Teaching with Open Source Physics Curricular Material

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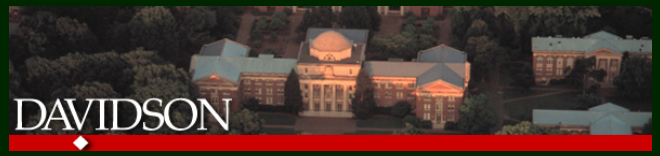


Teaching with Technology

Current technologies allow physics educators the ability to integrate instruction with computer-based modeling. This talk describes technologies that encourage interactive-engagement and limit the amount of programming when designing, implementing, distributing, and using computer models. It is based on:

- **Tracker** video analysis and modeling tool analyzes video clips. Students can both analyze the motion of objects and overlay simple dynamical models on the video and see how well the model matches the real-world.

- **Easy Java/JavaScript Simulations** (EjsS) creates interactive simulations in Java or JavaScript simulations without the necessity of prior programming knowledge.

- **OSP ComPADRE Digital Library** archives and distributes curriculum resources, such as **Physlets** and EjsS simulations, that engage students in physics, computation, and computer modeling.

Need for Digital Libraries

A Google search for "***pendulum***" returns 27,100,000 pages; while "***pendulum simulation***" returns 11,900 pages (The search for ***pendulum simulation*** without the quotes returns 449,000 pages).

- Most of the simulations (or animations that "fake" the physics) are inappropriate for teaching.
- There is usually no instructional material, no support materials for teachers, and no information about how these materials are correlated to state or national science standards.
- Most of these simulations also support a passive (viewing) pedagogy versus an active (interacting) pedagogy.

In order to be effective for instruction, simulations need to be easy to find, simple, adoptable, adaptable, and coupled with support content for students and teachers.

ComPADRE

We are out of the business of web hosting and let the experts do it.

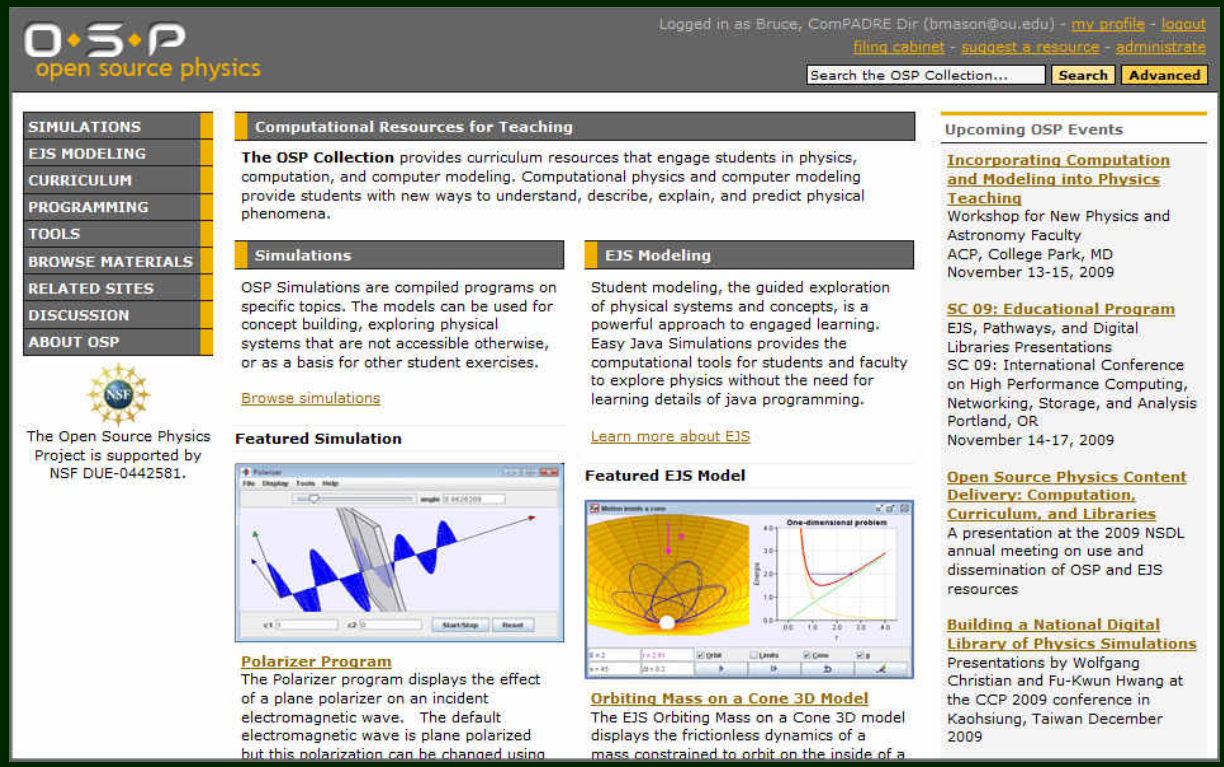
Standard and Custom Library and Web Services

