

MPTL'20 Proceedings:
**Creating Electronic Books-Chapters for Computers and Tablets Using Easy
Java/JavaScript Simulations, EjsS Modeling Tool**

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Abstract

This paper shares my journey (tools used, design principles derived and modeling pedagogy implemented) when creating electronic books-chapters (epub3 format) for computers and tablets using Easy Java/JavaScript Simulations, (old name EJS, new EjsS) Modeling Tool. The theory underpinning this work grounded on learning by doing through dynamic and interactive simulation-models that can be more easily made sense of instead of the static nature of printed materials.

I started combining related computer models with supporting texts and illustrations into a coherent chapter, a logical next step towards tighter support for teachers and students ,developing prototypes electronic chapters on the topics of Simple Harmonic Motion and Gravity customized for the Singapore-Cambridge General Certificate of Education Advanced Level (A-level). I aim to inspire more educators to create interactive and open educational resources for the benefit of all.

Prototypes:

<http://iwant2study.org/osp/sg/index.php/interactive-resources/physics/02-newtonian-mechanics/08-gravity/154-e-book-on-gravity-2>

<http://iwant2study.org/osp/sg/index.php/interactive-resources/physics/02-newtonian-mechanics/09-oscillations/234-e-book-shm>

and Apple iBook Store, Google Play Book and Kindle Book.

1 Introduction

After the Singapore Easy Java/JavaScript Simulations, EjsS Modeling Tool workshop¹ organised by Francisco Esquembre and Wolfgang Christian 25-28 November 2014, I started combining related computer models with supporting texts and illustrations into a coherent chapter, a logical next step towards tighter support for teachers and students. This paper aims to articulate some of the design ideas, tools used and a mathematical modeling approach (Wee, 2014) developed to work in EjsS, similar to Tracker's video analysis kinematics model (Brown, 2012; Wee, Chew, Goh, Tan, & Lee, 2012; Wee & Leong, 2015; Wee, Tan, Leong, & Tan, 2015). Some examples in the e-chapter will be mentioned and in conclusion, I hope to inspire more educators to create interactive and open educational resources (ISKME, 2008) for the benefit of all.

2 Tools Used

	Purpose
EjsS Modeling Tool ²	Make interactive models, generate epub
BlueGriffon ³ xhtml editor	Create remove markuperrors *.xhtml files with texts, images (recommend 1024x768), insert equations MathML
Mathtoweonline ⁴ MathML equation editor	Generate equations in MathML format

¹ https://girep.org/newsletters/newsletter_2015_05.pdf page 10

² <http://fem.um.es/Ejs/>

³ <http://bluegriffon.org/>

⁴ <https://www.mathtoweonline.com/>

Table 1. Tools used and the purpose for creating interactive textbook chapters.

The table 1 shows the tools used to create these interactive epub3 format electronic text book chapters, where EjsS Modeling Tool (Esquembre, 2012) is heavily relied on to generate these *.xhtml format texts and JavaScript simulations. Since EjsS Modeling Tool does not create the *.xhtml format texts but just package it with the JavaScript simulations, a separate xhtml editor such as BlueGriffon is used to create these texts with markup errors removed. Moreover, to generate free MathML format equations, I recommend using MathtoWebonline to create these equations and pasted into the *.xhtml files-texts-equations inside the BlueGriffon editor. Authors who wish to publish their e-chapters on Apple iBook should note that pictures need to size exactly to 1024x768 in dimensions.

3 Simulation Design Principles for electronic book-chapters

In the process of creating a suite of simulations for 2 chapters for Simple Harmonic Motion and Gravity (Wee & Goh, 2013) customized for the Singapore-Cambridge General Certificate of Education Advanced Level (A-level), three design principles (Wee, 2012; Wee & Goh, 2013; Wee, Lee, Chew, Wong, & Tan, 2015; Wee & Ning, 2014) emerged as worthy of mentioning in the paper and they are listed as below.

3.1 User design: Simple & Optimum View of Screen

For a less frustrating and optimum cognitive loading (Roth, 1999) user experience using the simulations, simple layout with optimize view, Figure 1 below, such as a bottom control panel seems to be well received by teachers and students in Singapore.

