



OLT e-Exams:

Ramping up the authenticity of high-stakes supervised assessment for the 21st century

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Presentation for Macquarie

23 Sep 2016

TransformingExams.com

Acknowledgement Office of Learning and Teaching



Transforming Exams Across Australia

Australian Government Office for Learning and Teaching
National Grant ID15-4747: AU\$500K over 3 Years + 100K Monash



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Assoc. Prof. Shona Leitch	RMIT University
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MONASH
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Acknowledgements - Diamond and Gold Sponsors!

500K in support for this project has been provided by the Australian Government Office for Learning and Teaching. The views expressed do not necessarily reflect the views of the Australian Government Office for Learning and Teaching or participating institutions.

100K additional cash from Monash University.

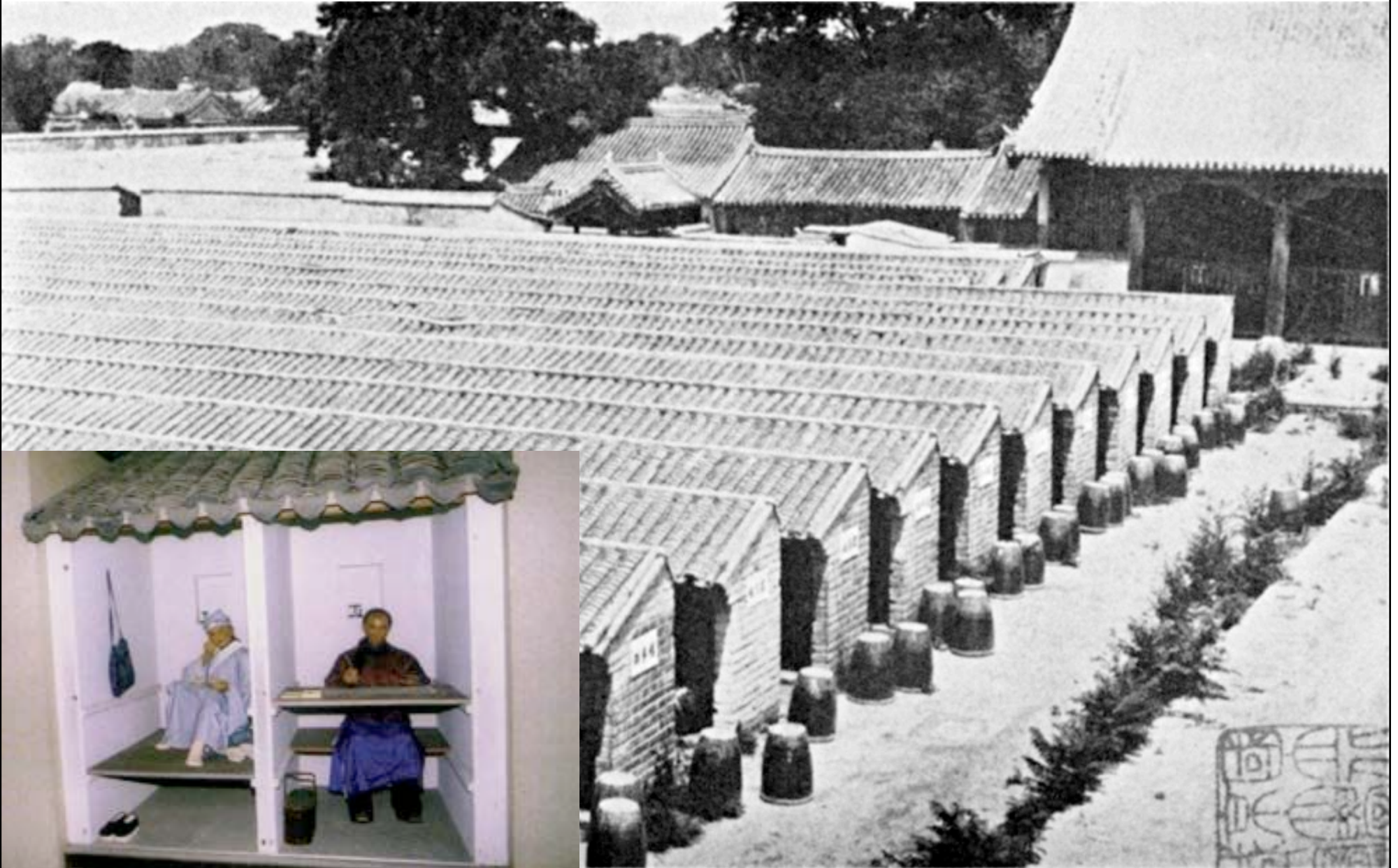
Demo & Guides



Is this your exam space?



**Actually it looked more like this and
they locked you in for 3 days!**



Imperial Examination Hall Gongyuan (1909), Beijing, China.

Questions to ponder

1. Why do we do exams?
2. Are exams still needed?
3. Can we do exams better?
4. How can we do better and what does it take?

Take 3 minutes

- In pairs, discuss should we still keep doing exams?

Then, share with the room

- Two reasons to keep (why we do them)
- Two reasons to reduce

Possible reasons to keep exams

High stakes, supervised testing is still needed because:

- Qualification identify verification (be sure it is the student's work – rise of ghostwriting/outsourcing)
- A test of the student's 'metal' under pressure.
- Accreditation requirements.
- Social/political stakeholder expectations.
- Time and workload efficiencies?
- Other reasons ... ?

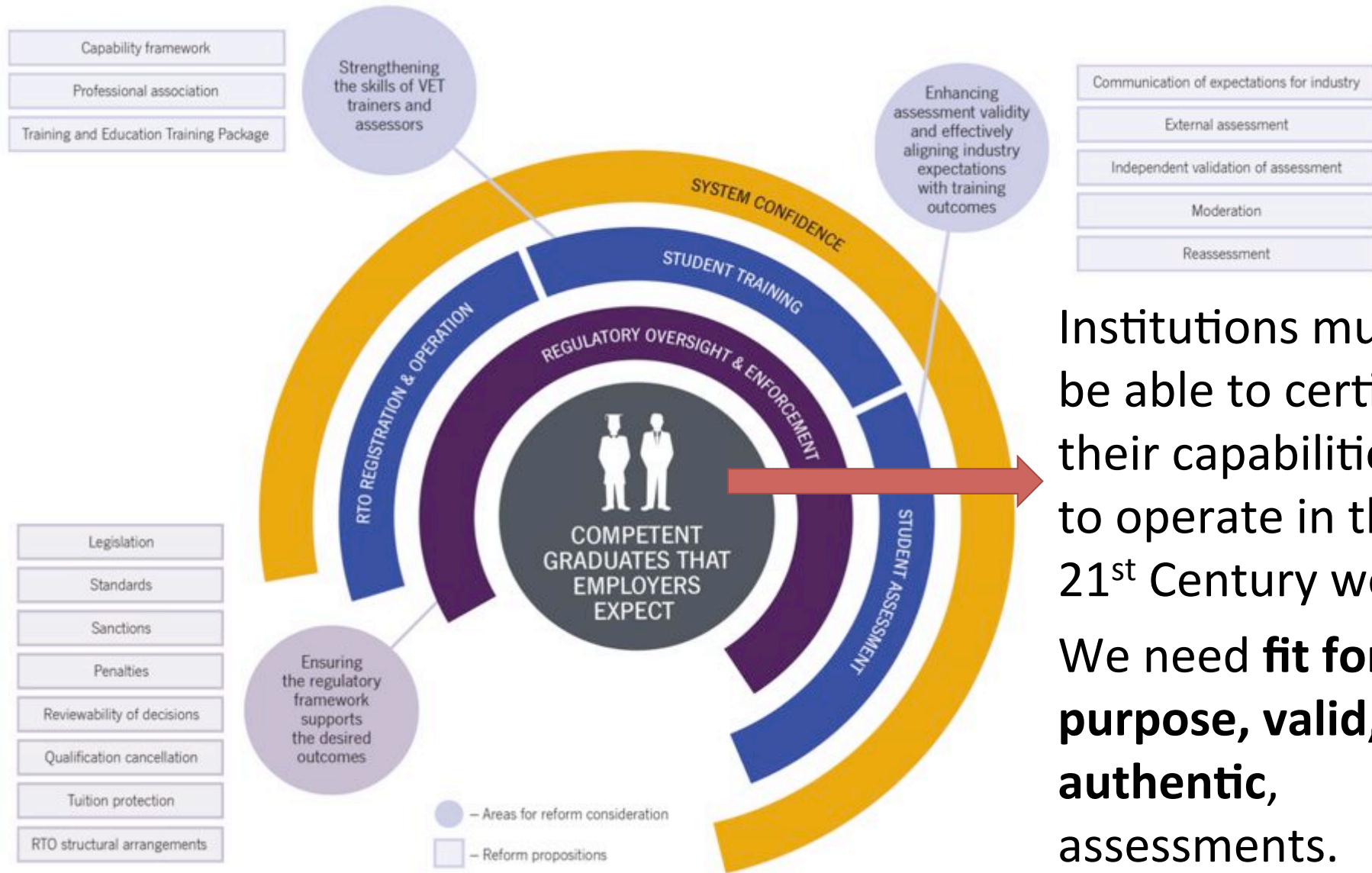
Possible reasons to reduce exams

Paper features...

- Limited pedagogical scope... MCQ/TF, short/essay response, flat and static, images/diagrams.
- End product (final response) rather than process.
- What they remember rather than what they can do (given access to real world conditions).
- Hand-written pen-on-paper is much less common as a problem solving and information presentation tool.
- Other areas of education delivery – progressive, formative assessment has moved towards richer forms of assessment, modern tools, simulations, multimedia, word processed, information repositories...