Connections to Users and NSDL

600+ Java Sims
150+ JavaScript Sims
1200+ Physlet Pages

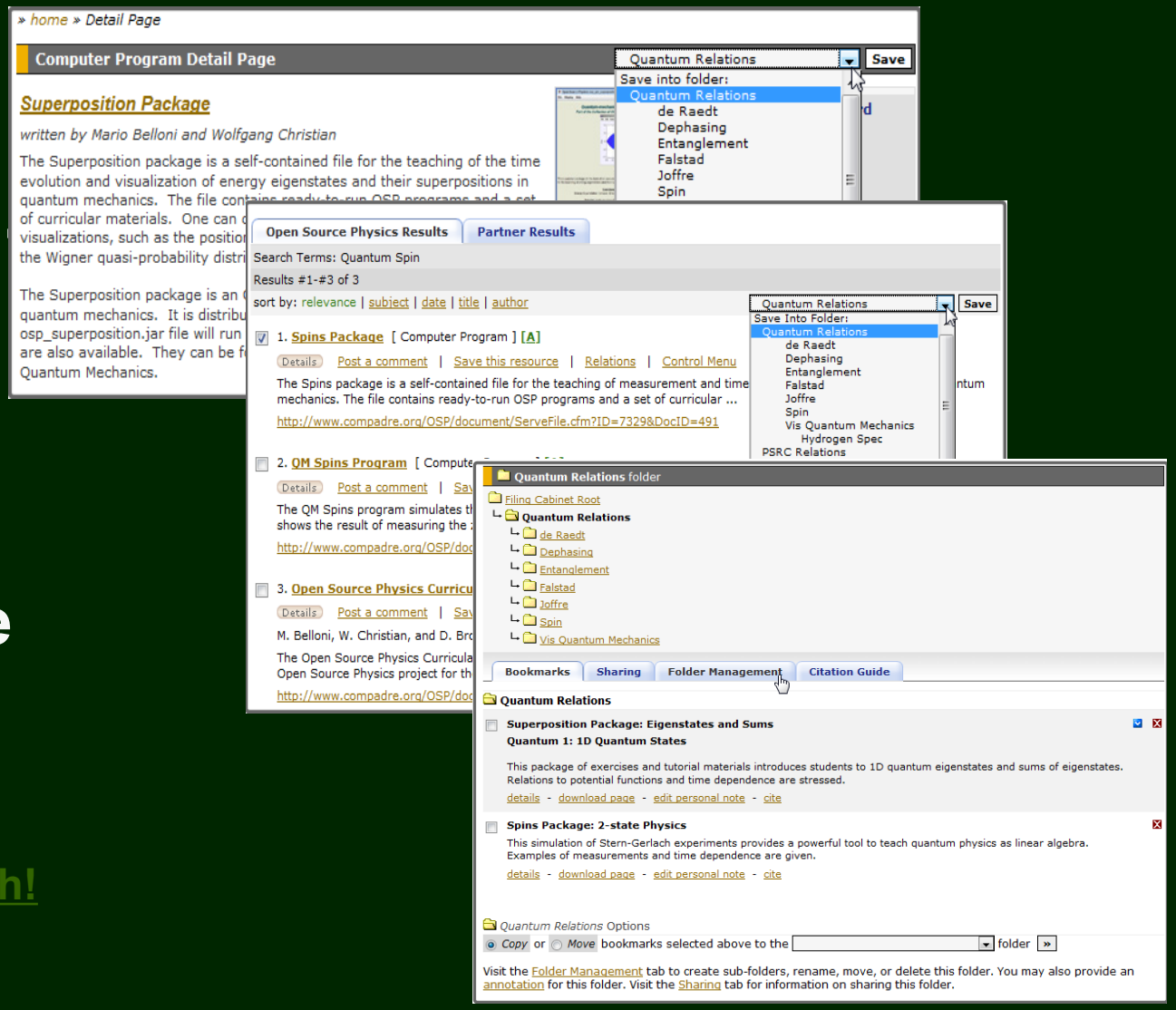
10,000+ visitors/month

5,000+ simulation downloads/month



Personalization

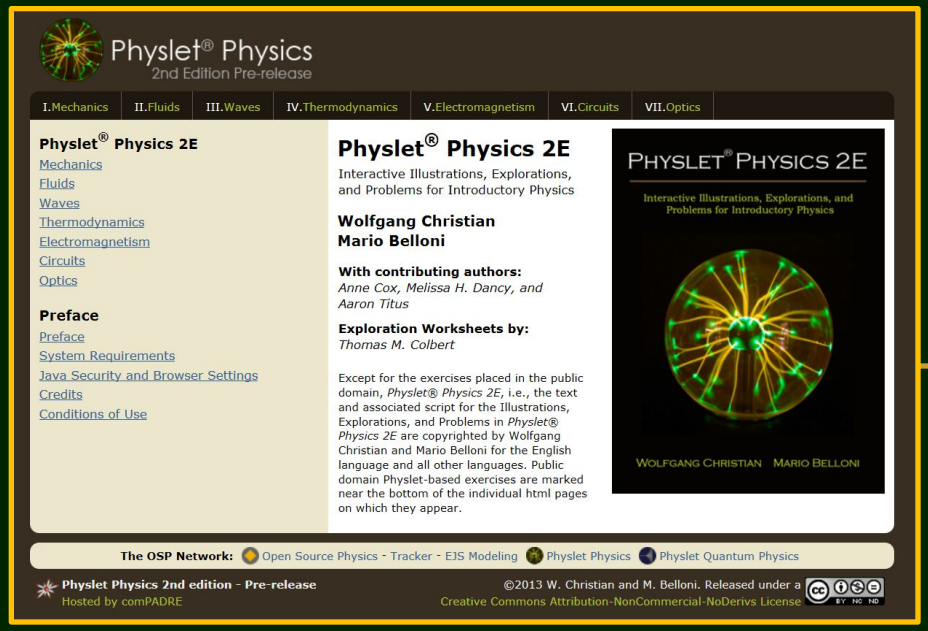
Content …
- Find
- Collect
- Sort
- Relate
- Annotate
- Share