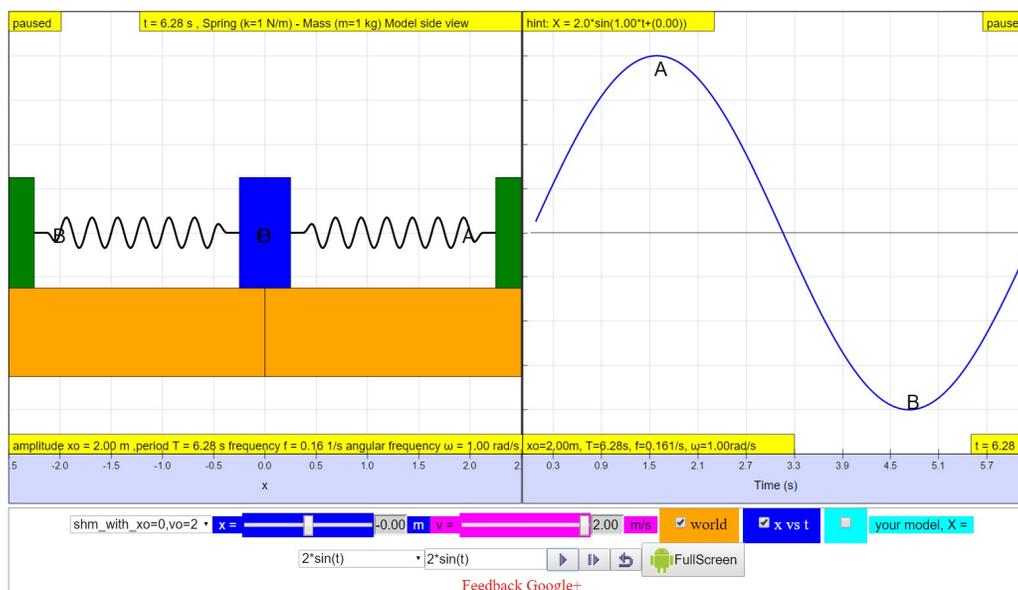


Figure 1. Horizontal Spring Mass Model⁵ with a simple world view layout on the left with only one other scientific view of displacement, x versus time, t graph.

⁵ <http://iwant2study.org/ospsg/index.php/interactive-resources/physics/02-newtonian-mechanics/09-oscillations/69-shm04>

In addition being simple in view, I have implemented a full screen capability on Android to tap fully on the smaller screen size of students' personal hand phones as devices for learning anytime and anywhere.

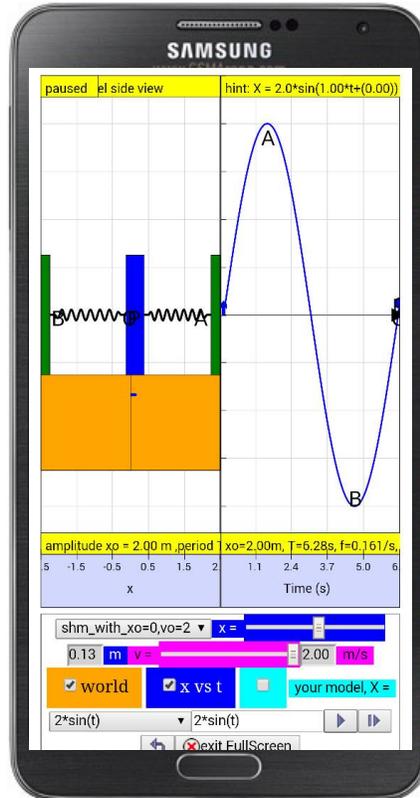


Figure 2. Same Horizontal Spring Mass Model showing full screen app-like capability, running on the Android Chrome Browser in a Samsung Galaxy Note 3, 5.5 inch screen size diagonally, in the portrait orientation showing with a simple world view layout on the left with only one other scientific view of displacement, x versus time, t graph.

3.2 Teaching design: Gradual build up of concepts

As teachers using the simulations in the electronic text will want to teach in a more coherent manner connecting earlier concepts to new build-up concepts like kinetic, potential and total energies Figure 3 in oscillating springs-mass system, the later simulations will have the ability to show earlier concepts such as displacement, velocity and accelerations concepts overlaying the energies plots.