Is this limiting our ability to accredit graduates as being able to operate in the world of today, immersed in technology, information and complexity?

Quality Assessment ?



Institutions must be able to certify their capabilities to operate in the 21st Century world. We need **fit for purpose, valid, authentic, assessments.**

21st century employability skills

Quality Assessment = fit for purpose!

Ways of thinking	<ul style="list-style-type: none">• creativity and innovation• critical thinking, problem solving• learning to learn, metacognition
Ways of working	<ul style="list-style-type: none">• communication• collaboration (teamwork)
Tools for working	<ul style="list-style-type: none">• information literacy• ICT literacy• discipline resources and tools
Living in the world	<ul style="list-style-type: none">• citizenship – local and global• life and career• personal and social responsibility (including cultural awareness and competence)

<http://atc21s.org/>

Binkley, M., Erstad, O., Hermna, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). [Defining Twenty-First Century Skills](#). In Griffin, P., Care, E., & McGaw, B. Assessment and Teaching of 21st Century Skills, Dordrecht, Springer.

21C Learners

- skilled use of tools ... *as appliances? for learning purposes?*
- active learning rather than passive receiving of knowledge
- authentic learning experiences rather than contrived tasks
- construction rather than instruction
- task (not process) oriented
- just in time learning
- search not memorise
- utilise social networks
- doesn't know answer but knows where to find it
- Google not libraries
- collaborate not compete.

Elliott, B (2007)

Learning and assessment

Community expects:

Employers, professional bodies and the community are expecting graduates to be able to perform appropriately in proactive, task-directed ways where they implement their discipline specific knowledge in a context that involves many stakeholders.

But...

Universities are more often concerned with students mastering the conceptual understanding of core discipline principles and applying these to artificially constructed tasks designed for assessments that can be easily delivered and marked.

Good for us?

Maybe not so
good for student
learning...?

Rethinking curriculum design – rethinking assessment

A rethink is under way... in the broad curriculum.

We are doing better curriculum design... that facilitates both the development and assessment of discipline skills and capabilities, as well as the application of these skills and capabilities ... when done well this reflects are more **authentic environment** with collaboration with other people, information resources, modern tools of the trade.

The real world is messy, complex, contradictory, uses a range of information sources, tools, perspectives, stakeholders and techniques.

We need to move along the continuum from the artificial towards the authentic.

Things already at hand: Assessment in LMS/VLE

	QUESTIONS
<input type="radio"/> Assignment	Calculated
<input type="radio"/> Choice	Calculated multichoice
<input type="radio"/> Database	Calculated simple
<input type="radio"/> External tool	Embedded answers
<input type="radio"/> Forum	(Cloze)
<input type="radio"/> Glossary	Essay
<input type="radio"/> Lesson	Matching
<input type="radio"/> Quiz	Multiple choice
<input type="radio"/> SCORM package	Numerical
<input type="radio"/> Survey	Random short-answer matching
<input type="radio"/> Wiki	Short answer
<input type="radio"/> Workshop	True/False

Assessment options in LMSs

<- Moodle Blackboard ->

Some computer marked while others require human intervention.

Drive towards higher order thinking.

How about ... have students use tools to develop solutions and then respond via LMS.

The screenshot shows a 'Create Question' dropdown menu with the following options:

- Test
- Survey
- Assignment
- Self and Peer Assessment
- Turnitin Assignment
- Mobile Compatible Test
- McGraw-Hill Assignment
- Group Peer Assessment

The question types listed are:

- Calculated Formula
- Calculated Numeric
- Either/Or
- Essay
- File Response
- Fill in Multiple Blanks
- Fill in the Blank
- Hot Spot
- Jumbled Sentence
- Matching
- Multiple Answer
- Multiple Choice
- Opinion Scale/Likert
- Ordering
- Quiz Bowl
- Short Answer
- True/False

Many more Moodle examples transformingassessment.com

Blackboard course archive available upon request.

Moodle e-Assessment Examples

The screenshot shows the Moodle e-Assessment Examples website. The browser address bar displays moodle.transformingassessment.com. The page header features a globe icon and the text "Transforming Assessment". A red banner at the top right indicates "You are not logged in. (Log in)".

The main navigation menu includes: Home, About Us, Webinar Series, Events Calendar, Past Events, Bibliography, Contacts, e-Assessment Examples (2.3), and e-Assessment Examples (2.8).

The "Tools and Systems" menu lists: Presentations, iPeer, Mahara, MediaWiki, Moodle, NanoGong, OpenSimulator, PhpBB, QuizHUD, SBL Interactiv, Second Life, and Sloodle.

The "Courses" section is expanded to show "e-Assessment Examples", which includes: Blogs (Using blogs for assessment), Discipline examples of e-assessments (Computer Science and Programming, Augmented reality examples, Accounting, Commerce and Economics, Arts and Humanities, Biological and Health Sciences, Earth, Environmental and), and e-Assessment Associations and Groups (e-Assessment Groups).

The "Calendar" widget shows June 2016, with the 30th highlighted in green.

The "Transforming Exams" widget features a logo with the letter 'e' above the word "Exam" and the text "Open source or scalable, invigilated high stakes assessment."

<http://moodle.transformingassessment.com/>

Interactive tools in assessment

Question 1

Not complete

Marked out of 1

Flag question

Edit question

1. Student clicks a link embedded in the quiz to launch a separate app.
2. Undertakes a task as instructed.
3. Then responds using selected response or numerical input to suit.

Open the [trading forecast applet](#) to assist in matching the following statements. Click on 'Cash flow' to enter sales data as shown in the following diagram.

Income	Startup	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Tot.
Sales	0.0	100.0	100.0	100.0	100.0	400.0
Owner's capital	500.0	0.0	0.0	0.0	0.0	1000.0
Other	0.0	0.0	0.0	0.0	0.0	0.0
Monthly Totals	1000.0	100.0	100.0	100.0	100.0	1400.0

Expenditure	Startup	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Tot.
Materials	500.0	50.0	50.0	50.0	50.0	700.0
Proprietor Drawing	0.0	20.0	20.0	20.0	20.0	80.0
Overheads	0.0	10.0	10.0	10.0	10.0	40.0
Miscellaneous	100.0	10.0	10.0	10.0	10.0	130.0
Monthly Totals	600.0	90.0	90.0	90.0	90.0	950.0

Cash Flow	Startup	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Tot.
Cash movement	400.0	10.0	10.0	10.0	20.0	450.0
Opening Balance	0.0	400.0	410.0	420.0	430.0	0.0
Closing Balance	400.0	410.0	420.0	430.0	450.0	450.0

test Choose... ▾

test Choose... ▾

test Choose... ▾

Check

Interactive tools in assessment

Spreadsheet linked to quiz

Question **2**

Not complete

Marked out of 1

Flag question

Edit question

Use the [elasticity spreadsheet](#) to assist in matching the following statements.

For an elastic demand, as the price increases

Choose...

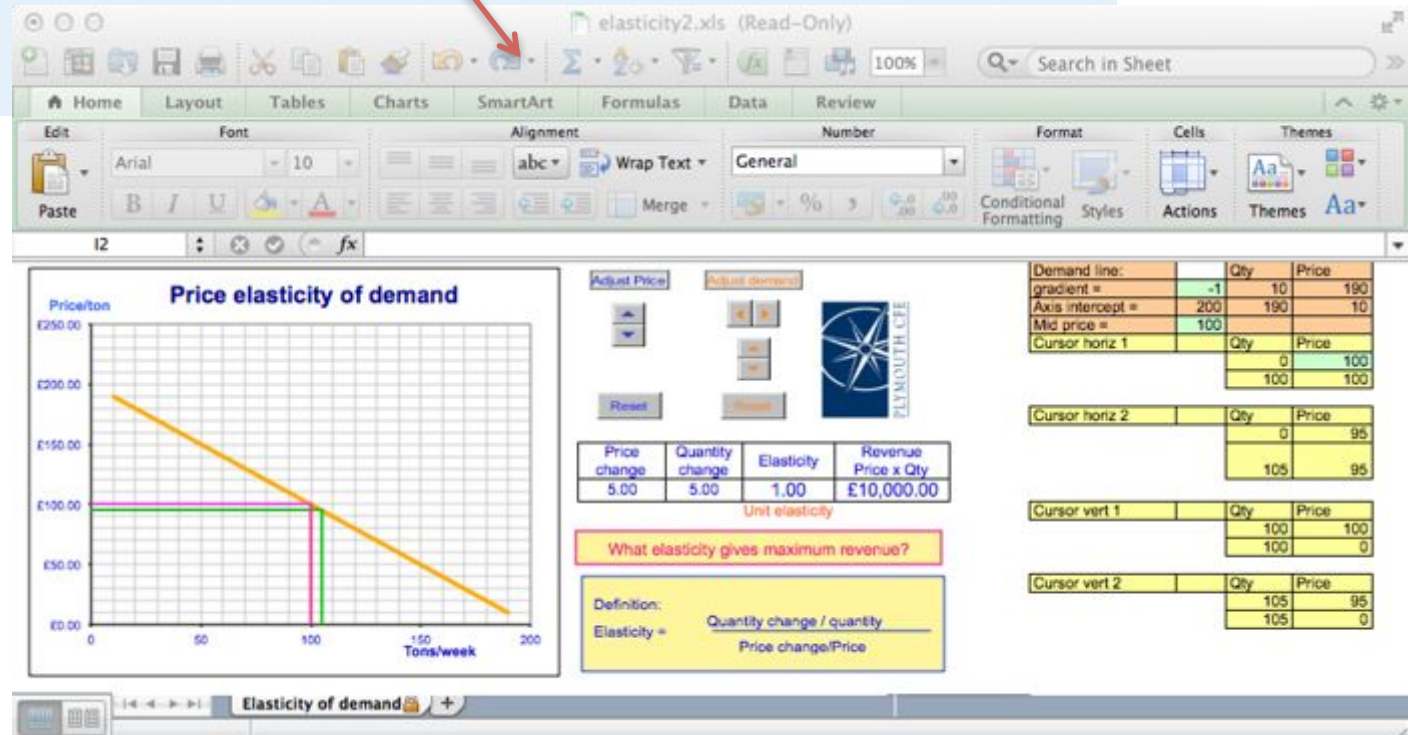
For an elastic demand, as the elasticity increases

Choose...

