

Australia-ASEAN Academics Forum:
Online Education during COVID-19 and Beyond

AAF Dr Ananda Maiti's talk 18th June 2021

Monica

Thank you so I'm going to begin with the acknowledgement of country and then I'll introduce a speaker. So the Australian ASEAN academic sport of online education during cover 90 and beyond acknowledges the traditional owners of the land where this program was developed the palawa of people of the lutruwita nations. We pay respects to the traditional owners and to the elders past present and emerging of the land in which the University of Tasmania campuses stand on behalf of the University of Tasmania we acknowledge all countries participate in this for and also acknowledge their elders and ancestors and their legacy for us. We acknowledge the traditional owners of the lands where our partners and participants live and work across Australia and southeast Asia.

So now it's my privilege to introduce our speaker to you and he has the terrific position of being our last speaker for the for the conference. So this is Dr Ananda Maiti who is a lecturer in information and communication technology in the school of ICT at the University of Tasmania. His teaching areas include the internet of things, web technologies and cloud [inaudible], he has a deep interest in technology enhanced learning specifically the use of remote laboratories for various aspects of engineering education.

Remote practical education requires a range of software-based services that are provided online and this is a key area of research within learning. Dr Maiti has influenced his affiliated with the [inaudible] lab and Newman Campus and also undertakes han interaction research with Australia with the Australian maritime college. I think Dr Ananda will present his presentation and then we will have questions at the end if that suits and I'll pay attention to that to make sure that people have an opportunity to ask questions so over to you thank you very much.

Dr Maiti



**INTELLIGENT INTERFACES AND FEEDBACK
MECHANISMS FOR ONLINE EDUCATION**

Remote Laboratory Case Study

Ananda Maiti

different ways we can incorporate
intelligent interfaces

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18/06/2021

So hi I'll be presenting this this I mean today I'll be discussing about the different ways we can incorporate intelligent interfaces and feedback mechanisms in online education. But I'll be

specifically talking about the remote laboratory thing so I mean there's obviously nowadays we are using AI I mean artificial intelligence and machine learning in a lot of educated fields as well for generating feed [inaudible] that is purely online and required to be to be online and which actually was a very important thing when last year due to the COVID-19 when we went online. We faced big problems regarding engineering or engineering style courses where people really need hands-on experience and need to deal with hardware and see things happening for their learning experiences.

OUTLINE

- Online Education
 - Practical Education with Laboratories
 - Remote Laboratories
- Computational Intelligence
 - What it is ...
 - How can it help in online education

education
specifically

So the outline is I'll be talking a little bit about the online education specifically in context of some engineering education things and the importance of practical education with laboratories and what is remote laboratories in general. Then I'll talk a little bit about the computational intelligence or how the intelligent things works in an online education context.

ENGINEERING EDUCATION

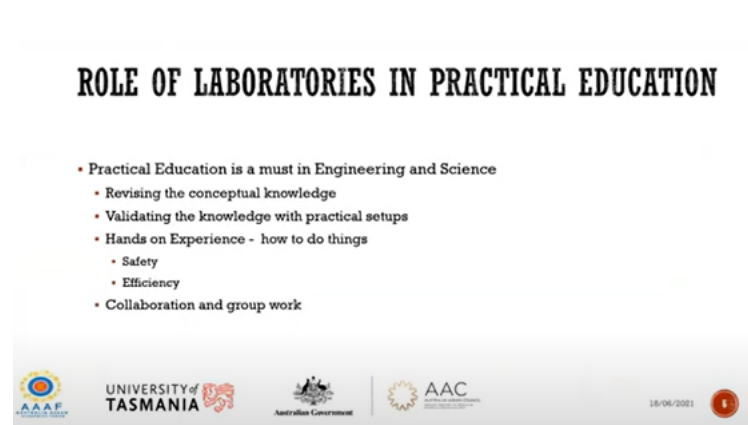
- Education related to engineering fields.
 - Involves learning a concept, strongly supported by mathematical models
 - Verifying the concepts through real-world examples
 - Service-learning
- Engineering Education includes various fields – general physics, chemical, mechanical, computer, electrical, architectural etc.
- Practical knowledge of engineering and its context is essential

broad terms
uh is

So engineering education in a broad terms is about like anything that is related to the engineering fields like the like it could be about general physics anything related to chemistry, mechanical computing, electrical, architecture and a lot of other things. So it basically it's all almost always involves learning a concept like related to physics or I mean it could be any scientific concept and then it is usually supported by a mathematical model. So for example if you are learning in electrical engineering if you are learning something like Ohm's law you have the equation of the Ohm's law and then you actually have to verify it by implementing a circuit and then applying voltage and then seeing it on a graph or on a device like that. So that's how typically every engineering field will work.

So depending upon what field it is it could be like a small setup on a table or it could be a very big thing like in the in the surveying and all which is done in outdoors and also. These are the that's the general characteristics of the in the engineering education in specifically in these fields. So we always stress on that we have to like the student learning is finished when they can actually apply their theoretical knowledge into a like a practical setup where they can show that well this actually works or it even if it doesn't work 100 per cent it works to an acceptable level. So that's how they learn.

And this is where we a lot of the new technology or new there's a new drive to incorporate service learning within this the engineering context is that we, it's difficult to do here in Tasmania, specifically during lock-down situations and all but generally we try to take the students to a real-world environment and try to solve a real problem. Once again it may not be 100 per cent correct but at least it's a workable solution and from that they'll learn all the aspects of the of applying any knowledge in a real-world situation. So that's why the practical knowledge is a very important in in this type of education. So yeah so that's why the practical knowledge is very important and okay.



ROLE OF LABORATORIES IN PRACTICAL EDUCATION

- Practical Education is a must in Engineering and Science
 - Revising the conceptual knowledge
 - Validating the knowledge with practical setups
- Hands on Experience - how to do things
 - Safety
 - Efficiency
- Collaboration and group work

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So that's where the role of laboratories comes in. So in practical education you have to like draw the conclusions like for example, you have to generate a graph or you have to generate a like a some kind of mathematical model or sometimes you actually have to calculate or recalibrate your setup according to what you see. So it's step by step procedures and which involves a lot of hands-on experience. So you takes you like put something in a bottle and then you add some more chemicals or you increase the voltage on the apparatus and then you see what's happening and then you essentially keep changing that like and you keep on improving whatever you have you are doing and then you keep lab notes and then you ultimately achieving your learning outcome.

So with the hands-on experience the key things are that that we want to teach the students is about safety and also efficiency so how quickly you can do it using the least amount of resources or without setting things on fire and all those things. So that that's part of the hands-on experience. The other key thing about laboratory education is about the collaboration of group work so almost always in the lab you want to work in groups at least groups of two. Like somebody is doing it the other one is watching and verifying whether things are working correctly or not. Also if you if in science education specifically, you want to verify things like whether the recorded values are all correct or not or if you are building a circuit then whether the wires are connected and everything all is kind of is connected correctly or not and all of and then we want we encourage students to talk to each other a lot during the laboratory activities.

WHAT DOES IT INCLUDE?