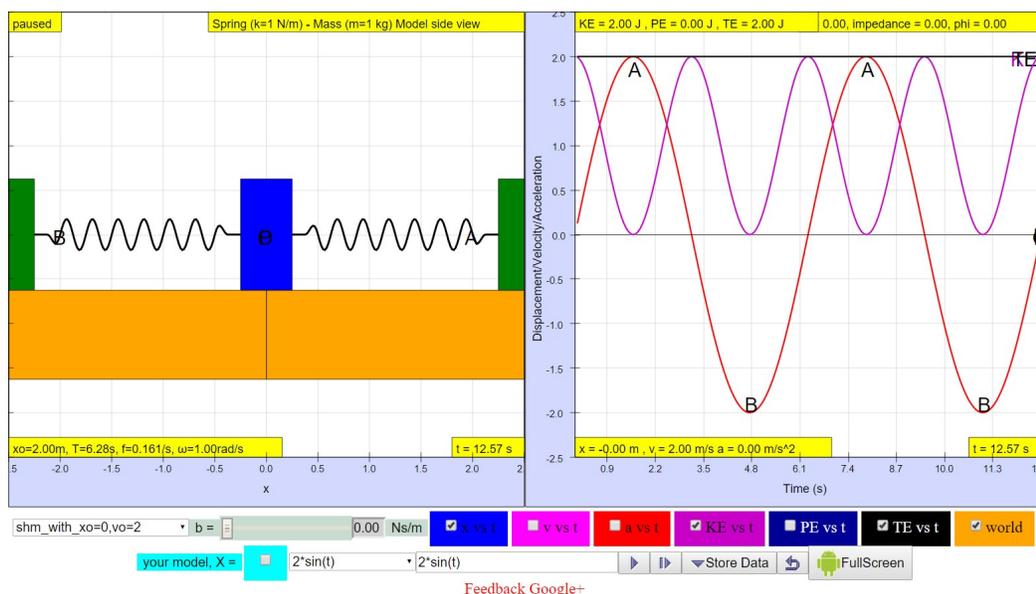
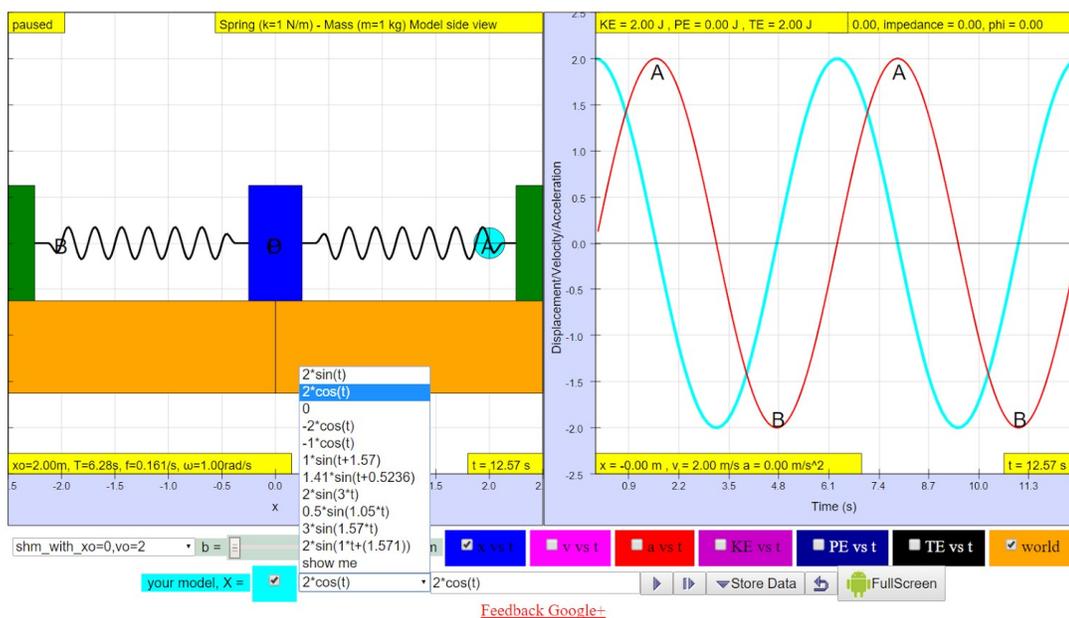


Figure 3. Horizontal Spring Mass Model ⁶ showing a simple world view layout on the left with only one other scientific view of kinetic energy KE, potential energy PE, and total energy TE versus time t, with earlier concepts such as displacement x, versus time, t, velocity v, versus time, t and acceleration a, versus time, t graph. Note that only KE and TE is selected with x versus t.

3.3 Pedagogical design: progressive mathematical modeling

In view of the phenomena success of Tracker in allowing students and teachers to represent their understanding of physics through video modeling, I implemented the same kinematics mathematical modeling capability in EjsS models, a new approach in teaching and learning with simulations, not implemented in other EjsS and non-EjsS simulations found on the public internet. This newly developed progressive mathematical modeling approach in EjsS allows students to propose an initial model where the closeness of fit between simulated data and proposed model suggests an understanding of application of theory. As in , the student may suggest $X = 2 \cdot \cos(t)$ as an initial model, the simulations immediately drawn the plot versus time allows for predict (Radovanović & Sliško, 2013), click play button allow the simulations to run according as designed for observe and lastly the apparent mismatch or closeness of fit between model and simulated data can allow for explanation and discussions. Finally, a “show me” which will display $X = 2 \cdot \sin(1.00 \cdot t + (0.00))$ as a generalized solution, is selectable from the drop-down menu to help teachers carry out this newly developed progressive mathematical modeling approach in EjsS.