For an inelastic demand, as the elasticity increases

Choose...

Check

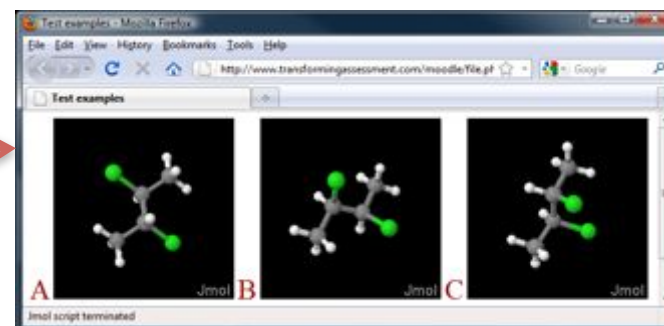


Interactive tools in assessment

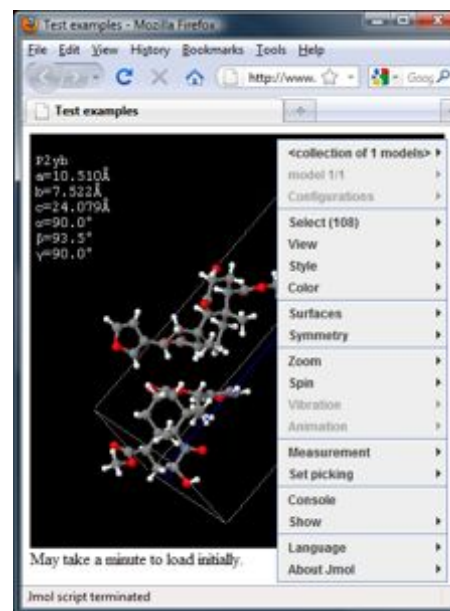
Jmol: Open-source Java viewer for chemical structures in 3D

Moodle Quiz

1 Which structure shown below represents **meso** 2,3-dichlorobutane, A, B or C?
Marks: --/1
[Click on the text below to open a window with the three choices]
Three structures, A, B and C
Answer:

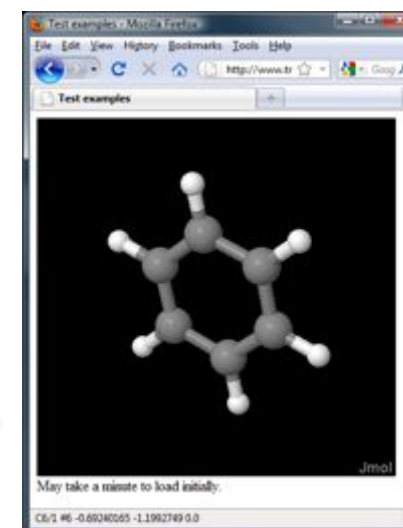


2 Use the Jmol applet to view the crystal structure of the presented molecule. Use the Jmol applet display to match the following statements.
Marks: --/1
There are 7 stereogenic centres in the molecule
There is evidence for an intramolecular hydrogen bond
There is evidence for an intermolecular hydrogen bond



Students interact with online tools to obtain data to construct a response

3 Use the Jmol applet to view the molecular structure of the presented molecule. Use the Jmol applet display to match the following statements.
Marks: --/1
The most electron rich region of this molecule is
The most electron poor region of this molecule is
The lowest energy molecular orbital for the molecule is
The highest energy molecular orbital for the molecule is



More examples in Moodle at transformingassessment.com

Simulated Conversation (Monash)

Students respond to a series statements via MCQs (maybe, yes, no) with feedback per choice to simulate a conversation e.g. **Moodle lesson activity**.

Can subterfuge be honourable?

Question 1 of 4

A problem

Two researchers in social medicine have devised a plan to investigate the hidden milieu of online anorexic communities. They are extremely secretive and members on pro-ana sites are suspicious and exclude all forms of research. One of the investigators adopts a pseudonym, uses the language of youth and projects all the neuroses to gain acceptance. How ethical is this methodology?

A response

It sounds ugly but we have to remember that anorexia is a serious condition, akin to suicide, and unless we understand how it is handled, we cannot advance medical science.

Maybe

Yes

No

Feedback

Good answer, Maybe. But this response doesn't answer the ethical question. It's true that we want to understand anorexia; but does that mean that we have to resort to deception. The investigators are conducting themselves in a somewhat fraudulent spirit.

Next

<http://conversationsim.org/>

Nelson, R & Dawson, P (2013) Assessment-as-learning: introducing the Conversation Sim ,TA webinar/e-Assessment Scotland, 21 Aug http://transformingassessment.com/eAS_2013/events_21_aug_2013.php

Examples – Short text response

Students type in a short sentence response which can be marked by computer based on pattern matching.

Available in standard Moodle.

Example question

Example settings

A boy climbs slowly to the top of a slide and then slides down it. At which point will his kinetic energy be a maximum?
Note: Your answer should ignore the effects of friction.

*You should give your answer as a **short phrase or sentence.***

Kinetic energy will be at maximum when at the bottom of the slide.

evaluation

The screenshot shows the 'Options For Entering Answers' section of a Moodle question editor. It includes settings for case sensitivity, subscript/superscript use, word length warnings, spelling checks, and a list of words to ignore. Below this is the 'Define Synonyms For Words in Answers' section, which lists words like 'impact' and 'just' with their respective synonyms. The 'Answer' field contains a regular expression pattern: `match_mw (bottom|base|end|flat*|floor|ground|horizo`. The 'Grade' is set to 100%. A second 'Answer' field shows a more complex pattern: `match_any (match_mw (fast*|quick*) match_mwp4 (great*|max*_velocity|speed) match_mwp4 (velocity|speed_great*|max*))`. The 'Grade' for this second answer is set to 50%.

Examples – Confidence questions

Confidence based approaches penalise guessing. Students need to choose a response and declare their level of certainty. Available in standard Moodle.

Certainty levels and consequences

Certainty level:	C=1	C=2	C=3	No Reply
Mark if correct:	1	2	3	0
Penalty if wrong (T/F Q)	0	-2	-6	0

Qu. 1:

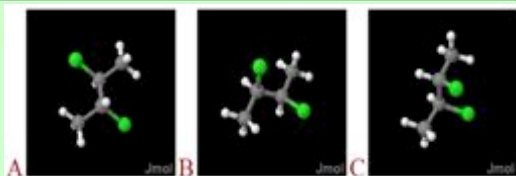
Which structure shown below represents meso 2,3-dichlorobutane, A, B or C?

[Click on the text below to open a window with the three choices]

Three structures, A, B and C

Choose one of the following:

- C
- A
- B



No Reply

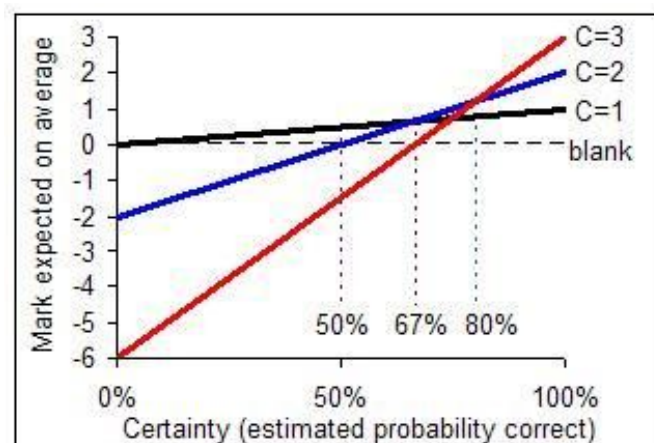
Certainty:

C=1 (low)

C=2 (mid)

C=3 (high)

Certainty v Mark Expected



University College London

Tony Gardner-Medwin, UCL, TA Webinar 6 April 2011

http://transformingassessment.com/events_6_april_2011.php

Use technology to enhance questions

1

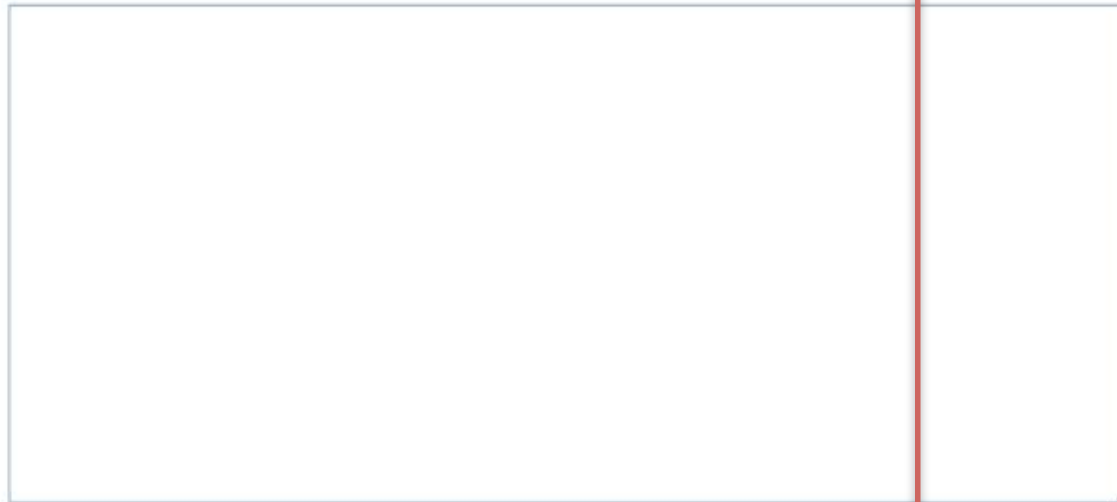
Marks: --
/1

You are required to construct a 500 word argument that **either** supports or refutes the statement 'Some historians claim that the Bayeux Tapestry is not an historical record of the Battle of Hastings, but rather it is simply Norman propaganda'.

