

# **Pre-packaged vs. make your own simulations: lessons learned**

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# Outline

- Using simulations in the classroom
- Boxed simulations
- DIY simulation engines
- The project I ran in my classroom
- Some student work
- Student feedback
- Lessons learned
- Try it out!

# Using simulations in the classroom

Within a simulation, the information is non-contextual and presented with as few distractions as possible from the primary learning goal (National Research Council [NRC], 2011), allowing the user to focus on the phenomenon and the relationships that impact behaviour.

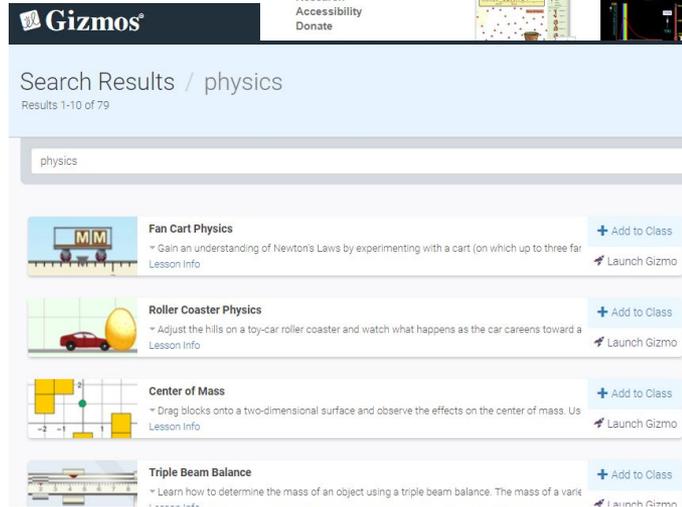
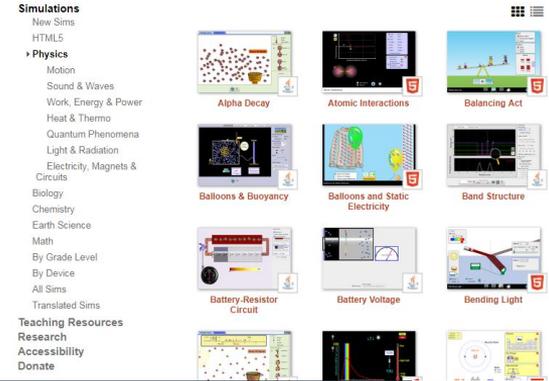
- Pre-packaged simulations are much more aligned with traditional classroom approaches that focus on applications to teach a fundamental law or concept.
- For physics, “hands-on” learning opportunities are critical to help learners understand incorporate otherwise abstract concepts into their understanding.

# Typical boxed simulations

Many educators use simulations found online or through Board licences.

These are:

- Focused
- Expertly designed
- Aligned with curriculum
- Many available



# Pre-packaged simulations

PhET (Physics Education Technology): Masses & Springs

The screenshot shows the PhET 'Masses & Springs' simulation interface. On the left, a vertical ruler is marked from 0 to 50 cm. Three springs are shown: Spring 1 (red) with a 100 gram mass, Spring 2 (red) with a 250 gram mass, and Spring 3 (red) with a 50 gram mass. A control panel on the right includes a 'friction' slider (set to 'none'), a 'softness spring 3' slider (set to 'soft'), and a 'Show Energy of' section with radio buttons for '1', '2', '3', and 'No show'. Below this are radio buttons for 'real time', '1/4 time', '1/16 time', and 'pause', and a 'Stopwatch' checkbox. A 'Show Help' button is at the bottom. A digital timer shows '00:03:96'. At the bottom left, there are 'reset' and 'start/pause' buttons. At the bottom right, there are '100 gram' and '50 gram' mass icons, and a 'PhET' logo.

