Physics for Engineering Majors
There are 6 in-class mechanics activities that implement the Euler-Cromer method using Glowscript.

There are 8 in-class electromagnetism activities that implement numerical superposition and the Euler-Cromer method using Glowscript.

1. Modeling constant velocity
2. Modeling constant force
3. **Modeling the non-constant force**
4. Modeling energy exchanges
5. Modeling particle collisions
6. Modeling particle collisions with rotation

1. Modeling point charges
2. Modeling lines of charge
3. Modeling sheets of charge
4. Modeling charges moving in external electric fields
5. Modeling charges moving in external magnetic fields
6. **Modeling mass spectrometry**
7. Modeling a solenoid
8. Modeling E&M waves

Mechanics course: Irving, Obsniuk, Caballero, EJP, 2017

Course materials: msuperl.org
A Falling Sphere with Air Resistance

Keep in mind:
- What concepts are reinforced with this activity?
- What new physics would students learn?
- Where might students struggle?
- How would you adapt/adopt this activity for your class?
- What are your goals for incorporation computational activities in your class?

Using Glowscript and Trinket
Computation Implementation Space (CIS)

- Using available simulations.
- Producing Pseudocode.
- Modifying working programs.
- Writing code from scratch.
- Modifying minimally working programs.

• with computational instruction happening in the classroom/laboratory or in a flipped classroom model (online videos or tutorials).
Integrating Computation into Undergraduate Physics: Benefits and Challenges

What skills and knowledge should the next generation of undergraduate physics degree holders possess to be well prepared for a diverse set of careers?

J-TUPP task force, 2014-2016
https://www.compadre.org/JTUPP/
J-TUPP

Joint Task Force on Undergraduate Physics Programs

Convened by the APS and the AAPT

https://www.compadre.org/JTUPP/
Knowledge and Skills Regularly Used by Physics Bachelors Employed in the Private Sector, Classes of 2013 & 2014 Combined

Percent Regularly Using Knowledge or Skill

- Solve Technical Problems
- Work on a Team
- Perform Quality Control
- Technical Writing
- Use Specialized Equip.
- Manage Projects
- Knowledge of Phys. or Ast.
- Science/Technology
- Programming
- Work with Customers
- Advanced Math
- Simulation or Modeling
- Analyze People
- Manage Budgets

Percentages represent the physics bachelors who chose "daily," "weekly," or "monthly" on a four-point scale that also included "never or rarely."

Figure based on the responses of 287 physics bachelors employed in private sector engineering positions and 215 physics bachelors employed in private sector computer science positions.

www.aip.org/statistics
What skills and knowledge should the next generation of undergraduate physics degree holders possess to be well prepared for a diverse set of careers?


Benefits:

- Students develop skills that are necessary in private sector jobs and in graduate school\(^1\).

- Computational homework and projects that are more closely connected to how professional physicists engage with their own work, excite students, and might help retain [physics] majors by providing enjoyable experiences\(^2\).
  - Allow open-ended questions.
  - Foment creative thinking.
  - Encourage collaboration.

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• Enhance content coverage with little or no loss.

• Enhance conceptual understanding by allowing students to play around in "parameter space" and to visualize system behavior.

Develop better prepared students.
Challenges:

“Computational physics does not yield instant gratification as is found in many other computer applications.”

Dancy and Henderson* have listed the most salient barriers to changes in Physics instruction:

- Student Resistance
- Time Structure
- Departmental Norms
- Expectations of Content Coverage
- Lack of Instructor Time

A. Replicated results in computation context*:

- **Student Resistance**: [students] are rejecting learning something new, and activities they think do not belong in a physics class.
- **Time Structure**: semesters are the same fixed length.
- **Expectations of Content Coverage**: was not as prevalent in the context of computation.
- **Time of Instructors**: The time of instructors is still valuable and the things that preoccupy them are still the same (e.g. large teaching loads and research).

B. New systemic forces for computation context:

- **Lack of Instructor Knowledge**:
  - Lack of experience with coding.
  - Do not know how to design activities for students that are just learning.
- **Accessible Platform**: Choosing a platform.

Post-workshop support:

Virtual: PICUP
   gopicup@googlegroups.com
   gopicup.slack.com

Get your colleagues involved!
Summer Faculty Development Workshop
July 8-14, 2019
U. of Wisconsin - River Falls
Apply at www.gopicup.org

APS April Meeting 2019
Calling all physics teachers: It is time to integrate computation into your courses!
Day and Time: Sunday, April 14 @ 3:30pm
Room: Sheraton Governor's Square 15

PICUP Workshop at Kansas State University
Integrating Computation into Undergraduate Physics with Python
Day and Time: Saturday, April 27 @ 8:30am-4:00pm

AAPT Summer Meeting 2019
(Provo UT, July 20-24, 2019)
Workshops:
W15: PICUP: Integrating Computation into Introductory Physics
Day and Time: Saturday, July 20 @ 1:00-5:00pm

W33: PICUP: Integrating Computation into Upper-Level Physics
Day and Time: Sunday, July 21 @ 8:00am-12:00pm