You will need to use this [QuickTime virtual reality link](#) to view the Bayeux Tapestry to assist you in selecting and describing two scenes that you will use as the basis for your argument.

Click on this link to the [assessment rubric](#) to view the marking criteria for this task.

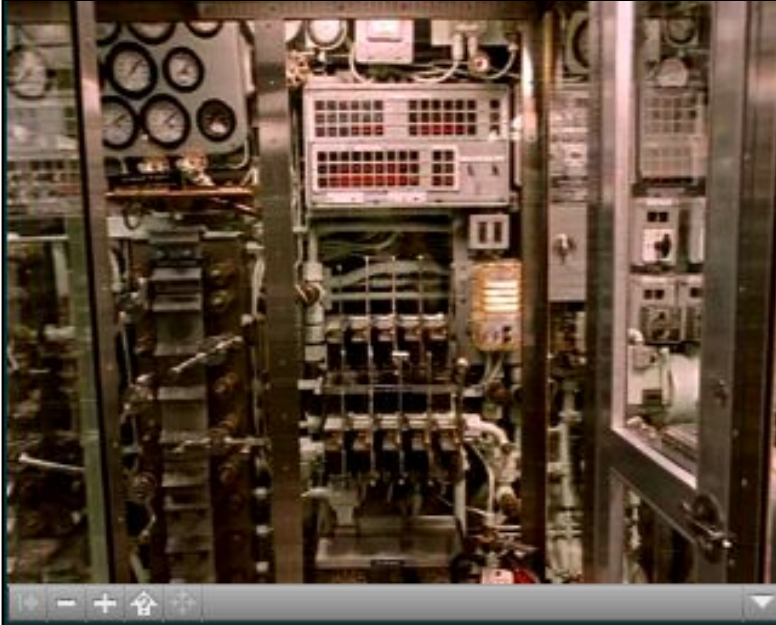
Answer:



Submit



VR, 360deg, spherical images



Virtual reality, 360-degree images, spherical images.
Take students to places they would not otherwise be able to go...

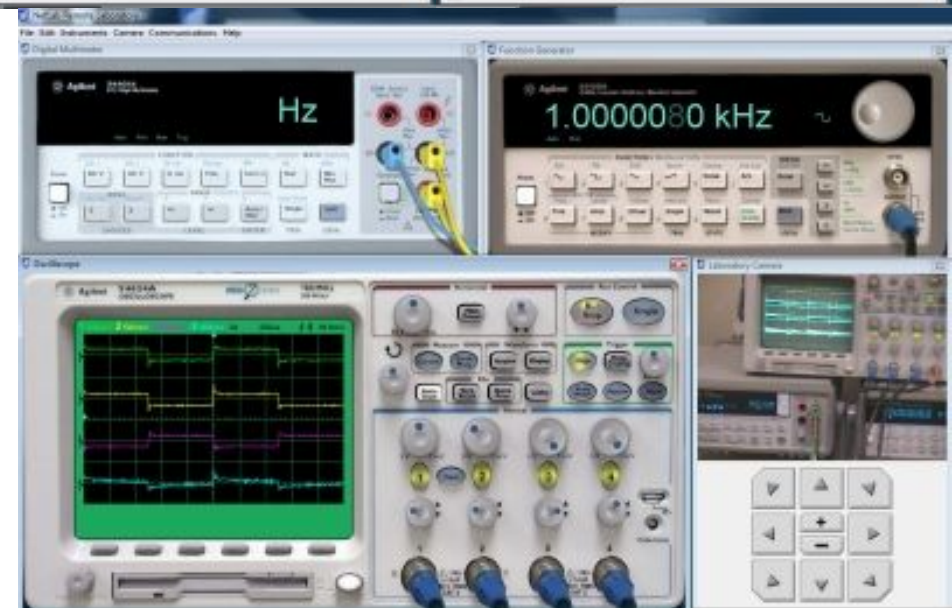
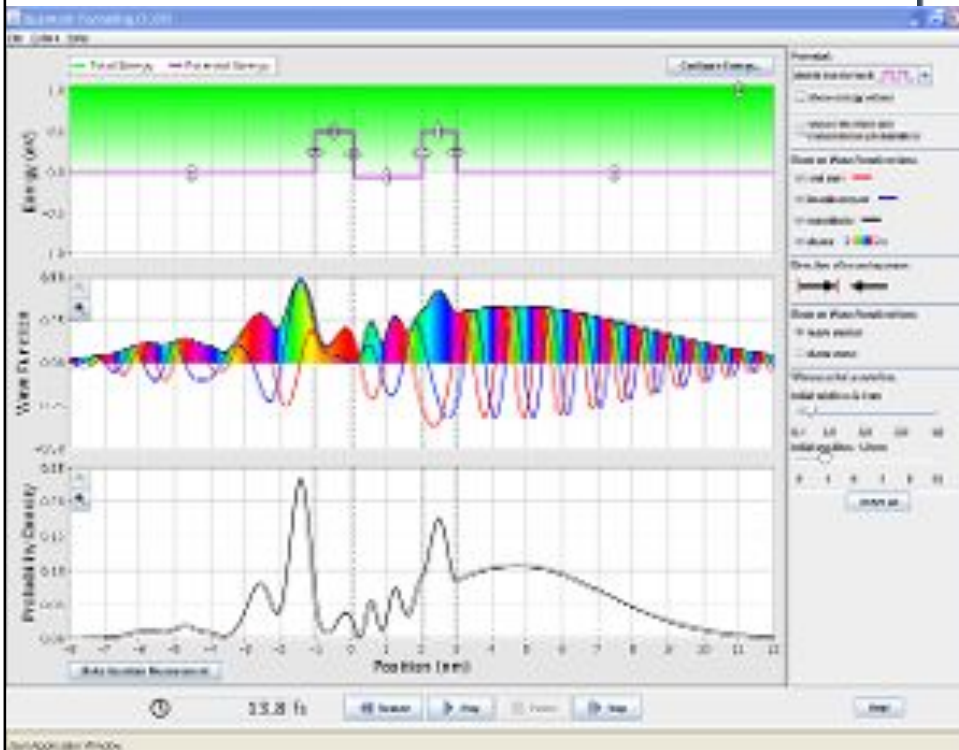
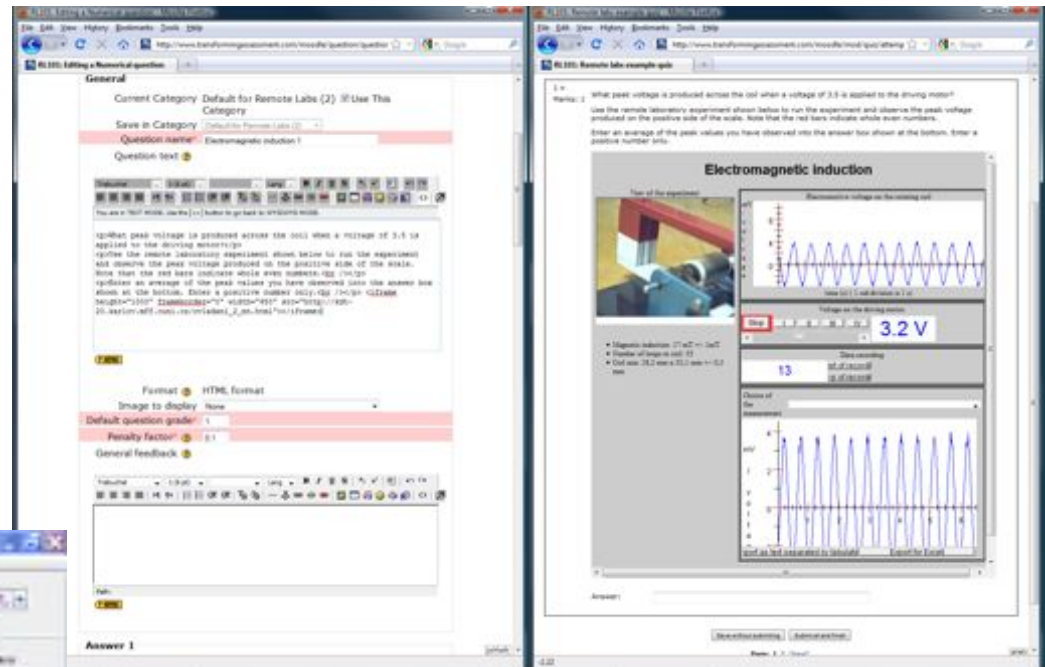
<http://www.pbs.org/wgbh/nova/subsecrets/nautconhi.html>



<http://www.pbs.org/wgbh/nova/subsecrets/nauttorlo.html>

Lab Simulations

Physical hardware can be connected to the internet or we can use **software simulations** of labs and experiments.



