DATA SCIENCE IN PHYSICS PRACTICALS
THE PENDULUM EXPERIMENT

AI in Education Chapter
A subsidiary of the NIE Student Teachers' Club

NIE NATIONAL INSTITUTE OF EDUCATION SINGAPORE

An Institute of NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

AI SINGAPORE

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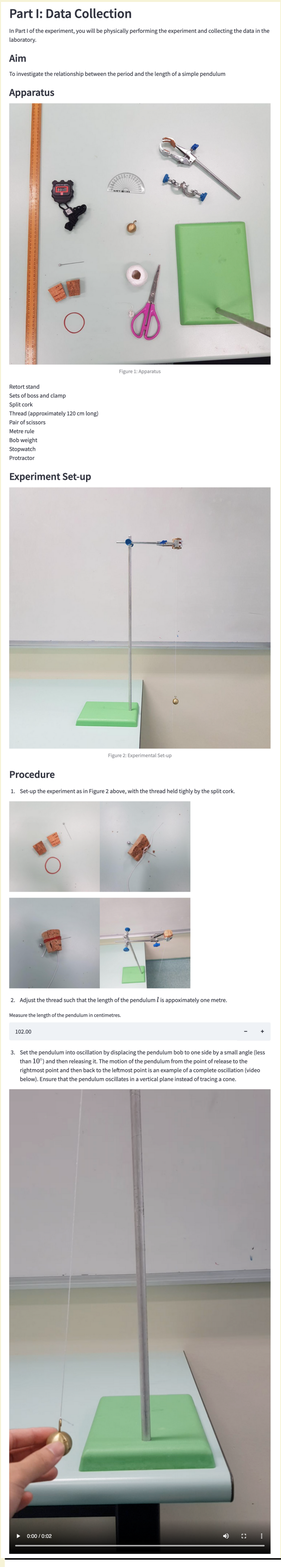
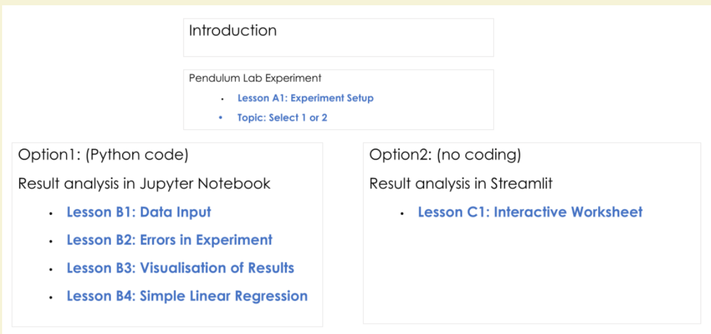


We report on a curriculum jointly developed by Physics educators and AI engineers from the National Institute of Education and AI Singapore respectively. The microcourse features two tracks: a Jupyter notebook based Python track and a code-free interactive web-based worksheet. In both tracks, the course is designed to integrate lesson objectives from both Physics Practicals and AI literacy, organically improving our understanding of the underlying Physics, as well as scientific experimentation and inquiry.

Microucourse accessible on AI Singapore Learn AI platform

Web-based (dynamic content) worksheet built with Streamlit



Overview of structure of microcourse

(Left) Lesson A1: Experimental Setup, data collection segment of the microcourse is common across both options and replicates the classic Pendulum experiment.

BACKGROUND

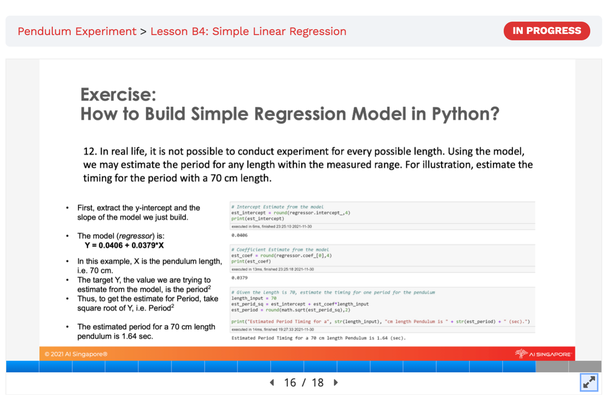
The Covid-19 pandemic has brought about a fundamental rethink of pedagogy. Blended learning has not only afforded the resilience of classes against lockdowns, but also normalized pedagogical modes once unthinkable. Practicals at the secondary school physics level have been largely unaltered since the new millennium including setting up laboratory apparatus, data collection, tabulation, computation and plotting of relevant quantities, and analysis. With exception to the physical experiment and data collection, students often tabulate, compute, plot and analyse the data by hand, typically requiring more time and thought than that afforded by the length of the lesson.

OBJECTIVES

- Increase the authenticity and transferrability of data analysis in Secondary Physics Practicals
- Build students' predispositions in AI (data, statistical literacy) in the teaching of Practicals

OPTION 1: PYTHON NOTEBOOK

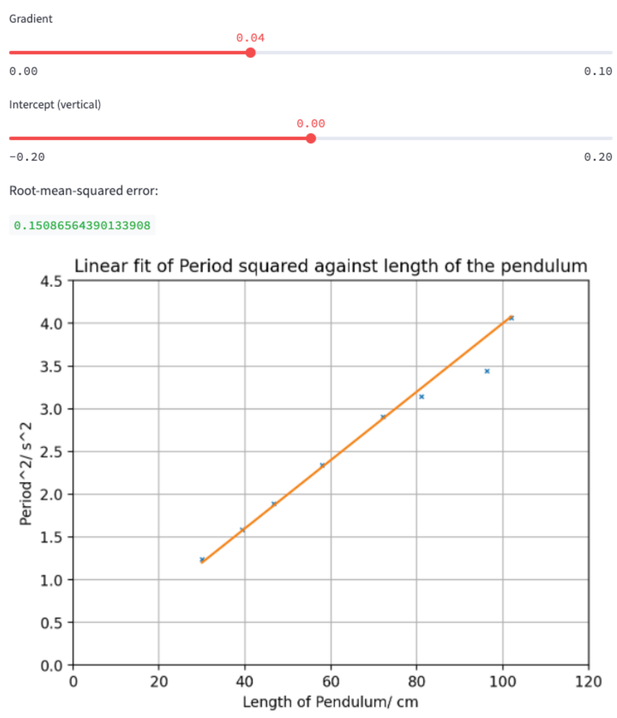
Option 1 is a a modularized micro learning unit based on the Python programming language. The Python track comprises five self-contained modules: physical data collection, digital data input, errors, data visualization, and linear regression. In addition to experimental skills and knowledge, students would be able to perform basic data retrieval, tabulation, visualization and analysis in a Jupyter notebook by the end of the course.



Lesson B4: Simple Linear Regression using Scikit-learn Python package

OPTION 2: CODE-FREE E-WORKSHEET

The key affordance of the app is in the sense-making of the plotting of the best-fit line, i.e. by minimisation of some cost function. This is achieved by a slide-bar widget where the student may manipulate the line of best-fit between the period of the pendulum squared, and its length.



Manual curve fitting using slide bars (Lesson C1)

DISCUSSION

The two tracks of the microcourse were conceived to cater to the widely varying learners' goals, profiles and teachers' efficacy, particularly programming ability, as well as taking into consideration the extracurricular content overhead that may be imposed. Work is underway to differentiate the course for each level, to improve the content and developmental appropriateness for school use.

REFERENCES

Chew, C. (2007). 'O' Level Physics Matters Practical Book - Teachers' Edition. Singapore: Marshall Cavendish.