Dr Ananda Maiti – UTAS – 18ᵗʰ June 2021

Intelligent interfaces and feedback mechanisms for online education

Purpose and context of the presentation

The presentation focuses on operating remote laboratories for online education with a subject focus of education. Laboratory work is central to engineering pedagogy. Students need to learn a theory and then be able to demonstrate that they understand the theory and can apply their learning. Lab work offers students the opportunity for revising conceptual knowledge, validating knowledge with practical application, hands-on experience, including for safety and efficiency, and collaborative group work.

Remote labs during COVID-19

During COVID-19, networking labs were converted into remote access labs so students could access them from their PCs. This enabled them to use the labs as if they were sitting in front of the computers and they could configure everything from their home PCs. For networking or AI lessons, typically students get remote desktop access to the machines and they can log in and access content for learning software.

Remote labs need more RAM and CPU power. They are low maintenance but still have associated costs. Successful remote labs consider scheduling and student access, e.g. using time allotment (shorter experiments) and queuing (longer experiments).

Benefits and challenges of online labs

- **Logging:** everything the student does (commands, programs, configuration and setup) can be logged, unlike in classroom labs, so that the teacher can monitor all elements.
- **Hands-on limitations:** remote labs cannot provide a full hands-on experience. VR technology has been posited, but access issues prevent this from being a universal solution.
- **Collaboration issues:** Online experiments are typically designed for individual experiments, not group work.

Intelligent computing in education

Intelligent computing is adaptive to student needs, can identify common problems and has 24/7 technical support. It can support education by providing more feedback to students, alerting teachers if students are having problems, identify issues with instructions and respond to student requests for what to do next. AI enables inputs to the remote labs to be automatically evaluated; however there are limitations to assessment in that students may be able to ask for so much help that they do not learn.

AI works on pattern recognition and must be trained so that it can generate a model according to the teaching material. This is particularly useful for objective experiments where students should follow a step-by-step process. The AI takes several semesters or years to be trained, which limits how much a subject can change.

In the remote lab, AI ensures that every input is digitally recorded, data is collected and stored in real time, and outputs are generated:

- The progress of the student with respect to time and their peers. Weekly tasks are divided into smaller learning goals with a suggested timeframe. The AI monitors the student's progress and can notify the teaching staff to follow up with students falling behind.
- Limited feedback, restricted to yes/no responses and prompts. However, feedback to ensure understanding remains a human-oriented activity. Useful feedback strategies include:
  - Telling students what is missing rather than what to do next.
  - Asking students to check back through points.
  - Enabling students to check correctness, but with limited attempts.
  - Real-time feedback is best when student input is poor, but allowing some attempts first is preferable.

Instructional design for remote labs

- **Modular design** is best, as large tasks often have multiple solutions, but students working remotely need step-by-step tasks. Smaller tasks help the AI to support the students. This is especially true for complex programming tasks with different programming languages.
- **Single user focus** is preferable as scheduling multiple users together is difficult. Group based activities also depend on network capacities and whether all group members log on to do the work or leave a few members to carry the load.
- **Time requirement** – activities tend to take 10-15% more time online due to web interface and devices.
- **Video-based tutorials** help to demonstrate the practical elements of the experiments.

Conclusion

Remote labs offer an augmented learning experience for simple experiments, can be supported with AI tools which can compare students' results and performance. Ongoing considerations include:

- Using AI to support data analysis,
- Whether it is possible to monitoring students' cognitive load and wellbeing through AI, and
- Whether webcam use and eye tracking to monitor student engagement is ethically appropriate due to student privacy.

Presentation Summary - Extracted Key Points from June AAAF Presentations