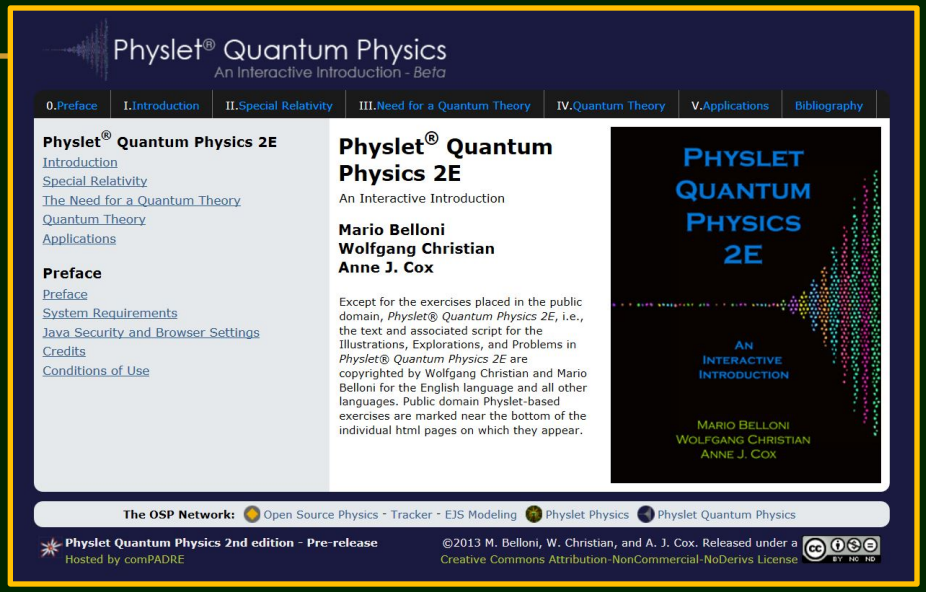
Lets do a search!

PP2E and PQP2E on ComPADRE

Materials are currently available (*Physlet Physics 2E and Physlet Quantum Physics 2E*) on ComPADRE. 1ed in 2003



Java Code: New signed jar. Updated and tested 1,300 pages.
New Narrative: Follows original format but many exercises and sections rewritten (especially PQP 2E). 1ed in 2013