- An apparatus – the main hardware setup
 - Can be a rigid body big electronic devices
 - Can be a flexible body setup
 - Reconfigurable with software/electronically or mechanically



- Consumables

So what it involves is an apparatus which is the main hardware and then we can have it could be like a rigid body like a big electronic device or it could be a flexible body setup with some wires and all those things. Some other equipment can be reconfigurable with the software or electronically or sometimes you just have to reconfigure things mechanically with hand.

So you like there's during experimentation with this sometimes you have things like consumable so specifically if you think about chemical lab experiments, then you are always using the chemicals and actually throw out the chemical that has been already been used or already been converted into something else and then you have to bring in new substances for the next round of experiment with newer students.

In some other kind of experiments like the electronics ones they are quite you know there's not much of a consumable thing so once you make this circuit you actually it can be reused for a lot of students so they can just come in change the parameters get the reading and then keep on doing so without actually having to re- reorganize anything physically. So this this is included in the in a normal lab activity.

So with the remote lab what we I usually do is that we just put that put all of that in on the internet. So we have this setup that is already created and that is put on the internet so that you can go to a website and you can see the operators through a camera and then you can give some inputs and then you can run the things remotely so that's the basic essence of the remote lab.

WHAT DOES IT INCLUDE?

- ICT or computation only labs
 - Typically, when high end computing resources are needed
 - Networking or AI
- Remote Desktop access
 - UTAS Labshare was created to give ICT students access to the PC and Mac Labs for teaching purposes.


Now there is another context specifically in context of ICT or computation only labs where you can where there is no external apparatus that is used it's all software so and which is this is more important in context of say high-end computing resources when they are needed like for example in networking. So in our university, we some of the networking units that we are teaching we

converted them into like remote labs during COVID-19 and the students essentially had managed remote desktop access to those the computers that were already in the lab. So they could then use it as if they were sitting in front of it and then configure everything in terms of networking and all those things.

The other requirements usually is when we need like more RAM or more computing resources like the CPU power and all those things. Which is typically needed in when we are teaching artificial intelligence or computer vision or anything like that. So in those cases as well we usually typically will give a remote desktop access to the machines and the students just log in and access the content as if they were in front of the in front of the actual machine. But this remote desktop context usually concept usually works when it is like it's the software only thing that we are teaching to the students.

ONLINE LABORATORIES

- Remote laboratories are the online version of the practical experimental setup.
- The setup is connected to internet.
- Lets students access the learning materials and equipment anytime and anywhere.
- First appeared in early 2000s
 - Main need was to manage resources and give students more access
 - The online interface was basic
 - In early days, it was mainly about electronics experiments



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So online laboratories are the online version of the practical experimental setup. So it is connected to the internet and it, the remote labs has been around for a very long time. So the first remote labs they appeared in early 2000s and their main motivation was to give the resources to a lot of students. So back then the issue the universities faced was that we had only one big setup which was very costly back then. I mean these days electronics are pretty cheap so but back in the early 2000s even in US or in Europe the cost of equipment was pretty high, so we only had say one or two equipment and we had to say 50 students so it's difficult to do that in a in a lab. So like you can't give every student access or enough learning time to be able to access those things. So that's why that was the primary motivation or the original motivation of going with remote labs

The online interface back then used to be quite basic so you actually just got a screen with a camera where you can see the interface and give some very basic inputs. So typically in the very big early stages it was always about electronic experiment because they were the easiest to put online so you already had high-end equipment that were connected to the computers and you essentially just connected them back to the to the web for students to access them.

EXAMPLES

- iLabs (US, Australia and various places)
- WebLab (Europe)
- REXlab (Brazil)
- Golabz
- iSES
 - <https://www.ises.info/index.php/en/laboratory>







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Some of the examples so this is just a very few examples there's probably hundreds of these labs developed by different universities across the world. So the iLabs was the first of its kind and then which was started in the MIT in United States and then it was like in Australia it was also built. Like the iLabs main a concept was to be able to share experiments through a common web platform so then you could build an experiment anywhere. So initially it was in the US but then in the university of Queensland they implemented a radiation experiment and a few other experiments there which were put through the online through the iLabs. And then there's quite a few other experiments online from Africa and some of some of the African countries and I think a lot of the latest experiments are now online from Europe as well.

Then a separate project started in Europe called WebLab which again had the same aim of putting experiments online but and then there was another similar one in REXlab in Brazil. Eventually a lot of these actually overlapped like the there was a federation of the remote labs started around 2015 with the Golabz project which was mainly is initiated in Europe. And then they actually like the way they designed it is that if you have an experiment then you can put it online and you can share the access to your experiment through this global platform of the Golabz website.

There was I put the iSES as another example. This one allowed the students to be very flexible so the other experiments were like you get the you get an interface like this and you get a bunch of buttons and you can see the graphs going up and down like that according to your experiment like that. iSES allowed a the students to like reconfigure the hardware using some electromechanical mechanisms and then run the experiment after that so that's just another example that's like as I said there's a lot of examples of remote labs in various different fields across the world.



ONLINE LABORATORIES

- Key aspects of the remote laboratories:
 - Scheduling:
 - Manage student's access
 - Different strategies: time slots, queueing
 - Student experience is different for each type
 - Web interface
 - Controls
 - Visual Feedback - Camera



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Yeah so some of the key aspects that we need to address in terms of learning and teaching with remote labs is like, you need to be there should be a proper scheduling mechanism. So if normally the students is going to the lab they are already scheduled as and they everybody goes into a room and then they do the experiments in the room. But after that like if you put everything online, then we have to schedule things properly so. Like students do the experiment on their own from their home or wherever else but they don't have like a coordination on who is able to access the experiments at what time and because the experiments can have different configurations, we have to reset the experiments before somebody else can start the new experimental session. So scheduling usually manages those kind of access things. And there's there are different strategies we either fix things by one hour time slots or 15 minutes time slots and things or people just submit their experimental request and it is put in a queue and executed after some point of time.

Student experience in this is quite affected by this one mainly because if you if the experiment takes a lot of time you usually want to put it in a queue but if it takes a small amount of time you want to give time slots to its students. But the length of the time slot you have to be very careful that it's actually proportionate to what you expect the amount of time the student will need to finish the activity. If it's too small then the students they usually get frustrated and they can't finish it in one session and then they have to come back and do it again at a later time.

So that's the other aspect is the web interface which will include some of the controls and a visual feedback through the camera.

WHAT WE DID IN UTAS

- Teaching of electronics and computer systems units
 - Since 2017 we had some form of remote laboratories for teaching embedded systems
 - Since 2020, this has been expanded to internet of things and web application units.

So in at the University of Tasmania so we have the remote lab specifically designed for emergency systems and internet of things applications so that's.

INTERFACES

Automation

Actual Devices



Web Interface



So this is the interface that we use in at our universities that we've got the actual devices on the left hand side so that's the blue color boards are what the students would actually get in the actual lab if they do it face to face and then they connect it to the to their computers and they upload the programs and everything.