More Simulations

A/Prof. Pierre Benckendorff (University of Queensland, Australia)

OLT work: bizsims.edu.au (31 Sims listed/reviewed)

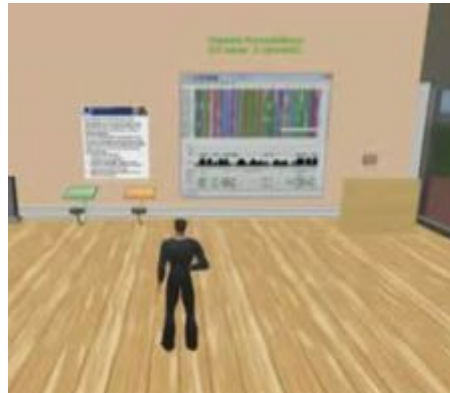
Complex simulations designed to teach strategy, competitive analysis, finance, marketing, HRM, cross-functional alignment, and the selection of tactics to build a successful business.



TA webinar: http://transformingassessment.com/events_4_march_2015.php

3D Virtual Spaces

- Sloodle (Second Life in Moodle)
- QuizHUD
- Scripted chat bots



Moodle and OpenSim Working Together

Undertaking an assessment activity in the VW initiates data transfers to the LMS.

Data flows as if the student was doing the activity in the LMS



Set up Quiz in the LMS. Results are stored in the in grade book.



A set of scripts for Moodle and VW that acts as a bridge.



Student undertakes assessment in the virtual world

1 Click on the link for Question 1 on the external web page. Use the emission and absorption spectroscopy tool below to determine the element corresponding to the colour orange-red in the gas discharge tube.

Marks: 1

Choose one answer.

- a. sodium
- b. copper
- c. neon
- d. barium

Moodle LMS interface showing quiz configuration for 'SLOODLE Controller for Chemistry'.

Status: Enabled

MOODLE Object Configuration

You can choose to configure some SLOODLE objects with a network instead of using the common web-based configuration. It is best to use, as it involves the use of a single print command for all objects, but it makes it quicker and easier to not pre-configure objects from your inventory.

Select which object you would like to create a configuration object for from the list below. If multiple versions are available, then they are shown in the brackets - only use the older versions if the main version does not work.

- Choice
- LoginZone
- MetaGloss
- Password Reset
- Picture Gloss
- Presenter
- PrismGrip
- Quiz Chair
- Quiz Pre-Quiz
- Registration/Enrolment Booth
- SLOODLE Set
- Second Life Tracker
- Sloodle API HQ
- Sloodle Award System
- Vanding Machine
- Webinarsum

Showing graded and ungraded attempts for each user. The one attempt for each user that is graded is highlighted. The grading method for this quiz is **Highest grade**.

Full name (2 columns)	Started on	Completed	Time taken	Graded (1)	Gr1	Gr2	Gr3	Gr4
Geoffrey Cline	3 May 2010, 06:09 PM	3 November 2010, 09:00 PM	184 Days 2 hours	1.000	1.000	0.000	0.000	0.000
	29 Jun 2010, 02:53 PM	3 November 2010, 09:00 PM	129 Days 8 hours	0	1.000	1.000	0.000	0.000
	6 July 2010, 03:46 PM	3 November 2010, 09:00 PM	123 Days 7 hours	0	1.000	1.000	0.000	0.000
	6 July 2010, 03:22 PM	3 November 2010, 09:00 PM	123 Days 6 hours	0	1.000	1.000	0.000	0.000
	6 July 2010, 04:16 PM	3 November 2010, 09:00 PM	123 Days 7 hours	1.000	1.000	0.000	0.000	0.000
	6 July 2010, 05:41 PM	3 November 2010, 09:00 PM	123 Days 7 hours	1.000	1.000	0.000	0.000	0.000
	3 May 2010, 09:04 PM	3 November 2010, 09:00 PM	184 Days	0	1.000	1.000	0.000	0.000
	3 May 2010, 10:10 AM	3 November 2010, 09:00 PM	183 Days 11 hours	0.000	1.000	0.000	0.000	0.000
	3 May 2010, 10:00 AM	3 November 2010, 09:00 PM	183 Days 11 hours	0	1.000	1.000	0.000	0.000
	3 May 2010, 10:02 PM	3 November 2010, 09:00 PM	183 Days 8 hours	0	1.000	1.000	0.000	0.000
	6 May 2010, 07:13 PM	3 November 2010, 09:00 PM	183 Days 2 hours	1.000	1.000	0.000	0.000	0.000
	7 May 2010, 10:28 PM	3 November 2010, 09:00 PM	182 Days 9 hours	1.000	1.000	0.000	0.000	0.000
	9 June 2010, 03:47 PM	3 November 2010, 09:00 PM	195 Days 6 hours	1.000	1.000	0.000	0.000	0.000
	14 June 2010, 09:00 PM	3 November 2010, 09:00 PM	142 Days 6 hours	0	1.000	1.000	0.000	0.000
	7 May 2010, 03:40 PM	7 May 2010, 03:40 PM	0 seconds	0	1.000	1.000	0.000	0.000
	29 Jun 2010, 03:06 PM	29 Jun 2010, 03:06 PM	26 secs	0	1.000	1.000	0.000	0.000
Overall average				0.200	1.000	1.000	1.000	0.000



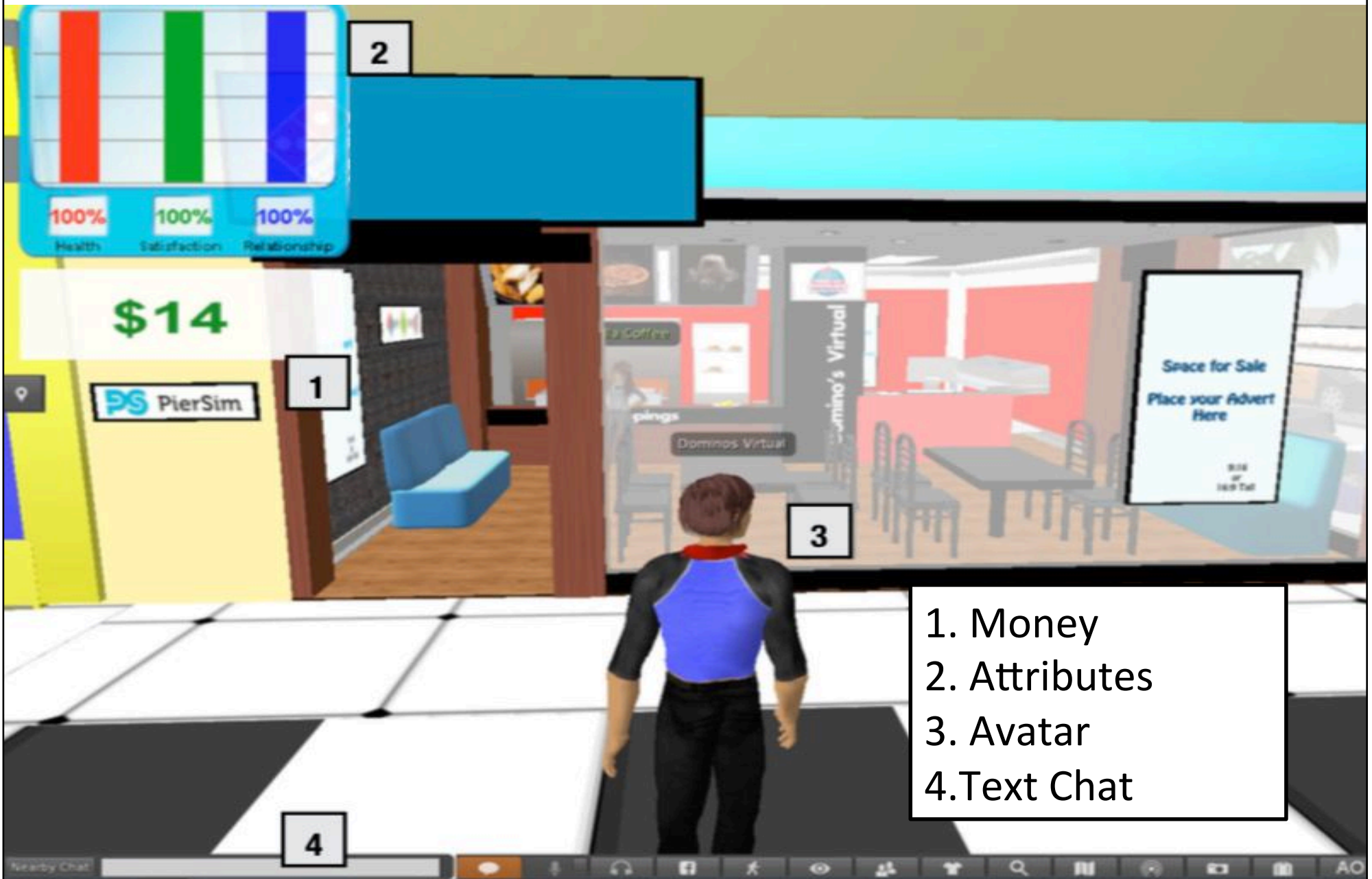
Videos: Transforming Assessment Youtube Channel

UQ Virtual Business Environment



TA webinar http://transformingassessment.com/events_5_august_2015.php

Sim Features - trading



Sim Features: Obtain a loan, resolve disputes, buy supplies



Australian Bank's 'Loan Terminal'

We offer the following loan plans:

PLAN 1 - \$100 @ 8.75%.