www.compadre.org/Physlets

www.compadre.org/PQP

Role of Simulations in Teaching

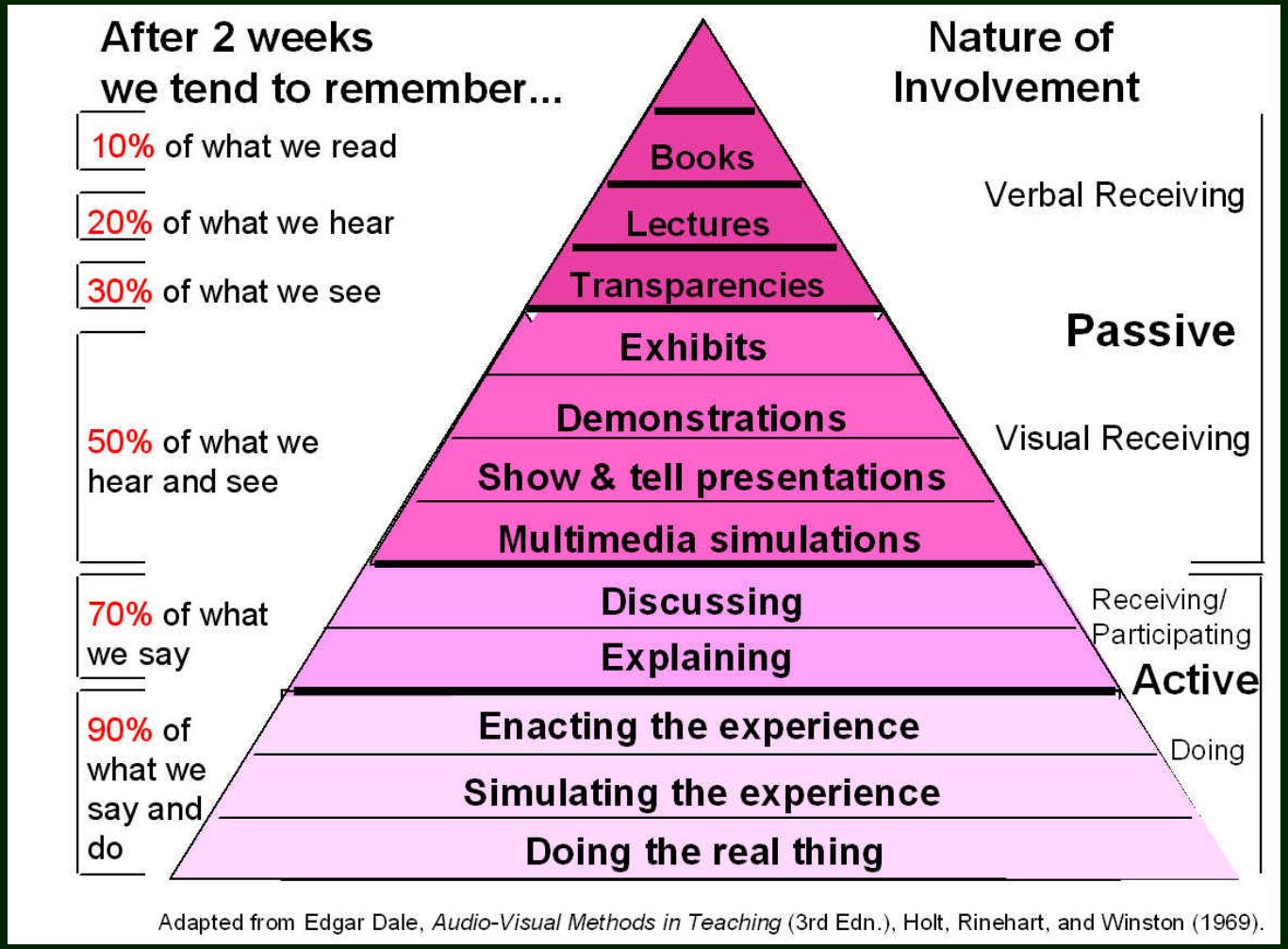
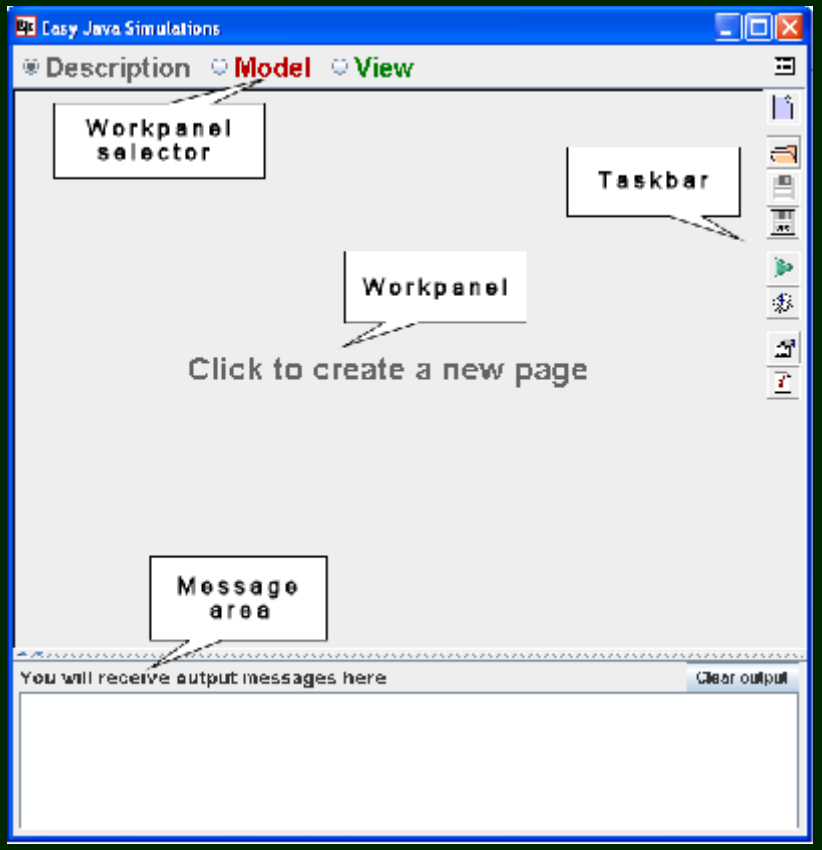


image from Bob Beichner

Easy Java/JavaScript Simulations



Load, modify, and save a model. [Colliding Galaxies]

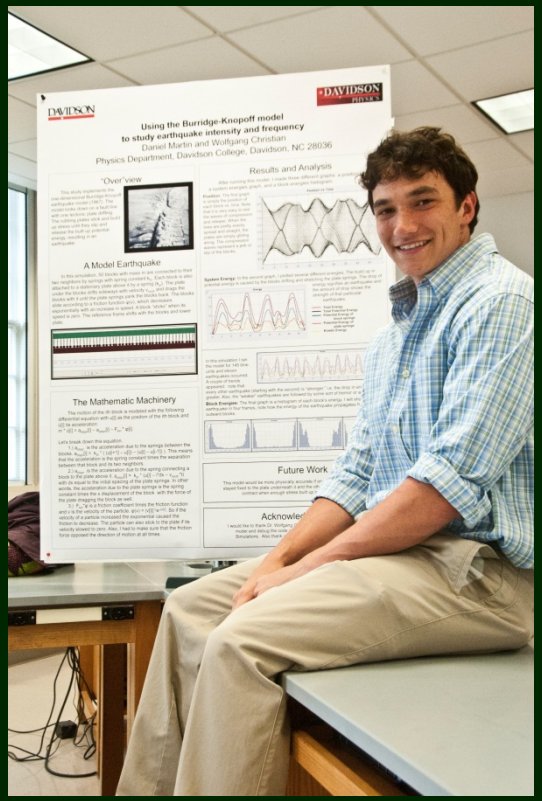
Computer Models

- Models allows students to think about things in terms of simpler artificial things.
- Curriculum
  - Exploratory models engage the student in ideas presented by an expert (teacher). Students are led to confront another's view of a problem.
  - Model-based and programming activities are expressive exercises that require students to externalize their own ideas and assumptions and to create concrete representations that they can reflect on.