But if we want to do the same thing remotely, then we have to attach some of the automation features on around that. Which then lets the student control the environment as if they were in front of or using the device hands-on. And then they do exactly the same activities but they have to use a web interface through the browser to set certain parameters and alter the environment for each of the sensors on this board. Now this is obviously one example specifically for IOT and embedded systems teaching. There can be like many different experiments like this but they will typically have the same kind of web interface with the same kind of components here.



ONLINE LABORATORIES

- Key aspects of the remote laboratories:
 - Everything can be logged, unlike a classroom lab
 - Commands
 - Programs
 - Configuration Setup

So one of the key aspects of the remote lab or using remote labs entirely for teaching is that everything can be logged unlike a classroom. So in a normal if it's a face-to-face teaching in a classroom then the students what they can do a lot of things but we cannot log the things, like the we cannot like no computing devices can log what buttons were pressed or anything like that. So it becomes a bit difficult to monitor what the student is doing. But if we do it everything online then the advantage is that every button they press or everything they do every parameter they change every program they upload or everything they do is now can be recorded with time. And this actually makes the basis of bringing in the intelligence or providing intelligent services on this online platform.



PROBLEMS WITH REMOTE/ONLINE LABS

- Lack of hands-on experience
 - Virtual reality – needs ubiquitous devices
- Lack of collaboration
 - Shared web interface – network is an issue

Some of the problems with remote labs online is that it doesn't give you much of a hands-on experience there has been attempts to like address this issue by using virtual reality so we have like some experiments where you put on a HMD to see a virtual reality and then you move your hand using some kind of like the leap motion or kinect or any other device like that where you can alter some parts of like some older things in a virtual world. But it usually will require a ubiquitous device that everybody can use like a mobile phone or things like that. But it's still a problem it's not, there is no global solution for this lack of hands-on experiences if we do things with remote labs only.

The other issue is the lack of collaboration. So usually when we do this kind of experiments online, we can't really expect students to form a group. They can do it like if we ask the students to use the setup simultaneously at the same time they can do it but typically when we design the learning teaching models for the online labs we make it as if it that it has to be done by a single person only.



INTELLIGENT COMPUTING IN EDUCATION

- Adaptive to student needs
- Figure out the problems – common hurdles
- 24x7 availability of support – improved version of google

...

So now the next part of the discussion is regarding the intelligent computing in education so what can the computer computational intelligence do in the education field? So it's mainly the it can adapt to the student needs. So if the student is facing difficulties the ai can detect that and then provide more feedback or it can like at least try to alert the tutors or the teachers that well this this student is facing some problems in this area. It can figure out problems like common hurdles like the if the instructions if the learning materials are not proper, or if there is something missing from there for which every student is failing to implement something, then that can be monitored as well automatically.

And then obviously it will allow it can allow for 24x7 availability of support. So it's like students at the moment if you can if you if the students face some difficulty they can always go to Google and see or this is like this is the solution to their questions. So if we have the same kind of intelligent support for online laboratories, then we can say the students if they face a difficulty they can ask for the feedback what's what to do next and like that. So these are some of the aims of putting intelligent computing in context of any educational teaching.



INTELLIGENT COMPUTING IN EDUCATION

- Automation
 - Let the students submit 'anything'
 - Evaluate automatically

- Example:

- Text mining –
 - Plagiarism
 - Marking

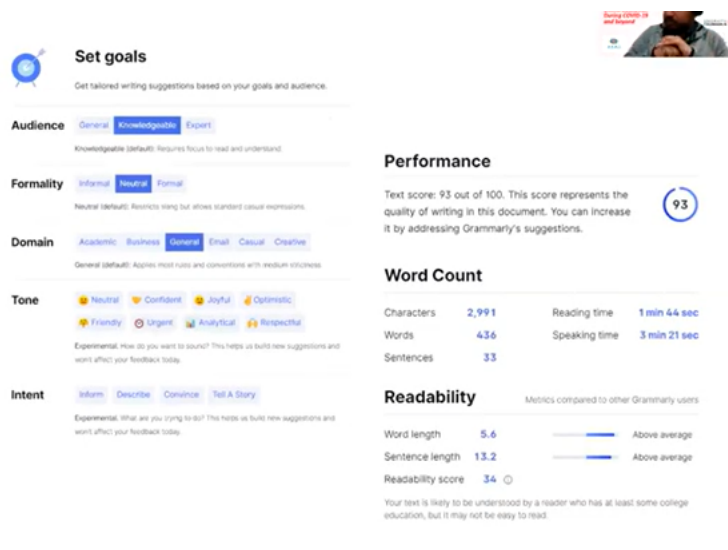
educational uh teaching
uh

So in the remote labs, it can also allow for automation. So if students can submit anything and the inputs can be then automatically evaluated. So if you know in a normal classroom if the tutor or the whoever the teacher is can monitor the student whether they are pressing the right buttons or giving the right inputs which are safe and according to the learning objective and all the things. But if the student is doing these things alone from their home through this when there is nobody else to watch, then we can have the AI look into the inputs that the student is giving and then they can like it can either like say this is not a valid input, so then it can be checked or they can they can see they can give some feedback that all this you need to change these parameters and then correspondingly revise the input and then execute it on the remote lab.

So intelligent computing is being used in education already in context of text mining which is used to detect plagiarism and also scoring and marking a lot.

EXAMPLE

- Grammarly
- allows the user to tweak a lot of parameters.
- The software then measures the quality of the documents.



Set goals
Get tailored writing suggestions based on your goals and audience.

Audience General **Knowledgeable** Expert
Knowledgeable (default): Requires focus to read and understand.

Formality Informal **Neutral** Formal
Neutral (default): Respects strong but allows standard casual expressions.

Domain Academic Business **General** Email Casual Creative
General (default): Applies most rules and conventions with medium strictness.

Tone
 Neutral Confident Joyful Optimistic
 Friendly Urgent Analytical Respectful
 Experimental: How do you want to sound? This helps us build new suggestions and won't affect your feedback today.

Intent Inform Describe Convince Tell A Story
Experimental: What are you trying to do? This helps us build new suggestions and won't affect your feedback today.

Performance
Text score: 93 out of 100. This score represents the quality of writing in this document. You can increase it by addressing Grammarly's suggestions. **93**

Word Count
 Characters: 2,991
 Words: 436
 Sentences: 33
 Reading time: 1 min 44 sec
 Speaking time: 3 min 21 sec

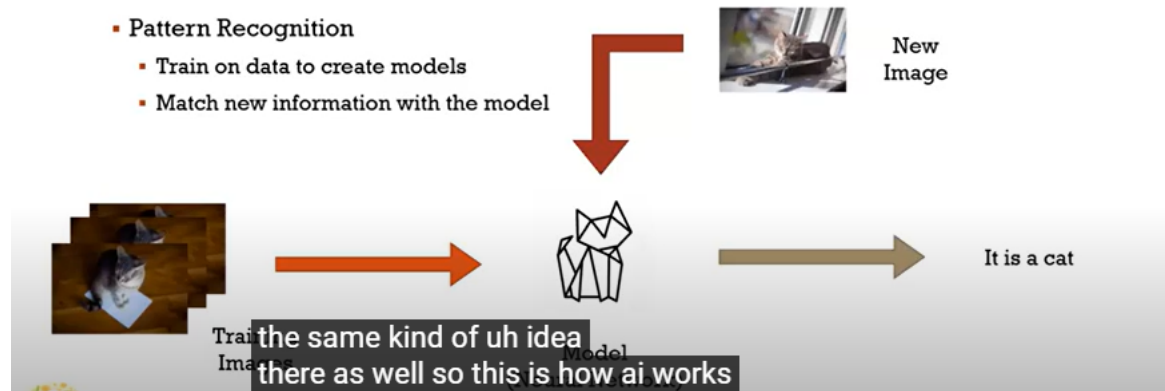
Readability
Metrics compared to other Grammarly users
 Word length: 5.6 (Above average)
 Sentence length: 13.2 (Above average)
 Readability score: 34
 Your text is likely to be understood by a reader who has at least some college education, but it may not be easy to read.