⁶ <http://iwant2study.org/ospsg/index.php/interactive-resources/physics/02-newtonian-mechanics/09-oscillations/80-shm17>

Figure 4. Horizontal Spring Mass Model⁷ with a simple world view layout on the left with only one other scientific view of displacement, x versus time, t graph. Note that student proposed model is selectable via a drop-down menu with some scaffolds mathematical syntax and a “show me” which determines the generalised form for the motion.

In gravity chapter of the gravitational acceleration and potential model⁸, similar designs are implemented where students can proposed for their own model in teal color, example $g = -6.67 \cdot 500.00 / r^2$ or $\phi = -6.67 \cdot 500.00 / \text{abs}(r)$ as the gravitational field strength and potential plots versus the theoretical formula of a gravitational mass $M = 500$ kg and a constant of $\times 10^{-11} \text{ Nm}^2 / \text{kg}^2$ for gravitational constant G . Again, this approach in our initial research findings with fifteen grade 11 in a mainstream junior college setting suggests students can figure out the meaning of the Red mass, $M = 500$ kg to be the mass that create the gravitational field and potential, previously not possible through paper representations in the lecture notes.

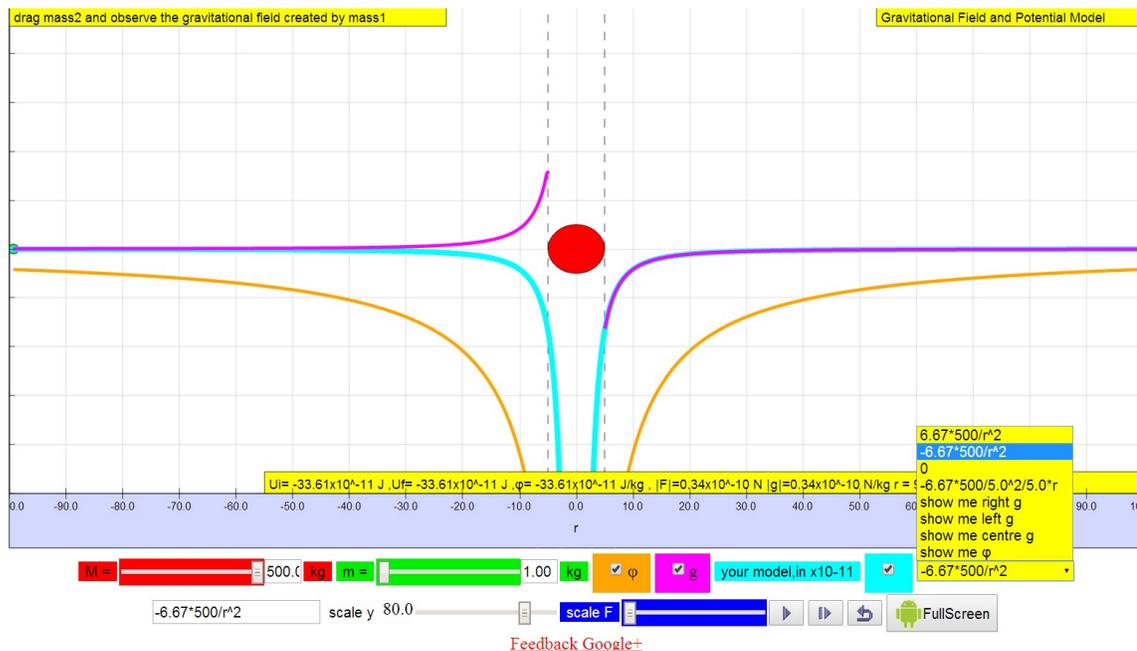


Figure 5. Gravitational Acceleration and Potential Model⁹ with a RED mass $M = 500$ kg creating a gravitational field with a test GREEN mass, $m = 1$ kg, where the field strength g and potential ϕ are simulated. Students then proposed their own initial TEAL model to test if their model matches the theoretical formulae using $g = -6.67 \cdot 500.00 / r^2$ or $\phi = -6.67 \cdot 500.00 / \text{abs}(r)$ from the drop down menu.