PLAN 2 - \$300 @ 6.25%.

PLAN 3 - \$500 @ 3.75%.

Please make your selection below.

PLAN 1

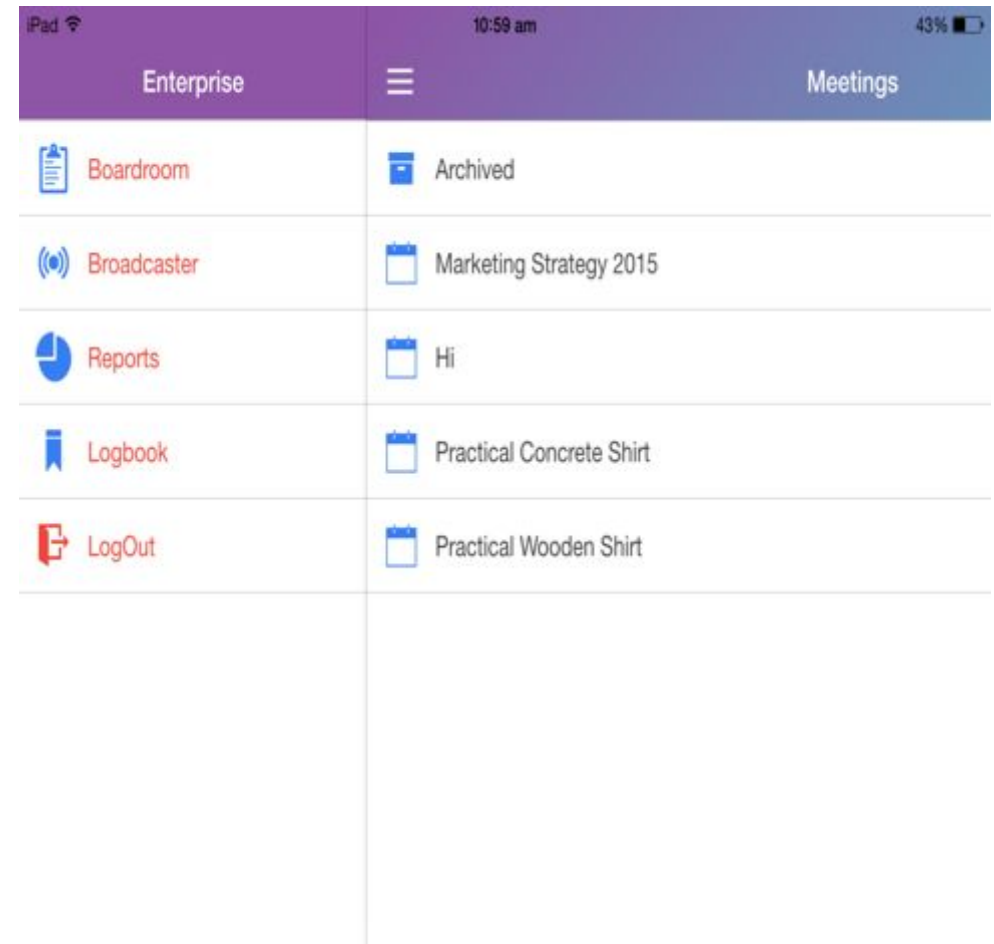
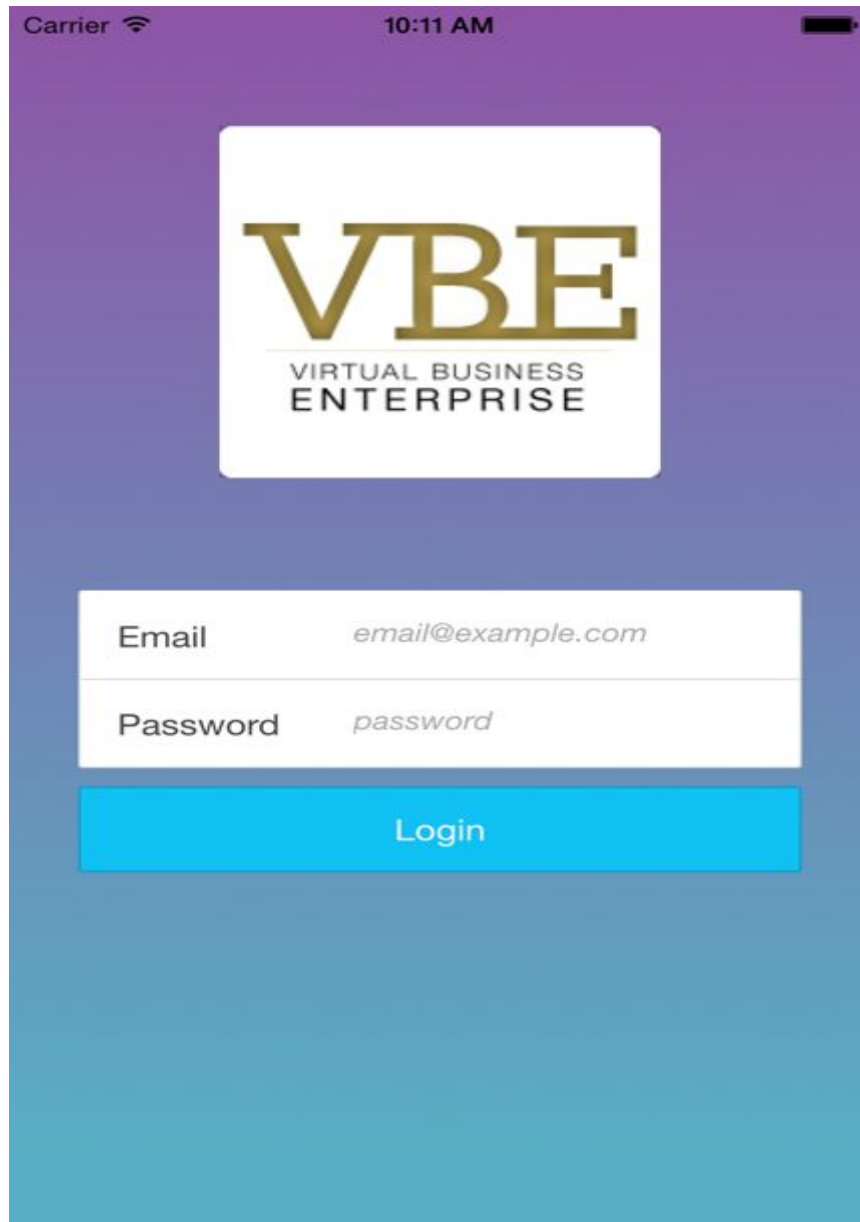
PLAN 2

PLAN 3

Ignore



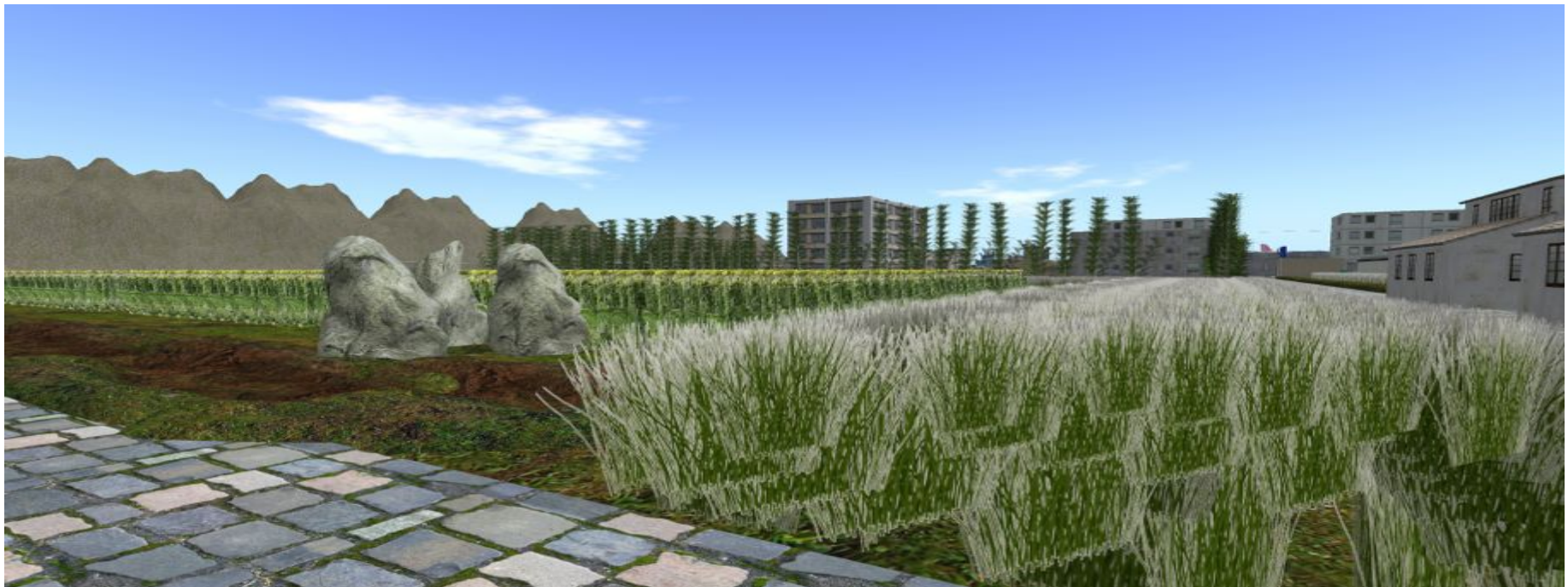
The VBE App



Virtual Immersive Language Lessons (1)

Scott Grant (Monash University, Australia)

<http://www.virtuallyenhancedlanguages.com>



TA webinar http://transformingassessment.com/events_1_april_2015.php

Virtual Immersive Language Lessons (2)

Task Based Learning or Task Based Language Learning (TBLL).
Includes communication activities, using language to carry out tasks, language use that is meaningful to the learner and has a purpose, and communication activities that reflect real-life activities with authentic materials.