Undergraduate Computational Physics

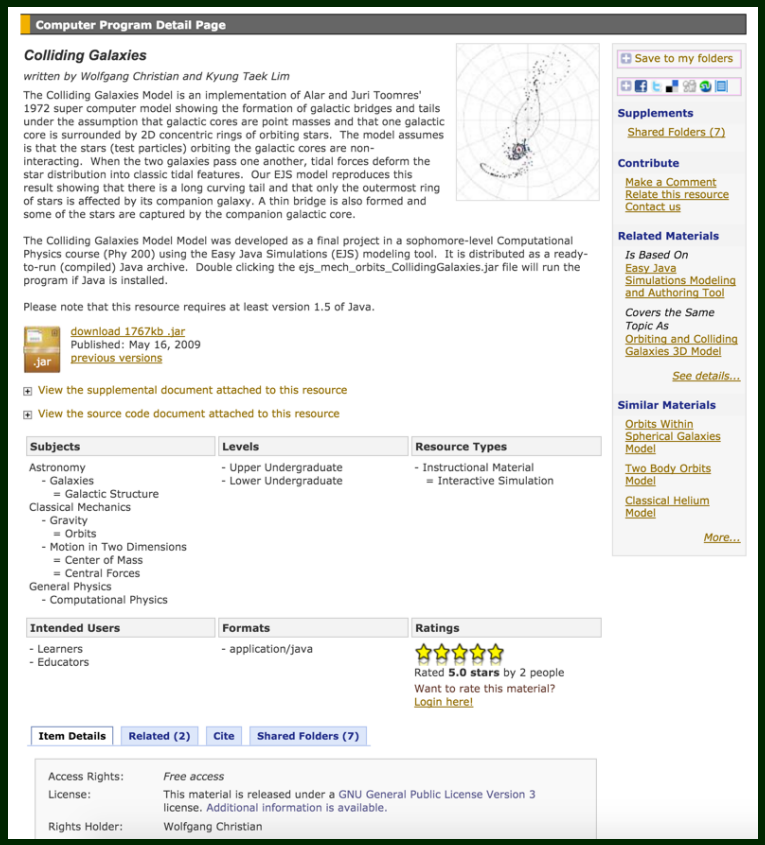
Teaching should reflect current research and professional practice. Every undergraduate physics major should know about computational physics, including essential algorithms, minimal level of programming experience, and computational ways of thinking.

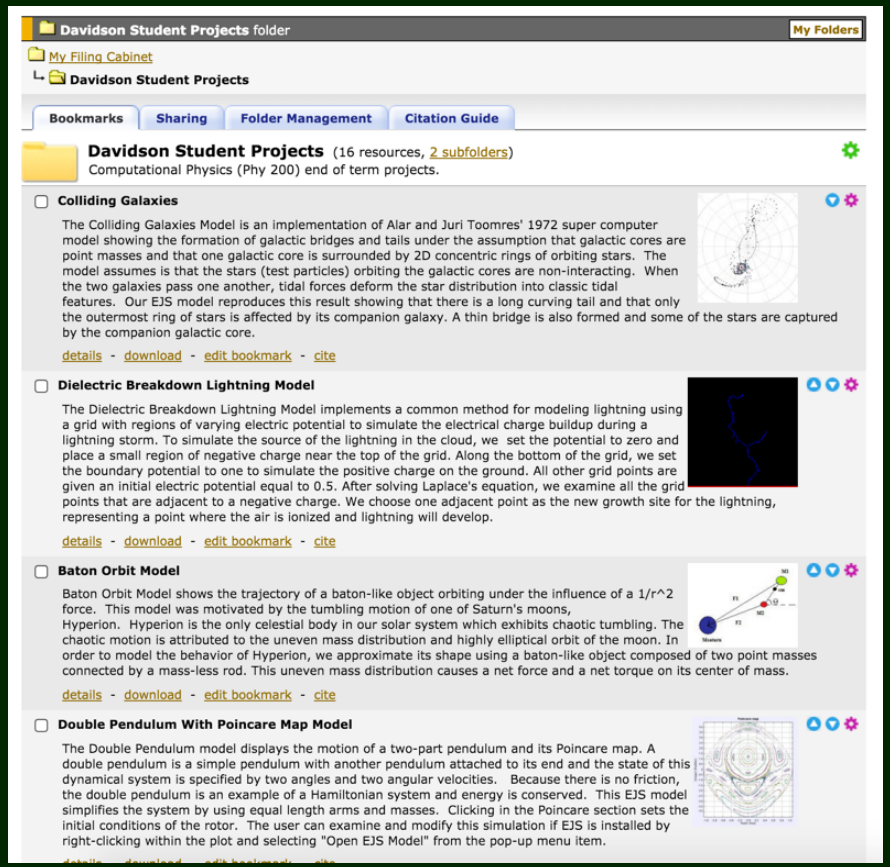
- Differential equations and ODE numerical algorithms: oscillators, Newtonian orbits, and few-body problems.
- PDEs and boundary value problems: Laplace and Poisson equations.
- Stochastic models and Monte Carlo algorithms: Random walks and the Ising model.
- Chaos theory: Logistic map and driven pendulum.
- Final project of the student's choice.