So just as an example people use Grammarly to set some parameters like the who is the audience or the like the domain and the tone and all those things. And the software like Grammarly then will give a score like 93 out of 100 in this context and then like analyse the document which is usually an essay or like a paragraph and then figure out its readability and the correctness of in in context of

grammar and everything like that. So in so when we talk about the remote labs we can apply the same kind of idea there as well.



APPLICATION OF AI



So this is how AI works in general I want to go into details of AI obviously. But the way it works is that you use a lot of training images I mean, if it's an image processing then use images if it's sound then you will use sound files and all those things. But it involves a lot of training material which is then used to generate a model like using a neural network or whatever. And then when a new image is put in then our new item is put in then it will be able to tell you that well it is a cat in this image here but it will be able to identify or classify whatever the new image has that has been put here.

So we can replace this concept of images with anything that the student does in the remote lab and then figure out whether that whether whatever they are doing is it good or is it bad or what should be the next change.



APPLICATIONS IN REMOTE LAB

- Every input is recorded digitally - commands, programs, and configuration setup
- Real-Time data collection and storage
- The inputs for AI can be any of these
- **The outputs are:**
 1. The absolute quality of the input for any given task.
 2. Progress of the student with respect to time and peers.
 3. Feedback generation on the input based on its type.

So specifically applying this kind of concept in the remote labs so every input is recorded digitally so like combines programs and configuration setups and everything. Data is being collected real time so whenever the student is online and they are pressing the buttons and then changing the

environmental parameters or uploading their programs, everything is happening in real time. So it's like and then so the feedback can be generated in near real time as well. So the outputs in this context will be like the or the way we can implement the AI in this context is that we can determine the absolute quality of the input for any given task. So if we are asking the students to do something like say turn on an LED or turn on a motor or anything like that, how good their program is to solve that problem. So we can we can monitor the or evaluate the absolute quality of the input that is given by the students to solve this task. Or we could also monitor the students' progress with respect to time. So if they are doing the things are they doing it in a timely manner or not and also generate the feedback according to what the students are doing.



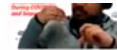
1 ABSOLUTE QUALITY ASSESSMENT

- This is basically similar to marking an exam.
 - We grade what ever the students upload or do on the web interface
1. *Input for AI:*
 - Student inputs to the experiments
 - Collected over a few semester
 - The learning activities must be the same each time
 2. *AI Model:*
 - Contains all possible classifications of student inputs

So if we want to like evaluate an absolute quality of the students then we it's very similar to marking an exam. So we can create whatever the students upload or do on the on the web interface. So the input in for the AI in this context is whatever the students press the buttons or their or the slider moving or anything like that. And we collect these inputs for a few semesters or like over a few years of time and then we train the AI that is running on the server with these previously collected information.

One of the limitations that is that it's if we use AI in this way it limits the amount of change you can do over the year. So if we train the model on a set of activities that were done in last year, you have to use pretty much the same activities this year. So if you change the learning and teaching activity you can't use the same AI model from last year in this year's in, you can but it becomes pretty quite difficult.

So the so the AI model that is generated will contain all possible classifications of the student input so if the inputs is like whether it's good bad or anything in middle like it's missing some components or there is something in the input that is not supposed to be there. So all this classification can be given by the AI model. So it work it will work pretty much as the same as the image processing one so we have all these training programs that has been uploaded by the student previously, and then we create the model a new program comes in and then the AI can say well the program is actually good bad or if it's missing something.



2 PROGRESS OF STUDENT

- Critical aspect of the student is to be able to complete tasks in time
 - Learning goals - stages within each learning activities
 - Every task and subtasks 'should' to be done in a time limit
 - Live tracking of the student progress
 - Check if someone is falling behind
 - Check if student are not doing the right things

after that
so um so the

The second one is about the monitoring the progress of the students. So if it's like it is critical that the students should be able to complete the tasks in time. So and this is obviously very important it is if it is running in a single semester. So we give tasks every week and they are supposed to finish it by the next week, so if they start falling behind then they will not be able to complete the task like two or three weeks ahead of after that.

So the way we do it is that we set the learning goals we divide the single week's work into separate learning goals and we make them smaller tasks and we set the time that okay this should be doable it should be done within this time. So and if the AI will then check the program that has been uploaded and then figure out whether the output is what should be given this specific task. So if someone is falling behind, then we can live track I mean we can check that in life and if the students are not doing the right things or if they are not uploading the right programs, then the tutors can know that pretty easily.

There is the thing is like there is no restriction that the students have to do it all at the same time. Like in the in the lab class so they could be doing it at any time before the deadline and then the system can automatically evaluate the performance right there.



3 FEEDBACK GENERATION

- What to tell the student?
 - *Direct Feedback:*
 - Given the answer directly
 - *Indirect Feedback:*
 - Point out what should not be there in the inputs
 - Provide hint on what should be there
- Where to stop?
 - Ex. Grammarly has no end
 - But online learning cannot give all the answers

The feedback generation is the third step which is what to tell the students. Now this one is quite difficult to do is that because it's easy to evaluate whether the students are doing things correctly or not, but it's very difficult to give a proper feedback to the students to ensuring that they understand things correctly. This is still a very human oriented activity like if I am teaching this thing in a class, I can understand okay this is what difficulty the student is facing, so I give a feedback that is very like fine-tuned to the difficulty that the student is facing.

Doing that with AI it's still a bit difficult. There are several examples like chat bots and that are usually put on websites and all which does this kind of thing, but it's still not at a stage where it can actually cover learning and teaching so you don't want to tell the student something that they don't understand and they are confused even more from before. So usually the strategy we can take is that we tell the students what's missing rather than trying to tell them that what to do next. So and we can give this feedback directly like saying that okay you it's failing or it is successful or the steps that are successful and the steps that are unsuccessful so you can give that direct feedback or we can give an indirect feedback where we can point a pointer that these are the things that should not be in the inputs in the program or in the input or anything like that, and these are the things that should be in there.

We can ask the students to simply check through the points whether they have included it so the other aspects with feedback is that where to stop. So if the students are given the like the opportunity to press a button and ask for feedback all the time then they could be like just asking for the feedback and their entire learning will be dependent on well how quickly they can press the button and then get the answer and then keep on doing that.