4 Conclusion

Which just these three computer tools (Ejss Modeling Tool, BlueGriffon xhtml editor and Mathweboonline MathML equation editor) it is possible to create epub3 format electronic books-chapters for computers and tablets, that can be accepted and published as Apple iBook (Gravity¹⁰, Oscillator¹¹), Android Play Book (Gravity¹², Oscillator¹³), and Kindle Book.

⁷ <http://iwant2study.org/ospag/index.php/interactive-resources/physics/02-newtonian-mechanics/09-oscillations/69-shm04>

⁸ <http://iwant2study.org/ospag/index.php/interactive-resources/physics/02-newtonian-mechanics/08-gravity/58-gravity06>

⁹ <http://iwant2study.org/ospag/index.php/interactive-resources/physics/02-newtonian-mechanics/09-oscillations/69-shm04>

¹⁰ <https://itunes.apple.com/us/book/gravity-advanced-level-gce/id1001442379?mt=11>

Three simulation design principles for electronic book-chapters are discussed and they are 3.1 user design: simple & optimum view of screen, 3.2 teaching design: gradual build up of concepts and lastly and more significantly 3.3 pedagogical design: progressive mathematical modeling. I hope to have inspired more educators to create interactive and open educational resources for the benefit of all.

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6 References

- Brown, Douglas. (2012). Tracker Free Video Analysis and Modeling Tool for Physics Education. from <http://www.cabrillo.edu/~dbrown/tracker/>
- Esquembre, Francisco. (2012). Easy Java Simulations <http://www.um.es/fem/EjsWiki/pmwiki.php>. Retrieved 13 September, 2012, from <http://www.um.es/fem/EjsWiki/pmwiki.php>
- ISKME. (2008). Open Educational Resources. Retrieved 02 June, 2008, from <http://www.oercommons.org/>
- Radovanović, Jelena, & Sliško, Josip. (2013). Applying a predict–observe–explain sequence in teaching of buoyant force. *Physics Education*, 48(1), 28.
- Roth, WF. (1999). Authentic school science: intellectual traditions. In R. McCormick & C. Paechter (Eds.), *Learning and knowledge* (pp. 6–20). Thousand Oaks, CA: SAGE Publication.
- Wee, Loo Kang. (2012). One-dimensional collision carts computer model and its design ideas for productive experiential learning. *Physics Education*, 47(3), 301.
- Wee, Loo Kang. (2014). *Open Educational Resources from Performance Task using Video Analysis and Modeling-Tracker and K12 science education framework*. Paper presented at the 8th Joint Meeting of Chinese Physicists Worldwide (OCPA8) Nanyang Technological University, Singapore. <http://arxiv-web3.library.cornell.edu/pdf/1408.5992v1>
- Wee, Loo Kang, Chew, Charles, Goh, Giam Hwee, Tan, Samuel, & Lee, Tat Leong. (2012). Using Tracker as a pedagogical tool for understanding projectile motion. *Physics Education*, 47(4), 448.
- Wee, Loo Kang, & Goh, Giam Hwee. (2013). A geostationary Earth orbit satellite model using Easy Java Simulation. *Physics Education*, 48(1), 72.
- Wee, Loo Kang, Lee, Tat Leong, Chew, Charles, Wong, Darren, & Tan, Samuel. (2015). Understanding resonance graphs using Easy Java Simulations (EJS) and why we use EJS. *Physics Education*, 50(2), 189.
- Wee, Loo Kang, & Leong, Tze Kwang. (2015). Video Analysis and Modeling Performance Task to Promote Becoming Like Scientists in Classrooms. *American Journal of Educational Research*, 3(2), 197-207.
- Wee, Loo Kang, & Ning, Hwee Tiang. (2014). Vernier caliper and micrometer computer models using Easy Java Simulation and its pedagogical design features—ideas for augmenting learning with real instruments. *Physics Education*, 49(5), 493.
- Wee, Loo Kang, Tan, Kim Kia, Leong, Tze Kwang, & Tan, Ching. (2015). Using Tracker to understand ‘toss up’ and free fall motion: a case study. *Physics Education*, 50(4), 436.

¹¹ <https://itunes.apple.com/us/book/simple-harmonic-motion/id967139041?mt=11>

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https://play.google.com/store/books/details/Loo_Kang_Lawrence_Wee_Gravity_Advanced_Level_Physi?id=LS3_COAAQBAI

¹³ https://play.google.com/store/books/details/Loo_Kang_Lawrence_Wee_Simple_Harmonic_Motion?id=lqGiBgAAQBAI

¹⁴ <http://edulab.moe.edu.sg/edulab-programmes/existing-projects/nrf2015-edu001-el021>