Gizmo: Period of Mass on a Spring

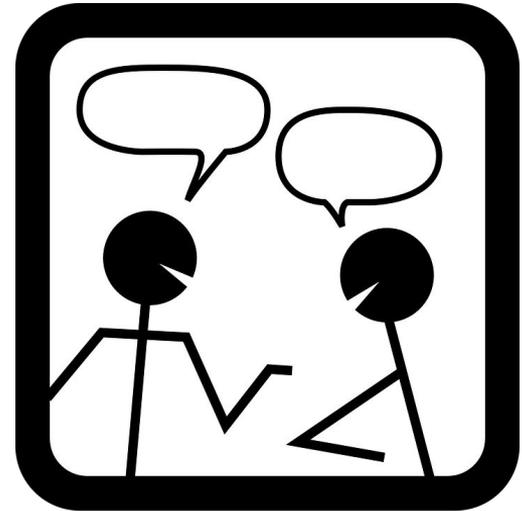
The screenshot shows the Gizmo 'Period of Mass on a Spring' simulation interface. The main window is divided into a 'SIMULATION' area and a 'DESCRIPTION' area. The 'SIMULATION' area features a graph with a vertical axis labeled 'y (m)' ranging from 0.0 to 2.0 and a horizontal axis labeled 'x (m)' ranging from 0.0 to 2.0. A purple spring is shown oscillating vertically, with a blue mass at the bottom. Below the graph are three sliders: 'm' (mass) set to 1.7 kg, 'k' (spring constant) set to 70.0 N/m, and 'g' (gravity) set to 13.9 m/s<sup>2</sup>. The 'DESCRIPTION' area contains a 'Gizmo Status' box with the text: 'In this simulation, an object is hanging at the end of a spring and oscillating up and down. You can adjust the mass of the object, the value of the spring constant, and the acceleration due to gravity. Click Mark time to measure the period of the spring.' Below the status box is a 'Simulation speed' slider set to 'Slow'. At the bottom right, there is a 'Seconds: 26.01' display and a 'Mark time' button. A 'Tools' button is in the bottom right corner.

# So, what's wrong with simulations built by experts?

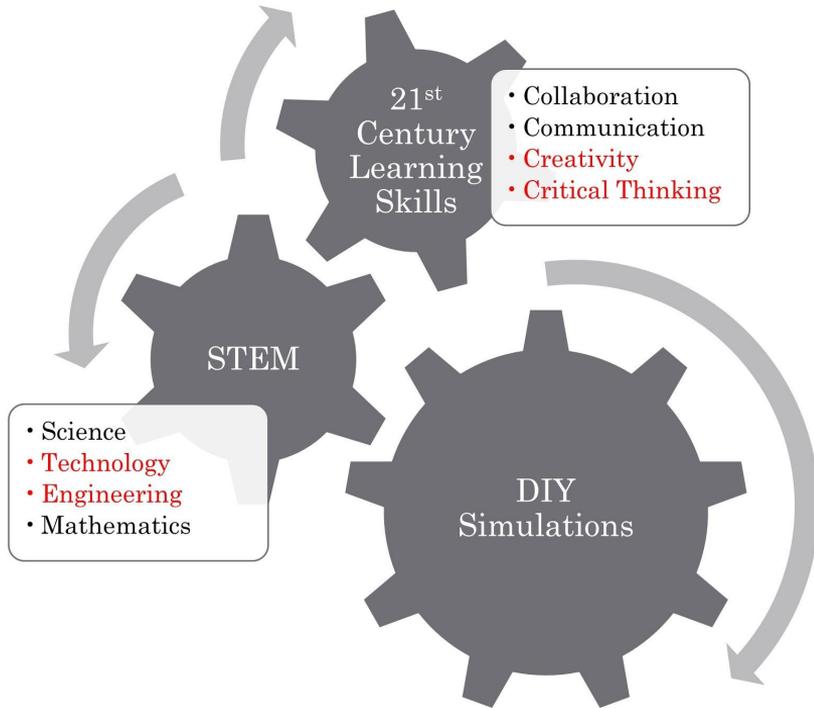
But... I had a conversation  
with a former student...

Nothing!

- Opportunities to “do” something that is otherwise inaccessible
  - Resource limitations (funding, practicality)
  - Safety concerns
  - Concrete experience with abstract concepts



# What learning can a DIY simulation support?



# The project I ran in my classroom

- Design an activity:
  - To explore a relationship between variables for a system
  - that could be run both in the class and within a simulation
- Run the investigation
  - Gather data in each environment
- Analysis
  - Produce an equation to describe the relationship between variables
  - Compare the results from each environment
- Submit
  - Report on the results
  - Reflection (modifications? Simulations?)
  - Simulation file

- Simulation software *must* be free
- For those unable to DIY, what can they do instead?
- Emphasize **simple**

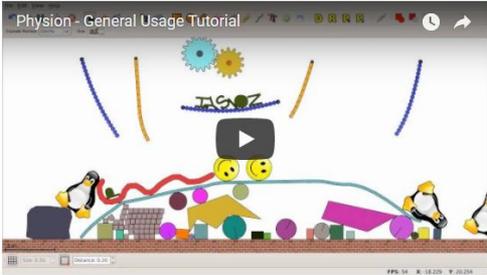
# DIY Simulation Engines

## Physion



### Physion - Physics Simulation Software

Physion is a 2D Physics simulation software. It can be used to easily create a wide range of **interactive physics simulations** and **educational experiments**. Teachers may find it particularly useful since it can be used as a virtual physics laboratory through which they can demonstrate some basic physics concepts in the classroom.