So just in context of Grammarly again, if a student is submitting an assignment and they put it on Grammarly and check the correctness of it they, can keep doing it like all the time it's not a problem. But in context of the engineering education where we are trying to get the students learn the physical implications of say turning a button on or off, we cannot it's not a good idea to tell the students everything step by step. So the critical challenge here is that how much feedback is good and how much feedback is like giving it all away to the student.



3 FEEDBACK GENERATION

- **Real-time vs on-demand feedback**
 - Should we provide feedback automatically – the system can monitor the students in real time.
 - Should the feedback be given only when student wants it.
- **Depends on activities and the desired speed of the student**

The other thing is about real time feedback first is the on demand feedback so should the feedback be given automatically? So if the system detects the student input is bad should the system be telling the students that oh this is bad? So you just need to improve it or the student should be

asking or at least they should be doing it a few times before they are allowed to see the see your feedback to progress further.

So all of this again will depends largely on the actual activity that is being done and the desired speed from the students. Like it depends on the deadline that you are giving to the students to finish the task so if it's short then you probably will like give more on demand feedback on real time.



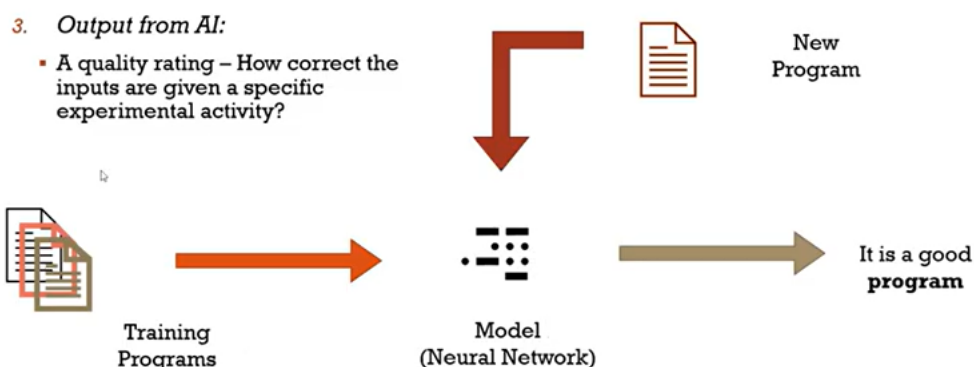
INSTRUCTIONAL DESIGN FOR REMOTE LABS

- Modular
- Single user focused
 - Scheduling two users at the same time is difficult.
 - Group based activities are difficult.
- Activities typically take 10-15% more time for the students
 - Due to web interface
 - Client devices
- Video based tutorials – not just text and images

Also okay so the instructional design for remote labs it becomes quite challenging because it has to be fairly modular. The reason again is that if you make a very big task there is a lot of different ways you can solve the problem. And if there are a lot of different ways you can solve the problem then the AI model will have more difficulty in identifying the problem. So if we go back to this diagram here



1 ABSOLUTE QUALITY ASSESSMENT



because we are using already pre-prepared training materials like the training programs to create this model in neural network whatever input we have given is the learning that the AI can achieve so that's the learning rate or the learning the quality of the learning that the AI can achieve. So if we are making like if you are giving these students a very broad objective and that can be solved in a various

ways but some of those were ways were not part of the original training thing then the ai will fail to identify whether the current student submission is correct or incorrect.

Now this is again an issue in its specifically that I faced in the ICT areas is that because computer programs can be written in many ways, like it's not necessary that it you cannot force the student to write a program using some specific variable names or some EPL statement or anything like that, they can write it in any way and then it becomes quite challenging to evaluate the whole thing like that. So, if you make it modular that means that we actually like we have very small tasks which ultimately add up to make a big one. Then we can evaluate the small tasks individually which will not have much variations in how they can be solved.

So the instructional design like when the when you give the learning material or the tutorial contents and everything, we have to make sure that the tasks are divided and the students follow them one by one.

The other issue is that it has to it's usually single user focus so which means that we have to schedule things properly but we have to maintain the time gap accordingly as well. Group based activities has been tried into more labs we don't try that in our university here, but some cases like sharing the same web interface for two students is also possible but it's still a bit difficult mainly due to network issues. If one student's network is bad the other student is good, then they will have difficulty coordinating things.

The other situation we had faced before is that people's one student logging in and starting the experiment, while the other one doesn't show up. So if there is divided activities then they cannot do it if it's if it's online. However what I noticed is that the activities do take a lot more time, so not a lot more but at least 10 to 15 per cent more time, for the students like if they were able to do something in like in one hour they probably take like an hour and 10 minutes or something like that typically sometimes more sometimes less. But they usually they would need more time to do the same activity on the remote labs compared to like an on-site face-to-face lab. And this is obviously due to the web interface because they see a flat screen only and they have to identify how to navigate the and give the inputs properly instead of just using their hand to change the things which they would have done in the face-to-face.

One it also is impacted by the client devices like if you're using like a very good setup, then it's easy but if you are using if the device the client device from where you are accessing the remote lab is not that powerful then sometimes it clears up it creates problems.

The other thing that is that has been critical for remote labs is that tutorials need to be designed containing more videos. So it's just not text like in a normal class you can just give a text plus image and a lot of instructions to the students and then you can be there to guide them. But if we are doing this on the in a remote lab in online situation, then we try to give more video based tutorials so that people can see how to because they need to learn the interface the web interface is also something they need to know very well then they can give the correct input for the experiment and then obtain the experimental results from the remote lab.



CONCLUSIONS

- Remote labs has been used for simple access and control
- Augmented Learning experiences
- Can be supported with multiple AI tools for individual training

So just in conclusion, so remote labs has been accessed for they were originally created for simple access and control but, over time they have augmented the learning experience a lot and in the future they can be like supported with multiple AI tools for enhancing this individual learning or training when the students are in like isolation so they learn things from their home. And then they like they improve their on their own. So they it's not like they have to go to the to the instructor all the time to ask the questions they can actually get the feedback from the system itself.

The other thing with this with AI tools is that it can compare multiple students' performance as well. So it's not like it's it can look into many different students and figure out okay this two students are doing it very nicely so then they can compare, I mean they don't have to tell every student that they are doing the comparison, but behind the scene they can do the real-time comparison that the best students who are on track who are doing everything correctly we are getting the right output then how do we bring the student who are falling behind up to that level? So what are they not doing and then what should they should they be doing to catch up. I guess that's all.



QUESTIONS ?

Ananda Maiti

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Monica

Thank you very much that was a really a very interesting presentation and I know we had a number of people who were concerned about how to do practical classes you know how to teach practical classes for once COVID-19 overtook us all and they needed to go online. So I'm sure that there will

be some questions and comments about your program about your presentation, Thank you very much. I've got a whole lot of questions myself but I'll leave those and see whether there's somebody else here who would like to ask a question. So if you do you could either put a note into the chat and I can call on you or, you can just jump right in and ask. Turn on your mic and ask the question to Dr Maiti.

