Enhancing student learning through online lectures using Moodle quizzes

Situation

- Large class sizes (500+)
- Dropping attendance (usually 50% by the end of the course)
- Some students have clashing lecture times, or are uncomfortable attending large lectures
- Lecture recordings do not capture demonstrations or working from the board

Task

- Give students the opportunity to enrol in one of the following lecture streams:
  - 1 of 2 x f2f lecture streams (term 1 and 2, or one f2f stream term 3)
  - 1 x web stream lecture stream (no f2f lectures timetabled – only complete the online lectures)

Note: Pre-COVID all students attend a 2-hour lab and 2-hour problem solving workshop f2f each week.

- Develop videos/lessons with best-practice teaching
  - Short videos with equations and key points appearing on the screen to reduce cognitive load
  - Regular questions allowing students to practice what they've just learned
  - Include solutions videos to allow students to learn from their mistakes ("formative-type")

- Decided to create Moodle quizzes to **stand in for lectures** for the following reasons:
  - Can implement "Description" question type for video/content delivery, intersperse questions throughout
  - Wide variation in question types (e.g. MCQ, short answer, STACK, etc.)
  - Marks can be fed through to a not-for-marks category in Gradebook so completion can be easily monitored
  - It is the LMS used at UNSW (familiar to students)

Action

- Structured the lecture (set up as Moodle Quizzes)
  - Align with learning outcomes for that lecture (~4/week), listed at start of lecture and tested in assessment tasks
  - 1 quiz per lecture
  - Create a "shell" for the lecture, research best way to present material
- Scripted the videos (either with notes or with PowerPoint slides)
- Produced short videos using camera at-home or in film studio
  - Including theory, small demonstrations, solutions to problem videos

- Edited videos using video-editing software (e.g. Screenflow)
    - Adding key words to screen (to reduce cognitive load/emphasise key concepts), pictures, formulas, etc.
- Identified students who seemed to be falling behind in lectures
    - Email to gently remind to keep up-to-date

Result

- Flexibility of delivery (asynchronous)
- Can make better use of class time for f2f students, while these were developed for online students it means students can be directed to watch long proofs online, freeing up class time for discussion and problem solving
- Allowed for easy pivot to fully online learning due to COVID-19
- 1A web stream data indicates that students learn at least just as much (possibly more) than those who attend f2f lectures
    - Tracked completion via Gradebook from Moodle lecture quizzes
    - Anecdotal feedback from students: appreciated the reminder to complete the lectures, appreciated the care for individual student progression
    - Data includes learning gains – peer-reviewed concept inventory tests measuring the learning gains of students regarding particular topics
- Measurements of student's emotional engagement in Physics 1A showed that students covering lecture content online were less emotionally engaged than those learning f2f.
- Work in Progress with data for 1B web streams (1B web streams first implementation in T3 2020)

Pros/cons

- Con:
    - Time consuming!
    - Need to refresh every few years
    - Completion depends on student intrinsic motivation
- Pro:
    - Lectures can be used for quite some time afterwards
    - Students tend to learn more provided that they actually complete them
    - Students are invested in learning due to increased responsibility of having to complete the lectures themselves

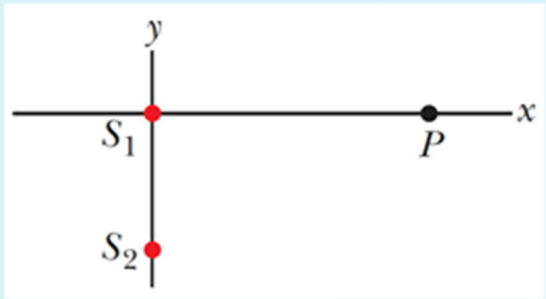
Screencap of part of quiz with video

We are going to touch upon a couple of interesting concepts in this video, including:

- **Constructive** and **destructive interference** - you'll remember these from Physics 1A.
- **Coherent light**, which is characterised by the electromagnetic waves being *in phase* with each other.
- **Monochromatic light**, which is light that is of a *single wavelength*.
- **Diffraction**, which describes how waves bend around openings where the size of the opening is of the same order of magnitude as the wavelength of light.

To recap some revision of interference, I'm going to do the question below. Attempt it before watching me do it, or just skip to watching so you can remind yourself of how to attempt questions like these, and then move on to trying for yourself.

Two isotropic point sources of light (S1 and S2) are separated by distance 2.70 µm along a y axis and emit in phase at wavelength 900 nm and at the same amplitude. A light detector is located at point P at coordinate x_P on the x axis. What is the greatest value of x_P at which the detected light is minimum due to destructive interference?



In the video below, we discuss the similarities and differences between electric and gravitational forces. As there are many similarities between these fields many of the techniques that you learnt in Physics 1A for dealing with gravitational fields can also applied to electric fields. Linking this new material, you are using what you already know will make it much easier to learn.

This part is optional. If you want a recap of Newton's shell theorem, it is covered in the video below. Note that the video is half an hour long and you would not be asked to reproduce this so feel free to skip it!

Use Coulomb's law:

$$F = \frac{kq_1q_2}{r^2}$$

where $k = \frac{1}{4\pi\varepsilon_0} = 9.0 \times 10^9 Nm^2/C^2$ to calculate the magnitude of the electric force between a Hydrogen nucleus (a proton) and an electron when they 120 pm (the radius of a Hydrogen atom) apart.

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Hint: When entering numbers in scientific notation use "E", so for example the charge on an electron $e = 1.602 \times 10^{-19} C$ would be entered as 1.602E-19.

Figure: Theory videos are added into Moodle quizzes as “description type” questions. These can then easily be distributed in quizzes along with other question types to gauge whether students have understood what they have just learned. Solution videos and formative explanations and feedback are also provided with each question.

Further information

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students’ learning with effective learning techniques: Promising directions from cognitive and educational psychology. Psychological Science in the Public Interest, 14(1), 4-58.

Bhansali, A., Angstmann, E., & Sharma, M. D. (2020, September). AEQ-PHYSICS: A VALID AND RELIABLE TOOL TO MEASURE EMOTIONS IN PHYSICS. In Proceedings of The Australian Conference on Science and Mathematics Education (formerly UniServe Science Conference) (pp. 93-98).

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