The user, using the tools of Physion, can create various physical objects (circles, polygons, gears, etc.) and joints (eg. springs, pulleys etc.) that obey the laws of Physics. This way the user can experiment by creating various scenes/scenarios which can be either simple physics experiments or complex structures/mechanisms like the ones shown in the video below

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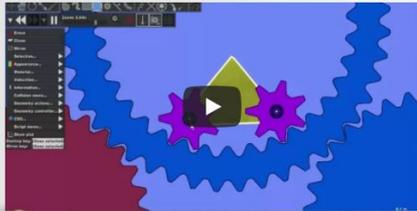
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## Algodoo (by Algorix)



Download What is it? Learn it Algodoo Forum



### Remember Phun?

**We do!**

Emil Ernerfeldt, the creator behind Phun, tells the success story behind Algodoo...

**Read the full story...**

### Algodoo is now FREE!

Algodoo gives you the opportunity to play with physics. Use your own hands and simple drawing tools to **design, construct** and **explore** the world of physics.

Sounds like an interesting idea? **Algodoo** is that program.

If you want to support the development of Algodoo use the Donate button



**Donate**

“It’s so simple to use. You can make anything, and I mean anything, and make it do whatever you want it to...”

[Read more →](#)

**Some student work**

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# Student feedback

Simulation software (easy vs hard to learn, limited functionality)

“I had a tough time to get familiar with the software. I watched some tutorial videos to understand the function of each command. Finally, the simulation came up the way that I expected”

“When creating the simulation of Physion, it was extremely simple to understand and learn the software.”

“Even though Algodoo looked like more fun and easy to use, its ropes/pulley system worked absolutely terribly, forcing me to use Physion which is much harder to use”

“While simulating with Algodoo, I wanted to reduce the uncertainty of the angle measurement... to accomplish this, I found the script menu and played around with the numbers until I was successful.”

“Algodoo had great accessibility to tools, but most of them were only limited to classical physics: there were no batteries, or data showing the laser.”

# Student feedback

## Simulation vs physical lab

“the time spent in the virtual lab was less than the time spent in a physical experiment. In the simulation, I was able to repeat the experiment for four trials in the same amount of time of one trial in the physical experiment.”

“Success with the simulation is that because one is able to pause the experiment to determine the range which will be more easy an accurate to measure”

“another success I had with this project is being able to see the data from the simulation fit a line of best fit almost perfectly, it's the best graph I've seen in my life so far.”

“the experience with performing the lab was both a discovery and learning opportunity, it allowed me to discover all the physics resources at our disposal, and allowed me to "play" with software that allowed me to simulate many simple physics experiments at home.”

# Student feedback

## A few additional comments

“Creating my own lab was also a bit of a struggle because I didn't know what relationship to explore and when I did decide what I wanted to do, it was too complicated to set up in Physion.”

“In a sense, the limit put forth by not having real access to electrostatic simulation software encouraged me to think creatively and put to use my understanding of these two separate strands of physics. I could even say that I learned just as much about these strands as I did about learning to use simulation software.”

“... and I had always personally been interested in conducting an Atwood machine experiment to confirm the force of gravity near Earth's since being taught about it in this course.”

# Lessons learned

- Emphasis on *simple* for a simulation/physical comparison
- Support for students to learn software
- Keep it open-ended
- Due to focus on Mechanics of software, consider as a consolidation activity mid-semester, or as an exam review activity.
- Introduce an earlier check-in point with the class
- Continue to explore other simulation software as they become available (those for purchase exist... Board licences?)
- Other thoughts?

**Try it out!**

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# Keep the conversation going

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### Pre-packages vs. make your own simulations: lessons learned

11/5/2018 0 Comments



Do-It-Yourself (DIY) simulations can encourage creativity and critical thinking in ways that pre-packaged simulations do not. Presented at the OAPT 2018 conference, this session shared some of the lessons learned about how to incorporate a DIY simulation project into your own classroom.

The simulation engines students used primarily, included:

- Algodoo (this can be either downloaded onto a desktop computer as a standalone application, or purchased as an App for iPad)
- Phython (no longer available, as of January 2018)



A brief summary of these ideas can be found in my article "DIY Simulations" posted in the OAPT newsletter (April 24, 2018).

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