Learn by doing:

Purchase supplies then cook noodles – all in Chinese.



SO...

Where does that leave exams?

The dissonance of it all!

Real world of work

Exams



World Economic Forum – How will digital change your working world. <https://agenda.weforum.org/wp-content/uploads/rtr2m8vm1-628x330.jpg>

Exams at Monash Caulfield in 2015 (mathew.hilier[at]monash.edu)

We are faced with a growing disconnect between the way *high stakes testing* is conducted using pen on paper exams and students' everyday experiences of study, work and life.

Take 3 minutes

- In pairs, discuss what would be an ideal exam?

Then, share with the room

- Two outcomes
- Two enabling features of an ideal exam

Better exams

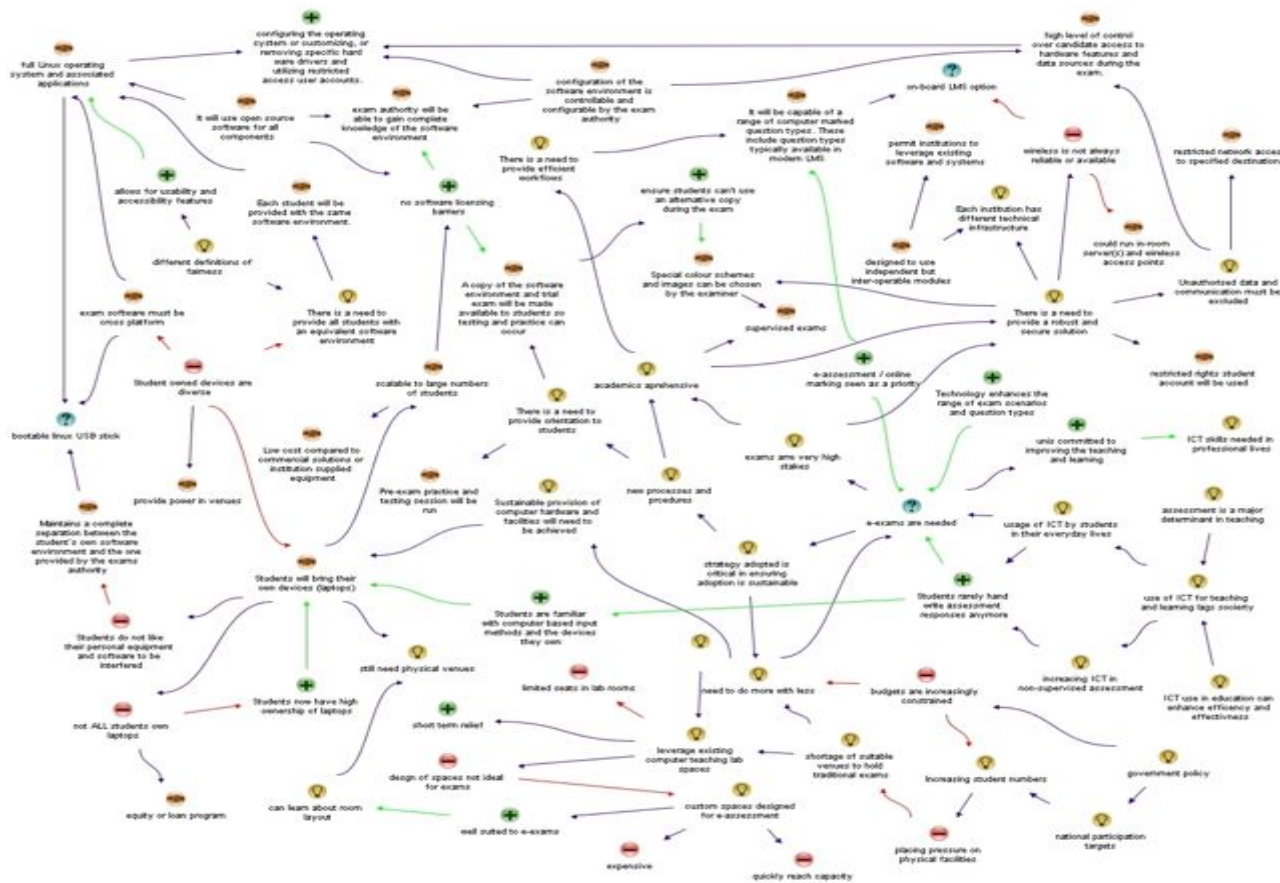
- Lets make exams as good as they can be...
 - Broaden the pedagogical landscape in the exam room.
 - Give students access to the ‘tools of the trade of the twenty first century’...
 - To solve problems typical of those faced in the work and life world – wicked, messy, complex problems that require constructed responses.
- Challenge: must work with the pragmatics and requirements of existing education delivery.
 - Valid, robust, easy to use, efficient, economical, supportable... It must work in the world we have, not the world we wish we had!

Why and how of e-Exams

Rationale: Concerns, drivers, possible solutions for e-Exams.
A truly 'wicked', 'messy' problem and a long road to get it right!...

Presented rationale in 2013 and Seed grant findings at 2014, 2015 ASCILITE confs.
More to come ... and explored in depth in Hillier & Fluck (2013)

<http://www.ascilite.org.au/conferences/sydney13/program/papers/Hillier.pdf>



ta.vu/eexam-map



Possible Future - when and how?

An evolution rather than a revolution. Some aspects may occur quicker than others depending on particular implementation, technical models chosen, socio-cultural-policy environment conditions. Outlook for Australasia. *Denmark and Norway already have 'internet in exams'.*

	About now	2015-2020	2020-2025	2025 and beyond
Medium for high stakes assessments	Paper	Paper-replacement – students can opt to type instead of handwriting (uses USB drive to boot BYOD). Some post-paper exams appearing.	Post-paper exams common. All questions and materials are digital, a computer is required to respond to assessment challenges.	Fully computerised, internet enabled exams with candidates using a range of software and input devices.
Connectivity	None	None to some use of restricted ad-hoc networks for response reticulation in post-paper exams.	Mix of offline and online exams limited to selected resources. Connections logged.	Open internet access but all transactions are fully logged inclusive of communication, timing, sources.
Authenticity of assessment	Scenarios are written descriptions, with monochrome illustrations	Full colour diagrams and video begin to provide more authentic scenarios	High fidelity, data-driven simulations	Real-time links to global databases
Candidate identity assurance	Manual comparison of face with ID card photo by a trusted supervisor	Practice continues, linked to local database via handheld device.	Practice continues, but laptop camera takes pictures of the keyboard user at random intervals.	Practices continue, with two-factor authentication incorporating biometrics such as face recognition.
Materials provided/ allowed	A range of published books, electronic calculators and stationery equipment bought into the room by students	Digital equivalents begin to replace some materials. E.g PDFs.	e-books, high resolution images, video, simulations, all software tools are provided (open source).	Practice continues with increasing diversity of subject-specific software tools.
Assessment workflow	Bundles of scripts are physically transported to assessors	Practice continues, but digital response scripts can be duplicated, archived and e-mailed.	Digital responses, extends to data files created using subject specific software. E-workflows, banked and tagged questions.	Digital response files are accompanied by performance metrics for individual students, and interaction logs
Achievement measurement	On quality of solution, and written process	Practice continues, analytics of selected response items.	Practice continues, but analytics increasingly detailed. E.g. time taken per question, marks gain.	Detailed analytics, keystrokes/screen touches available – the solution process dominates assessment.
Continuous assessment improvement process	Year-on-year bell-curve comparisons regulate overall difficulty of exam.	Some data on overall ease or difficulty of individual questions/ options is available.	Individual questions are rated for discrimination and reliability etc.	Question ratings take into account all candidate interactions within the assessment.

Our e-Exam Project...

- Supervised
- High stakes
- On campus
- Large scale

(image credit: Dr Fluck UTAS)



*What we are **not** specifically addressing here is off campus, online only, distance education, cross institutional students – there are extra issues (later!) and some possible e-solutions to address these needs.*

e-Exams: Online, Offline, On Campus or Distance

There are trade-offs for any e-exam solution.

**Online
(net)**

- Space issues for institutions.
- Improved exam management efficiency.
- Equipment: need computer labs to cater for 2000 at once or BYO.
- Most secure: live IT monitoring/control and spaces are supervised.
- Needs reliable network.

- No space issue for institutions.
- More efficient exam management.
- Students supply equipment.
- Less secure: IT monitoring but wider spaces are unsupervised.
- Needs reliable network.