Well while people are thinking perhaps, I can ask a question. So one of the things that I was interested in was the student response how they found learning like this? Particularly those who were new to this kind of approach. So could you talk a little bit about that?

Dr Maiti

I haven't actually evaluated the exact impact on the students learning because we just collected, because we have been collecting data but normally what happens is that... I mean pre-COVID what used to happen is student use this to when they were not in the classroom. So they still went into the classroom and then when after in the afternoon they say okay I want to test out a new hypothesis or something like that, they used to do it. But their main learning and everything and assessment used to happen face to face. Now since COVID started we went online totally so it's kind of like students didn't really have much of a choice other than to use it to finish their task. But as I said like the with it the only thing that I noticed is that they take a little bit more time. But as regarding participation I didn't find any problems like they, every one of them were able to do the things as well as the general feedback was pretty good I think over 90 percent would have found it quite usable. But again that that depends on how well the activity is designed and how well the interface matches the experiments, the actual activities. I mean if you if the activity is too complex and you don't get the inputs correctly I mean the interface doesn't allow the students to interface correctly then it's a problem.

Monica

Thank you. Is there anybody else with the question?

Meridian (Brunei)

Yes, it's me Meridian thank you Monica. I think this is one of the great presentations I enjoyed from the perspective of the electronic things. Another I have questions, do you have an did you have any breakout sessions for students or yeah. And then what's your strategy Okafor you know the breakout groups works very effectively during online learning thank you.

Dr Maiti

Okay yeah that's a good point one thing I noticed in the online learning, I'm not sure if this is just for the remote lab thing or not, but is that students are usually like so okay the software that we used is the Blackboard so we so there were breakout groups and I mean student had the option of going to breakout asking for going to breakout groups and then in the record groups we used this we asked we were seeing what they were doing and then we instructed them to make changes and all.

But the concept of remote labs is that we don't it's not necessarily that the students have to finish everything during the two hours of designated tutorials. They can do everything on their own later on. And the whole idea of using the AI is that well you don't have to go into breakout groups you just can do it on your own later on whenever you want to. However one thing that I did notice, is that in the online context students sometimes who are pretty shy and easy like in asking or even saying that

they were facing problems. I don't know I'm not sure I don't know the psychology behind that, but like that's one of the reasons I started making the video tutorials because a lot of the students I found like after like this was just at the beginning of the pandemic when the lockdown started. Is that I had no way to confirm whether the students were actually doing these things correctly. I mean back then I didn't have the AI stuff or monitoring at that much I just had the remote lab and it was just logging everything and I was doing a lot of these things manually in the semester one last year.

So I started creating the video tutorial just to make sure that everybody if they want to catch up they can do it later on. But those are the issues that the AI can solve so they don't go to the breakout group, they can like or the AI can tell me look this person is not doing it correctly or not. So in the online interface right now I have the access to every code that the student is uploading I have access to the video they're saying if it's real time then I can see the video that they are seeing exactly. And if things break down or anything that happens I have the record of that as well.

Monica

Okay thank you Martin [Ortega?] I think of course I have another question. Martin are you there?
[Question from Iris in chat]

Dr Maiti

Okay so the question is *like is there a computer program which can help teachers understand better quality feedback from students* yeah not that I'm aware of. Because most of my teaching is just computer programming so there's not much of a software to do that yeah sorry I'm not...

Monica

I can answer that to a small extent only not to my experience but through my I do read a lot of research applications and there certainly are people in the analytics area who are using eye tracking with respect to student engagement and performance and so on. So there certainly are programs around that I'm afraid that's as much as my capacity to answer that question. Irish Mae?

Irish Mae (Philippines)

Good afternoon Dr Ananda. My question, I'm not really from the programming field, this is not really my expertise, but my interest is more on discourse analysis like analysing qualitative feedback experience etc. My question for you would be is there a computer program or software which can help teachers understand better qualitative feedback from students specifically about their perspectives about the lesson their appreciation or frustration about the course?

Dr Maiti

Not that I am aware of but if it's just a perspective about the lessons, you could just like collect it using any online system I suppose. Like I don't know I mean if it's just a bunch of questions that you want to ask that could be collected pretty easily. But if you want to analyse them whether because that goes down deep down into text mining context like you want to determine the mood of the like given a sentence you can actually analyse whether the mood is positive or negative yeah. There's like a lot of python programming that I have used in the past which does this but those were mainly in terms of scientific research and they don't have really didn't really have a like a good accuracy in terms of like if you they were accurate enough for in a scientific research context, but not accurate

enough when you if you want to apply it on your students like that. But that was I think one or two years back I haven't done anything I'm not updated about that since then.

Irish Mae (Philippines)

All right thank you sir the reason why I asked that is somehow I have this hesitation about getting quantitative feedback or responses from just surveys because what we learned from experience is that some students would just normally answer quantitative surveys you know haphazardly sometimes without even thinking, and we don't know sometimes if the results really yield genuine feedback or perspectives from our students. So that's why we want it as much as possible to look into qualitative but then when the feedback gets too overwhelming already. So as a teacher we wanted as we wanted supposedly to get some advice for the specific software or platform that we can use.

Dr Maiti

Yeah, I get the problem. I actually had this kind of situation in my previous university where we used to have peer feedback. So someone presented and the others were supposed to give the feedback and that was part of the actual teaching thing. The entire curriculum thing. So they were supposed to give meaningful feedback otherwise we cut marks, that was the thing so. But as I said I had written some programs myself to do some basic matching but I couldn't at that point this was like in 2017, 2018 so at that point I didn't find any software that could readily do that but yes so I'm but maybe there is now. Because the software's like the Grammarly the example that I gave is quite powerful now so there should be something like that which can give you the mood and the depth of the... but the challenge that I did find back then was that if you want to automate, these I mean I ultimately did everything myself. I mean I did it manually and then I validated it with the software so just because I don't want to rely on the software giving very bad I mean incorrect and feedback to the students. So but the challenge that you could face, is that you have to put it in the context. So like let's say as a student you know let's say let's put give the example of the peer feedback thing. So a student listens to another students and then they would have to give a feedback. Now if one of the key things is that you need to even if that feedback that was given it has depth and it's not just a random one line or two line thing, you have to put it whether that thing is in context of the presentation or not. So if the student is talking about say his topic like say making some civil engineering structures and presenting that this structure is better than that and all those things so if that was the presentation, and the peer feedback that came from the other student is that oh this is all good or something like that if that is that the context doesn't match it's going to be difficult for you to be able to you know like it's going to be difficult for the teachers to understand the quality of the feedback. You can figure out okay it's good or bad whether the student is but whether the listener actually understood or the listener actually paid attention to the final details or not is going to be a challenge.

But as I said this was a challenge like I the last time I did something like this was in 2018 or something. If you if you want to do it I don't know if that's the tools like that, you once again the issue is that you have to train the if you're using AI for this kind of things the challenge is that you have to train the model to be able to understand everything about those what the student is giving the feedback about. So it's like if the student is presenting about that the topic then the AI should

already know everything about the topic then they can give a feedback regarding the feedback given by the student.