AAPT/ComPDRE Filing Cabinets

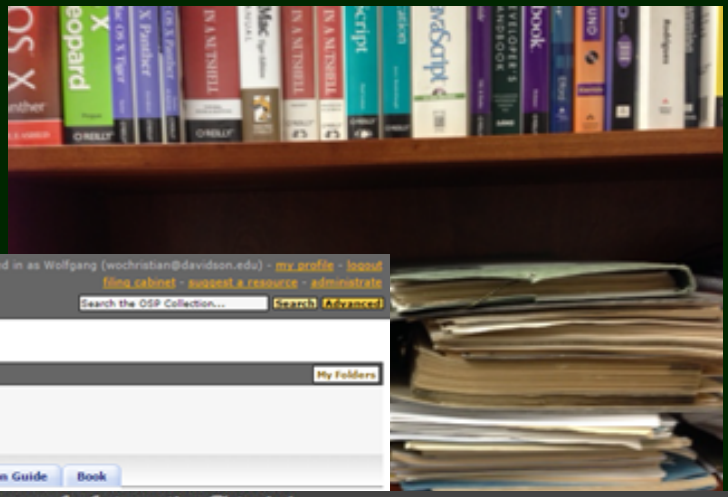
Authoring by Building Mash-ups in the Digital Library





AAPT/ComPADRE Books

Going from this



