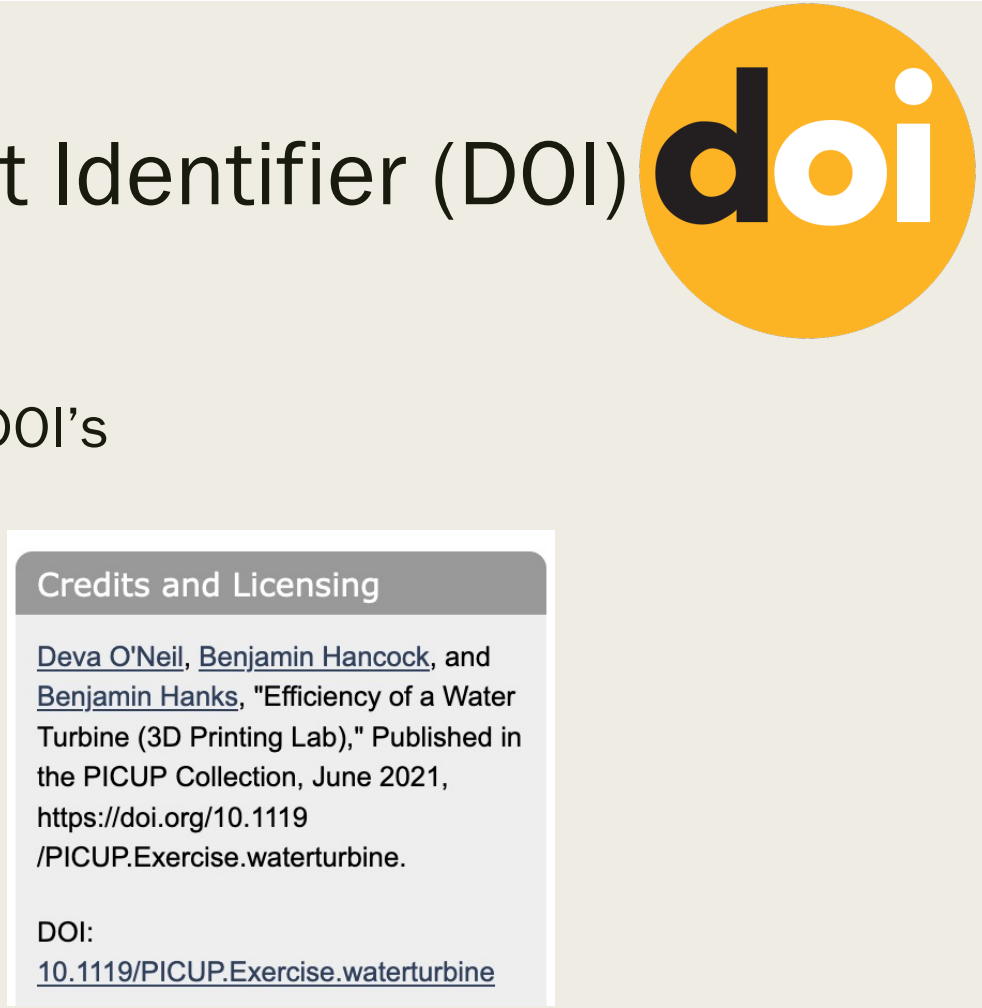


Errata Tab

- You can point out errors in ES

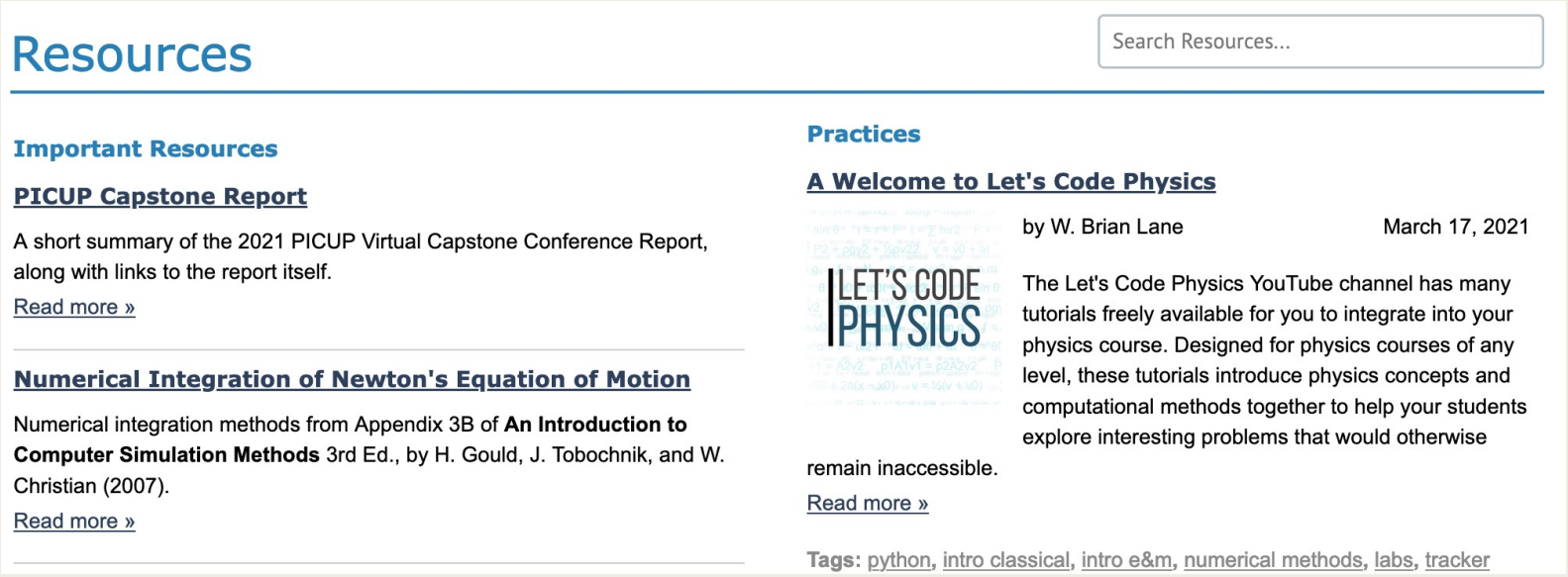
Digital Object Identifier (DOI)

- All ES now have DOI's



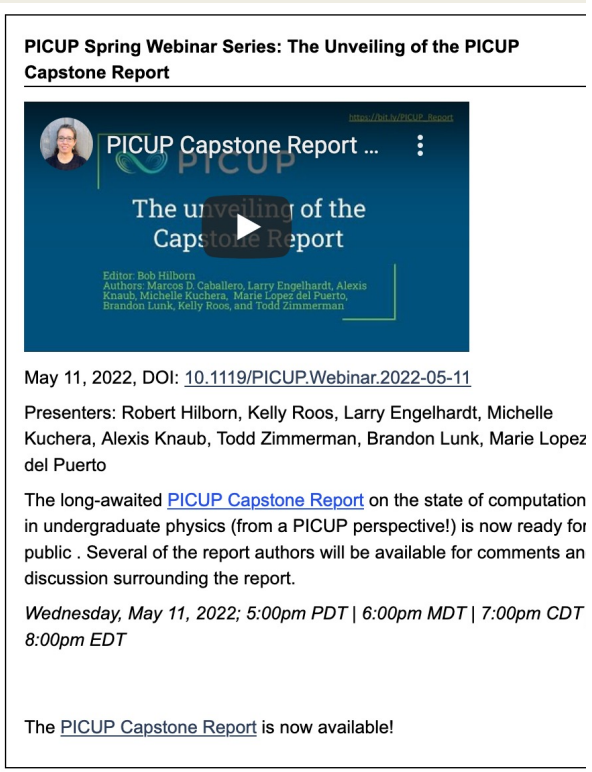
Resources Tab

- Important Resources
- Practices



Community Tab

- Collection of previous PICUP Webinar Series
- Now include DOIs



PICUP Spring Webinar Series: The Unveiling of the PICUP Capstone Report

May 11, 2022, DOI: 10.1119/PICUP.Webinar.2022-05-11

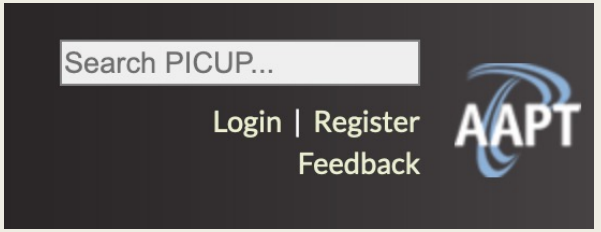
Presenters: Robert Hilborn, Kelly Roos, Larry Engelhardt, Michelle Kuchera, Alexis Knaub, Todd Zimmerman, Brandon Lunk, Marie Lopez del Puerto

The long-awaited PICUP Capstone Report on the state of computation in undergraduate physics (from a PICUP perspective!) is now ready for public . Several of the report authors will be available for comments an discussion surrounding the report.