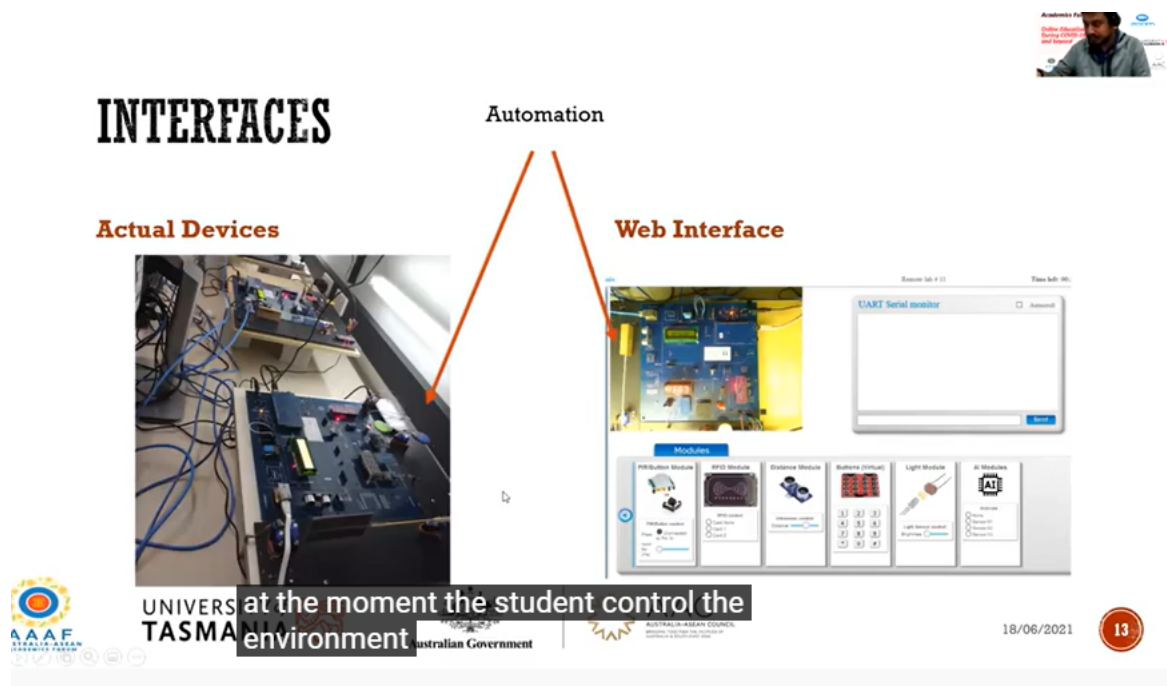
Monica

Thank you very interesting discussion so and I think Dr Maiti, one of the things that I took from your presentation is that you sort of had the two elements to it one was actually the remote learning lab and then there's the development of the AI to support your assessment and capacity to work with that and so especially things while they help your job they're not necessary to actually use AI to effectively use the remote labs. Is that correct?

Dr Maiti

Yeah I mean the topics that I mentioned today are very relevant to the remote labs, but some of the examples like if you're assessing something that is more theoretical or more written, only I mean because I'm looking at a problem that is like where something that needs to be done hands-on, so those knowledge like which button to press which where to connect and like how the timing sometimes like you have to press the buttons one second apart sometimes you have to press it two seconds apart. This this knowledge is something you have to develop in students. So those are the things that come into very important in context of laboratory education. And that's where if you can implement something AI then you can that can be very monitored in a very proper way.

But in terms of normal education AI can be used in a lot of other contexts. I actually didn't put something in context of remote lab, there's another thing that can be done which is my teacher plan is let's go to the diagram here



So if you look at the image here so at the moment the student control the environment okay but we could the ai that's another thing that the AI can do is that they can actually create environment automatically for the students. So it's like if say for example this is IOT there's a bunch of sensors here that manage the temperature I mean measure the temperature the distance and a few other things here this is IOT so that's why there are sensors like this. But in any kind of remote labs if the

artificial intelligence could create customized situations for the students to solve given an objective. So not every student doesn't get the exactly the same thing they are there is a variation in how the objective is delivered or how the objective is given to the students. Now obviously the problem comes in is that, you don't I mean there should be some parity between the difficulties like you don't want to one student to have a super difficult problem with the other student to have something easy. But you can use ai to actually create those variations and create multiple scenarios where different students will solve it slightly differently. And then they can maybe look into each other's things. but I haven't done it yet because that's too difficult and too dangerous.

Monica

Probably more sophisticated than most of us are able to do! Are there any other questions about the presentation or that sort of broader issue around having the remote learning for practical subjects? Michael please go ahead.

Michael

Hello good afternoon Dr Maiti. I would like to ask a question. I've been doing research related to machine learning. So I've been looking for like the best software that I can use to analyze the data that we're gathering. So to give a little of a context of what we're doing is, you're trying to predict what are the best predictors for the success of students in a particular exam. So currently I am considering the application Wakato environment for knowledge analysis or Rica so can you suggest any software which would be better or that would provide me more functionalities as to doing my analysis later on?

Dr Maiti

This psychic library from I think the second I can't remember the name the, that used to do a lot of the text mining based analysis. but I can't remember the actual there was a python library that I had used to analyse like the one document with another government that kind of thing. Sorry I mean the thing is like my research and stuff has moved a little bit from the text-based things, to a more program and hardware and those kind of things I'm kind of not after that with the learning and teaching that is more regarding documents and stuff like that.

Michael

Yeah I understand because we're also trying to like reach the gap between what has been conducted before the pandemic and what are those outputs or inputs that we can get from the students especially that we're integrating the online learning setup. So I think that the one that you have said about the python environment is I think very useful for us because we will, if ever we will consider to use like the text from the qualitative assessment. So that's that can be something that we can I think use as our parameters to interact. So having said that one I think thank you so much....

Dr Maiti

I just remembered it's like it's just called spacey s-p-a-c-y it's a natural language processing library from python so you can maybe try that

Monica

Swasti do you have something you want to ask?

Swasti (Indonesia)

Thank you. Yeah very interesting presentation Dr Maiti. Do you have or maybe you know like a software or a computer program that can identify like a cognitive load or a mental load? You said that yes because of this pandemic so our students have to learn online full days all of the time and also the teacher for meeting for teaching. And so if we considering about the physical fitness or psychological wellness of the students and the teachers so I think I have to know yes the cognitive load of the students when they when they join my class something like that so I know that if maybe they effective in that class maybe you know like maybe from the iBlng we can identify their fatigue what what's your idea what's your opinion?

Dr Maiti

Yeah once again I'm not aware of any ready-made solution there's probably a lot of research going on around these things. The main issue with this kind of tech is that is the technology that you want to use. So you have to if you are I mean the easiest way that I can think of is using a webcam you ask your student to turn on their webcam and you can these days AI is pretty good in identifying your mental state and everything just by looking at your face. If it gets like a good view of your face it should be it will be able to figure out it's whether you are like tired or paying attention or whether you are looking at somewhere else or something like you don't.