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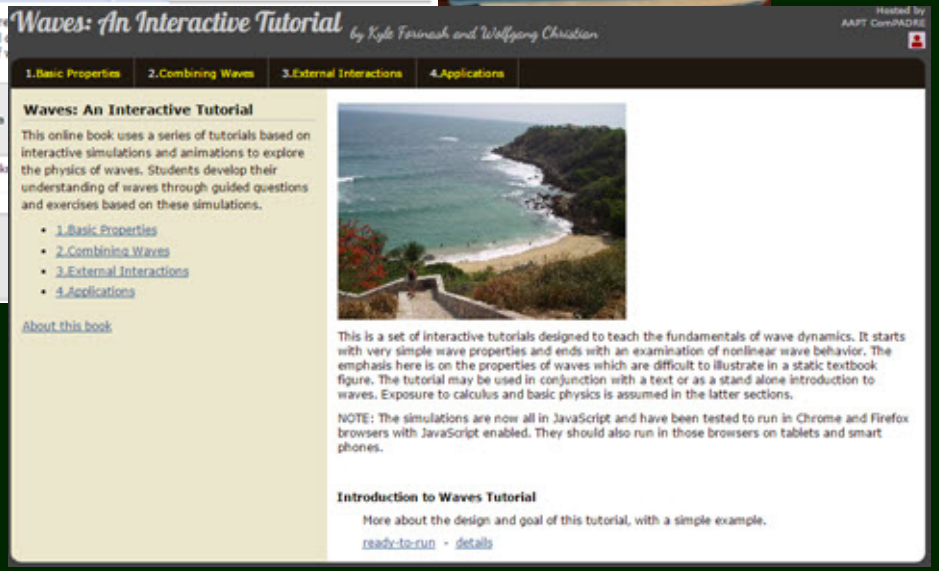
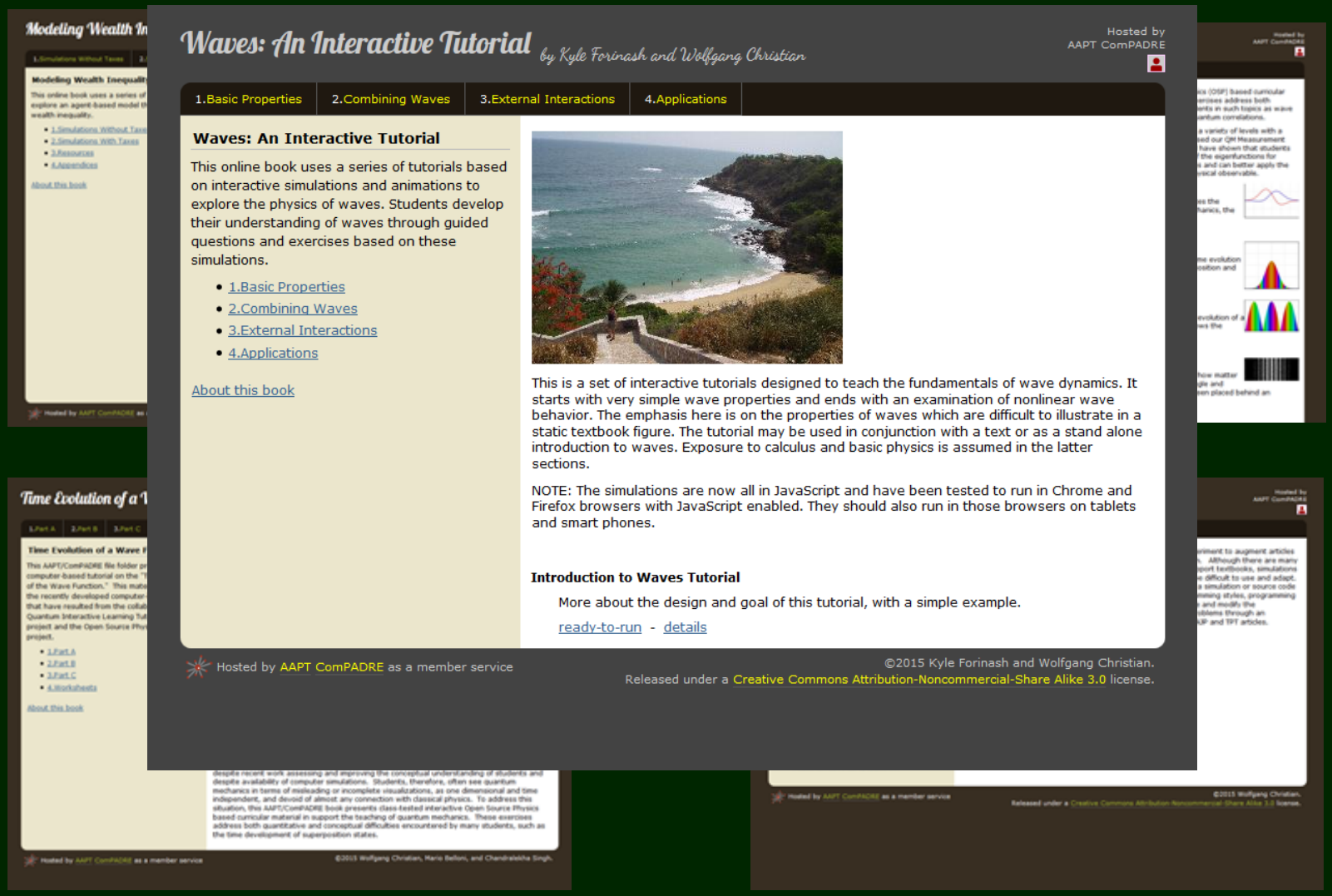
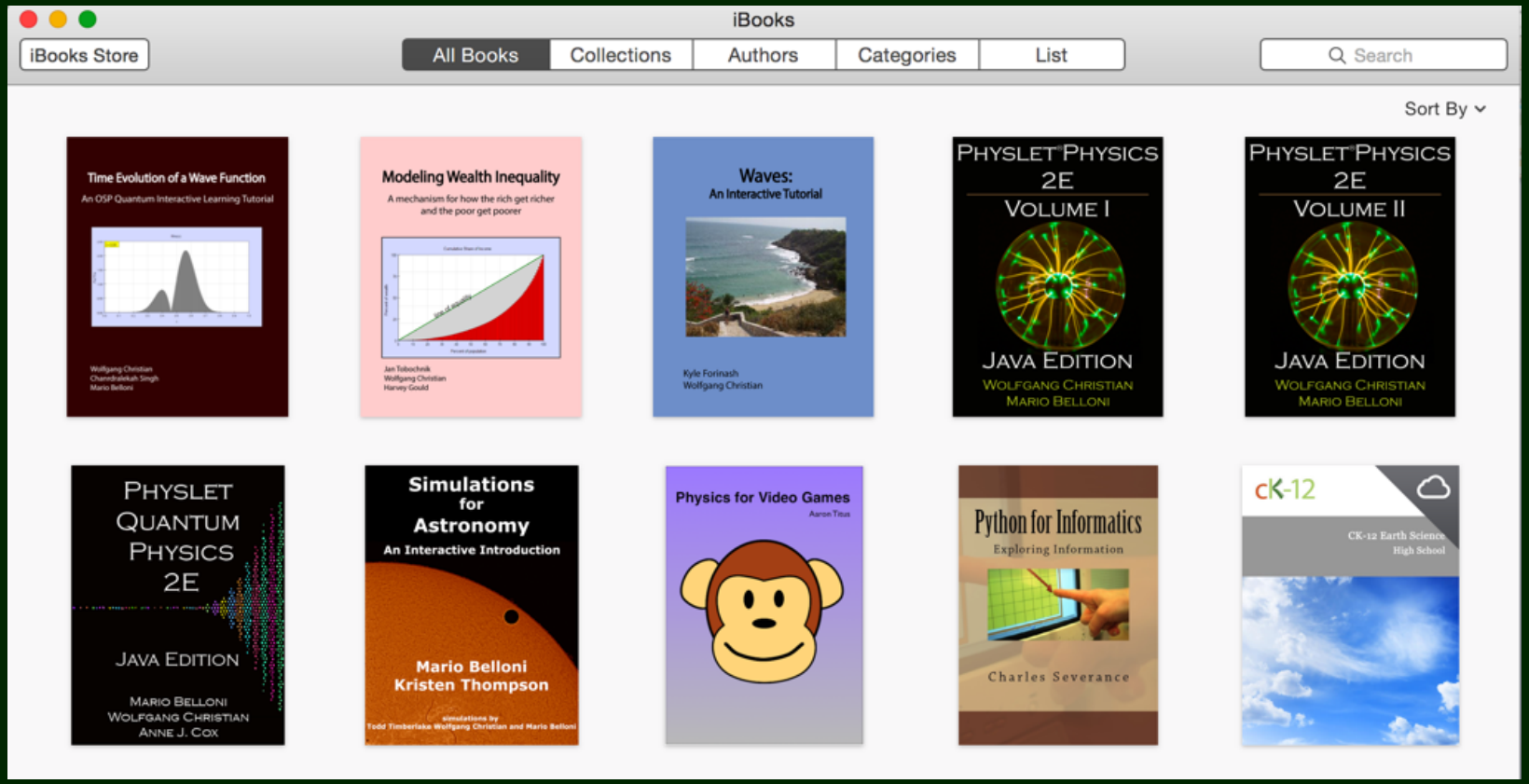