Wednesday, May 11, 2022; 5:00pm PDT | 6:00pm MDT | 7:00pm CDT 8:00pm EDT

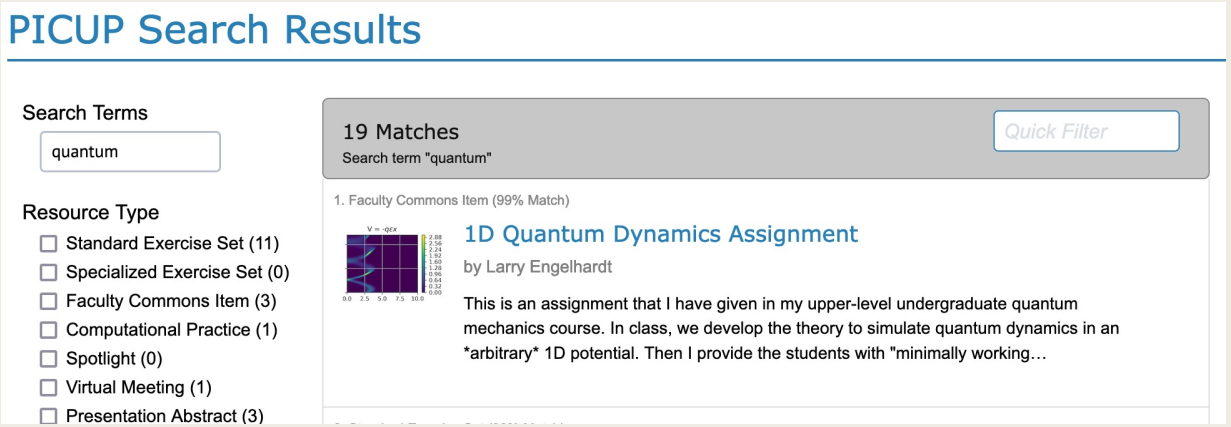
The PICUP Capstone Report is now available!

Site-Wide Searching



PICUP

- You can search:
  - *Exercise Sets*
  - *Faculty Commons*
  - *Resources*
  - *Webinar abstracts*
  - *Conference abstracts*



Workshop!

- Summer 2022 Virtual Workshop
  - *Aug 2-4*
  - *Sign up by July 19*
    - Go to Events Tab

PICUP

What can you do?

- Submit Exercise Sets
- Share activities in Faculty Commons
- Write posts for Resources
- Stay connected with the community

ES Needs[1]

- EJS
- C++
- PhET-style simulations
- High-school material
- Upper-level material
- Condensed Matter Physics
- High Energy/Particle Physics
- Biophysics
- Chemical/Molecular Physics

1) Lane, W. Brian. "Analysis of the PICUP Collection: Strengths and Areas for Development." *arXiv preprint arXiv:2103.02408* (2021).

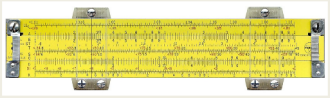
A Short History of Computation

PICUP

- Hand-written math: ~ 3000 BCE - …

- Logarithm Tables: 1614 to ?

- Slide Rules: 1620 to 1975



- Handheld Calculator: 1972 - …

- Personal Computer: 1977 – …

- Python: 1989 - …

Thank You

- Resource Development: Lyle Barbato, Kelly Roos, Larry Engelhardt
- Other PICUP Leadership: Marie Lopez del Puerto, Danny Caballero, Robert Hilborn, and Norman Chonacky
- Evaluator: Alexis Knaub
- PICUP Associate Editors and Reviewers
- You, the PICUP community

Link to slides

- Thank you to the UW-Stout Chancellor, STEMM Dean, and Department of Chemistry and Physics Chair for funding

Links

PICUP

PARTNERSHIP FOR INTEGRATION OF COMPUTATION INTO UNDERGRADUATE PHYSICS

PICUP

- Shodor Visioning Workshop
- Computing in Science and Engineering Special Issue on Physics Computation
- Fuller, Robert G. "Numerical computations in US undergraduate physics courses." *Computing in science & engineering* 8.5 (2006): 16-21.
- Caballero, Marcos D., and Laura Merner. "Prevalence and nature of computational instruction in undergraduate physics programs across the United States." *Physical Review Physics Education Research* 14.2 (2018): 020129.
- Leary, Ashleigh, Irving, Paul W., and Caballero, Marcos D. The difficulties associated with integrating computation into undergraduate physics. *Proceedings of the Physics Education Research Conference* (2018).