I mean eye tracking is obviously a thing the traditional way that these things have been done in the past, but I'm not sure if I mean depends on how you are teaching these things and if you are expecting the students to look at specific part of the screen all the time then you can use eye tracking. But otherwise maybe you probably should look at more of that facial expression and stuff.

Swasti (Indonesia)

Facial expressions yeah so okay so I yeah thank you for...

Dr Maiti

The problem with this kind of research or I mean if, you're doing it as research or development, is that if you ask students to turn off their webcam they're usually not going to not very happy to do that. And you also run into a lot of ethics related issues or you those are always a problem. That's one of the reason that I never tried to go into the details of how like look into more of on the on the student behaviour and stuff like that. I only look at what they upload on the interface. How do they like what like everything that do on the interface that is recorded, but that is always anonymized so it's very easy to anonymize those kind of input to corresponding to the students and all right. So and then the research becomes much easier and it's but yeah but obviously for if you want to detect the load and everything like that then you obviously...

Swasti (Indonesia)

Okay and I saw martin Martin comment in the chat room that he need to experiment by eye tracking so maybe martin can add in the explanation. Thank you Dr Maiti.

[Inaudible]

Martin

So because my computer hang for a while so I didn't know if he did answer my question or not but my question was if there are any online labs that allow for eye tracking experiments? So I'm interested in doing some advertising or marketing research with eye tracking also for e-learning now.

Dr Maiti

I'm not aware of any online lab that's to the... so you mean like eye tracking the students to see whether they're doing the right thing or not or you're looking for experiment that is about the eye tracking? Are you looking for a remote lab that actually implements eye tracking or you are looking for an interface that implements eye tracking?

Martin

I think yeah I got it turn it off I didn't realize that so sorry about that so what I was saying is that so I don't know if you answered my question but. So my idea is that, when I'm teaching for instance I don't know if the students are actually listening to me are looking at the slides that I'm showing or they're browsing other websites right. Or just sleeping. So therefore when I ask them to turn up the camera online with AI I can see or determine what their eyes are doing and based on those movements we can tell whether they are actually concentrated on the screen or they are doing something else without me actually having to look at the 50 of them at the same time. So I thought that was a very interesting way to analyse their engagement right. But the same type of research I was interested in doing it for marketing and for advertising so I was wondering if there are online labs or specific software that online labs is much better since I can just send it to the students where I can you know get all the data from that eye tracking,

Dr Maiti

The thing is that you need the device to do the tracking.

Martin

Well that would be the webcams right pretty much every computer or phone they use it has a moment yeah.

Dr Maiti

I mean I'm aware of some research that has been done but I don't know if there's any commercial product available that you can just start using.

Martin

Yeah well the commercial products I do know them but I was thinking on the free labs online right since my university cannot really pay for the commercial software.

Dr Maiti

yeah no I'm not aware of anything that you can just start using of the cell although it's I'm not sure it could be shouldn't be that difficult to make one because these days browser-based javascript libraries for AI are pretty strong and others can take the camera image using web kits and everything like that. So you may be able to find some examples I mean I haven't searched for them before so I'm not aware of anything specific. I should be able to find something for them.

But yeah so just out of curiosity, how many students do you actually get in a classroom? I mean when you are like?

Martin

For me, somewhere between 35 and 50. It depends.

Dr Maiti

Okay that's pretty good because I don't know about billions but I think within ICT it's pretty like usually the first two weeks people actually show up and after that they just don't stop attending the lecture it's always a recorded lecture and they then hear it back and then we don't have attendance like mandatory attendance.

Monica

Meredian, I can see that you've got your camera on do you have another question to ask? You know okay one of the things that I was really interested in was that was the issue around the sharing of devices you talked about the global platforms and how people can use some of those and contribute to some of those that seems like such a wonderful idea for other areas as well, who are people who are creating these kinds of online practical labs so I thought that was a really interesting.

Dr Maiti

Yeah so it's like basically obviously everything. Okay one of the problems with remote labs is that they are low maintenance but they still require some maintenance and needs to be built by some expertise. Like you need to have expertise to actually build it and then keep it going all the time and it varies like so every university if it's like in physics or whatever they need they know what they are building and how to keep it operating. So from the beginning, it was the tradition was that every university what they are teaching they just build the staff for their students. Then I think around 2010 the first attempt I think was made called to a system called LILA, the library of labs again in Europe. Because the thing is like in Europe pretty much every big universities has this like remote labs and so they started to combine the things and started to share the things so the experiments were still hosted by one university, but students from another university could just log in and access it remotely.

So that so that was the idea and then I think in 2015 the Golabz initiative was started. So that was that we take this to the school level so the same setup and everything, but we alter the learning materials to make it more easy like more suitable for two towards school children and all. So that way they were promoting the STEM learning and teaching through that. And again the idea was the same thing that we bring in every experiment from like in the world, and as long as it has a web page and can be authenticated we just put it connected to their interface.

However one trend that did happen unfortunately like in because before COVID, a lot of the remote labs I think this is just my personal opinion I haven't actually looked into the real world thing, but before that a lot of the remote labs were quite openly accessible. It's like anybody can go because they were not the main thing like they were just additional thing that the student could do. After that I think they a lot of universities imposed some kind of limits because they were the only way the students could do the engineering learning and teaching so universities just were like restricting them to their specific users and all those things. So hopefully once this is over it will go back to what.

The other way is to scale it up. The image that I showed up like I have got 12 setups of the similar setup so the student can do it if I have 24 30 or 50 then I could obviously share that with a lot of other people in the world.

Monica

Yes I thought it was a very generous activity, but I did wonder about the commercial aspects no matter how you know that I can see universities going oh we've created that you know we can't just let it go for free so

Dr Maiti

Yeah, that's the thing. So I mean if it's one or two people can give it for free but if it becomes a large scale thing and then because these machines that I showed they I mean they are meant to be running online and they do run quite well for a semester, but after that usually the camera falls down I mean I mean they just there's some issues that has to be maintained.

But at least from my experience in our university, because of the Australian border lockdown, a lot of my students were stuck in China so or overseas so they couldn't come here. So this was the only way if they could actually finish the course otherwise they had to have to I don't know how they would have done it but I mean otherwise I would have... okay the way it happened in the engineering I'm not sure about how they did it in the school of engineering in our university I think they have some remote access stuff but a lot of their because of the time limit they had to change the assignments a lot to more written only things and stuff like that during their COVID.

Monica

So, do we have any final questions for Dr Maiti? I think not so let me just say then thank you very much for the presentation it was really very interesting I'm sure there will be many things that spin off in people's minds about what they might do in their classes from your presentation so thank you very much and thank you to all of you who have participated both today but also of course across the entire conference it's been fascinating for me time such interesting presentation such interesting questions and clearly addressing such a significant topic for us all at the moment so thank you all we look forward to talking to you over the next couple of weeks about your experiences and what you're doing and look forward to seeing you again in September I think after so in small groups initially and then at the second round of our conference in September so thank you all very much see you again goodbye everyone goodbye thank you goodbye everyone thank you see you next week for the interviews we look forward to hearing your reactions thank you we will send you the information soon thank you very much bye-bye.