Available on ComPADRE Now!



Authoring Epub 3 with EjsS

And this



Distributing Content with the EjsS Reader

Available Android, iOS, and Online with Google Chrome,

What we have learned about:
Getting Simulations Right

- Work on curriculum development from the start as you work on programming. It will carry the message in the end.
- Focus on an important concept or application. Too many options distract.
- The devil is in the detail. A small practical problem can ruin a grand plan.
- It is HARD to do new things in front of students. (e.g. JiTT, Peer Instruction, ILD, Flipped Classroom, Etc.)
- Real curriculum change, which means changing people, takes time. My first book, CUPS: *Waves and Optics*, was published in 1994.

The **OSP-EjsS-ComPADRE** platform removes many of the complicated tasks involved in integrating simulation and modeling into the classroom allowing teachers and students to focus on the science.

Open Source and CC – Facilitating Collaboration

Physlets and the OSP Collection are recognized by over 50% and 22%, respectively, of United States physics faculty as a research-based instructional strategy they are familiar with or have used (Henderson & Dancy).

OSP Collection Team & Collaborators

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  - Matt Riggsbee- AAPT
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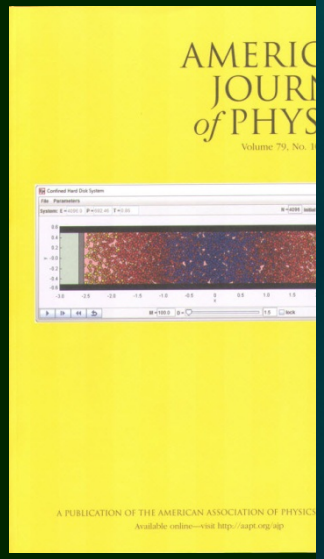
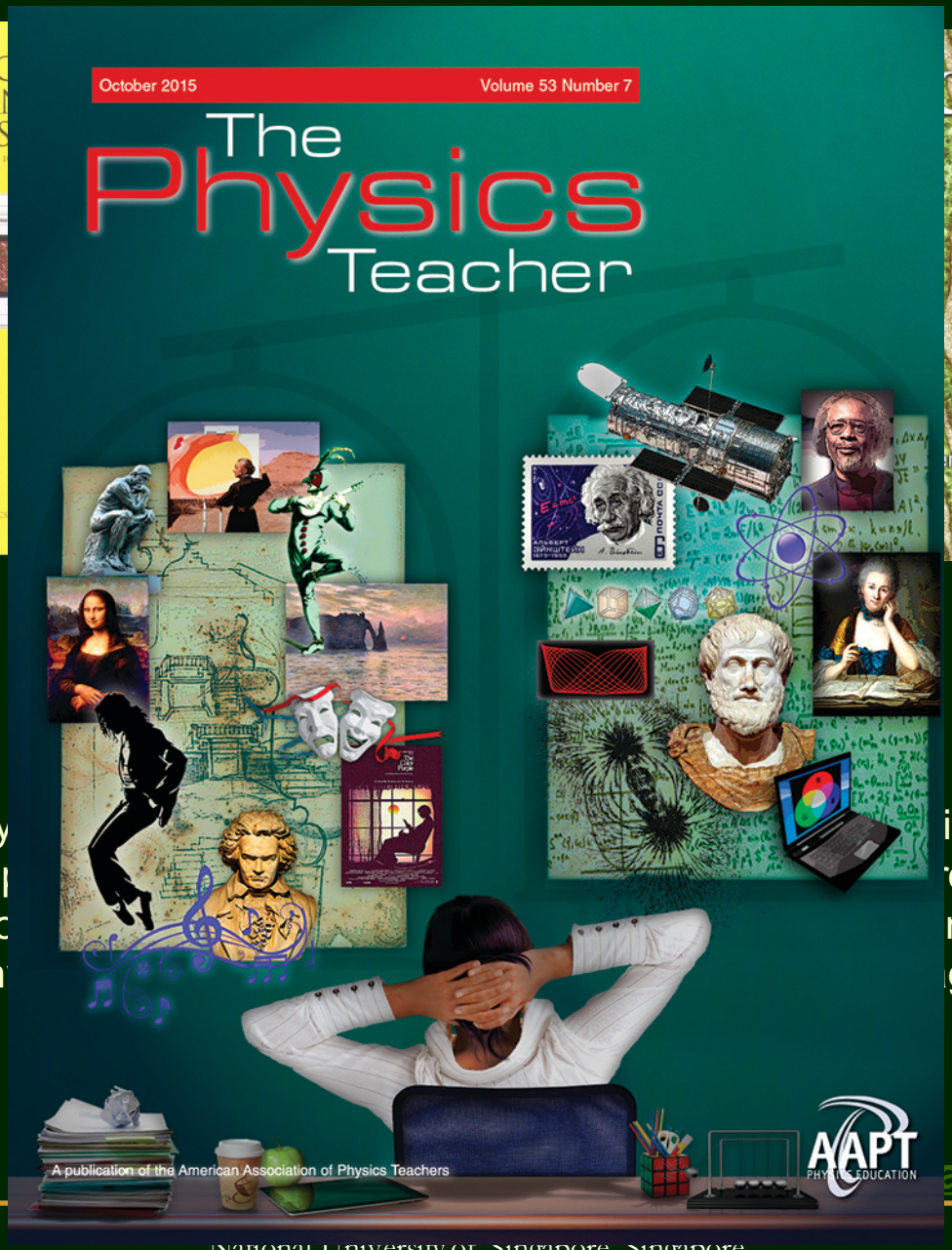
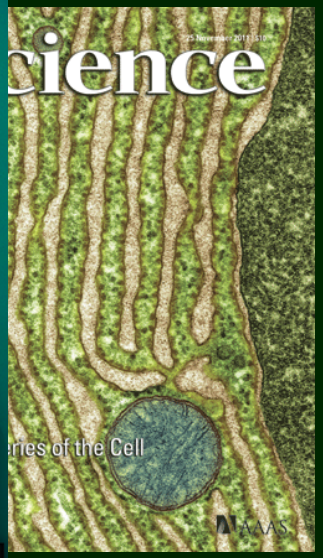
AAPT ComPADRE
Resources and Services for Physics Education







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