Offline

- Space issues for institutions.
- Less efficient exam management.
- Equipment: need computer labs to cater for 2000 at once or BYO.
- More secure: IT control possible, spaces are supervised.
- Network reliability not an issue.

- No space issue for institutions.
- Less efficient exam management.
- Students supply equipment.
- Not secure: no useful monitoring/essentially unsupervised.
- Network reliability not an issue.

On Campus (controlled spaces)

Distance (at home)

Quick Guide to OLT e-Exams

Aim: to better assess student capabilities using the 'tools of the trade' of the 21st Century. To develop future looking, 'work ready' (and life ready) graduates we need to be able to assess complex, constructed, even 'wicked' tasks.

e-Exam: a supervised examination undertaken by a candidate using their own computer.

Candidates start their computer from a custom designed USB which contains:

- The operating system and a full suite of office applications.
- The questions and all ancillary material in digital format.
- A reserved location for candidate responses

Works on most Apple and 'Windows' laptops.


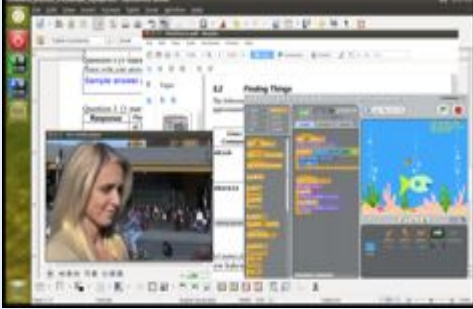

e-Exam System Affordances

Pertinent Features	Affordances
A 'Whole computer' environment (OS, LMS, applications...) on a stick.	Expanded pedagogical scope over that of a pen or browser window.
Typed responses via Word processor, constructed via apps (human marked) or on-board learning management system quiz (computer marked).	Caters for introduction to advanced uses. Components can be added/removed to suit. Electronic collection facilitates analytics, item response analysis...
No live network required during exam, even for LMS questions.	Robust. Greater control. (network could be used for admin)
Student owned equipment used as host and left untouched.	An ethical approach to scalability (no invasive software to install)
Modular, open source code base and commodity 'off the shelf' components.	Leveraging popular and sustainable projects for better efficiency. Fully 'known' (no 'blackbox'). Available!
One version works on most Intel based laptops - Apple, 'windows', Linux, that have a USB port.	One software version can serve all. Streamlines development and maintenance.



Bootable
'live'
USB
drive



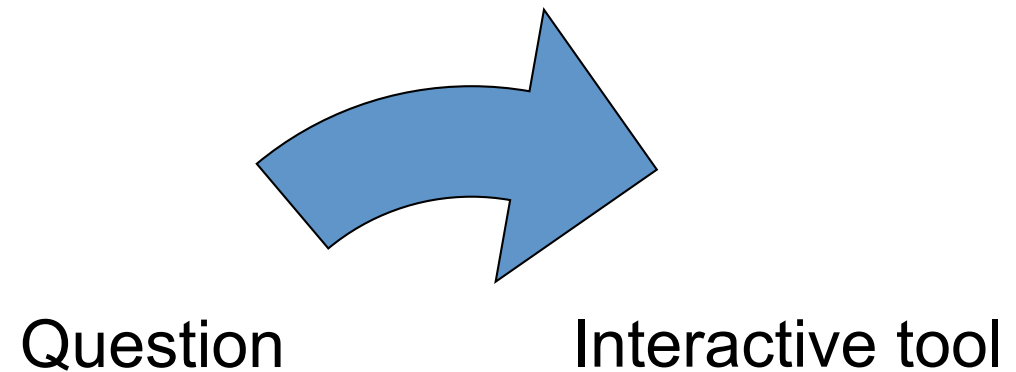
Start	>>>	> current phase 1 trials >	>>>	>>>	>>>	Future >
Get Ready Institutional approvals, Research Ethics, Hardware & infrastructure.	Phase 1 Paper equivalent small scale. Basic doc exams only to begin!	Phase 2 Post-paper small to medium. Expanding the media landscape.	Phase 3 Medium to large scale. Adding the power of an LMS.	Phase 4 Whitelisted and logged Internet Network during BYOD exam.	Phase 5 Open but fully logged Internet Network during BYOD exam.	
	Crawling	Walking	Running	Jumping	Flying!	
Type 1: Paper equivalent - word Docs 	Type 1: Paper equivalent docs Students given choice to type. Small numbers typing ~ 20 to 50. Simultaneous, on campus, supervised. No live network. Paper fallback. BYO student laptops, Venue power sockets, spare laptops.	Type 1: Paper equivalent docs Students given choice to type. Medium numbers ~ 100-200. Simultaneous, on campus, supervised. No live network. Paper fallback. BYO student laptops, Venue power sockets, spare laptops.	Type 1: Paper equivalent docs Students given choice to type. Large numbers ~ 200+ Simultaneous, on campus, supervised. No live network. Paper fallback. BYO student laptops, Venue power sockets, spare laptops.			
Type 2: Post paper (Word docs linked to media) 		Type 2.A: Post paper via word docs linked to media and other tools All students must type. Small to medium ~ 50-200. Simultaneous, on campus, supervised. No live network. Docs linked to multimedia, 3rd party apps, simulation, PDF, etc. BYO student laptops, Venue power sockets, spare laptops.	Type 2.A: Post paper via word docs linked to media and other tools All students must type. Medium number ~ 100-200. Simultaneous, on campus, supervised. No live network. Docs linked to multimedia, 3rd party apps, simulation, PDF, etc. BYO student laptops, Venue power sockets, spare laptops.	Type 2.B: Post paper via word docs linked to media and select online refs All students must type. Large numbers ~ 200+ Simultaneous, on campus, supervised. Whitelist Internet. Docs linked to multimedia, 3rd party apps, simulation, PDF, etc. Mix BYO student laptops, Venue power sockets and Lab PCs.	Type 2.C: Post paper via word docs linked to media, open online access All students must type. Large numbers ~ 200+ Simultaneous, on campus, supervise Fully logged open internet. Docs linked to multimedia, 3rd party apps, sims, PDF, etc Mix BYO student laptops, Venue power & Lab PCs.	
Type 3: On-board LMS (Moodle) 			Type 3.A: On-board (Moodle) All students must type. Medium numbers ~ 100-200 Simultaneous, on campus, supervised. No live network. On-board Moodle quiz tool. BYO student laptops, Venue power sockets, spare laptops.	Type 3.B: On-board LMS, online All students must type. Large numbers ~ 200+ Simultaneous, on campus, supervised. Whitelist Internet. On-board Moodle Quiz tool. Mix BYO student laptops, Venue power sockets and Lab PCs.	Type 3.C: On-b'd LMS, open All students must type. Large numbers ~ 200+ Simultaneous, on campus, supervised Fully logged open internet. On-board Moodle Quiz tool. Mix BYO student laptops, Venue power and Lab PCs.	
				Type 4.B: Online/Networked. Mixed Mode, online refs All students must type. Medium numbers ~ 100-200 Simultaneous, on campus, supervised. Whitelist Internet. Online LMS (Blackboard, Canvas, D2L etc.), on-board LMS, remote desktops, docs, media, sims, apps Mix n match! Mix BYO student laptops, Venue power sockets and Lab PCs.	Type 4.C: Online/Networked. Mixed Mode, open online All students must type. Large numbers 200+ Simultaneous, on campus, supervise Fully logged open internet. Online LMS (Blackboard, Canvas, D2L etc.), on-board LMS, remote desktops, docs, media, sims, apps ... Mix BYO student laptops, Venue power and Lab PCs.	



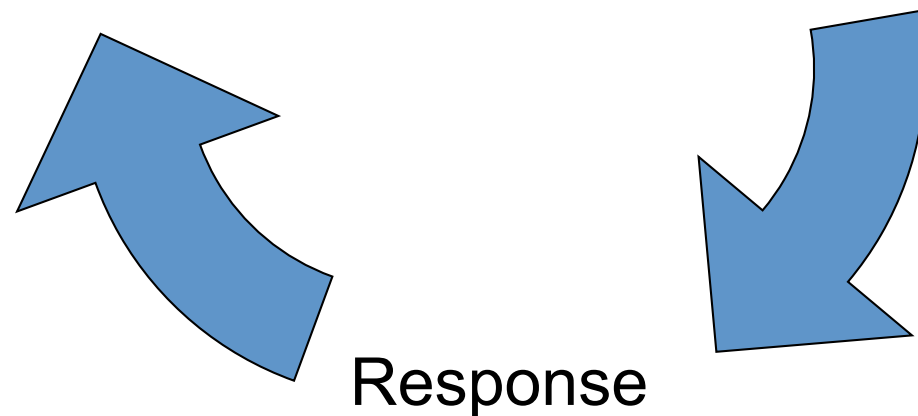
Refer to handout or this
<http://ta.vu/e-exam-roadmap>

Interactive e-assessment design

Separate the interactive tool/object/artefact from the question and the feedback.



Now apply that to exams too!



Where we are now: Paper Equivalent

Word doc! Question types used: short answer/essay, matching, construct a table, label a diagram/image (by filling a table).

Manual marking.

Question 2. Match the following host-MOTA r below).

Possible descriptions:

- a) Mauris id mi id orci interdum semper.
- b) Sed eu neque ut est dignissim fringilla.
- c) Vivamus in dolor euismod, luctus liber
- d) Mauris vehicula eros a viverra pellentes
- e) Curabitur eu mi at nibh commodo variu
- f) Aenean eget orci porta, malesuada lore

Please write or type the letter of the descriptions listed a

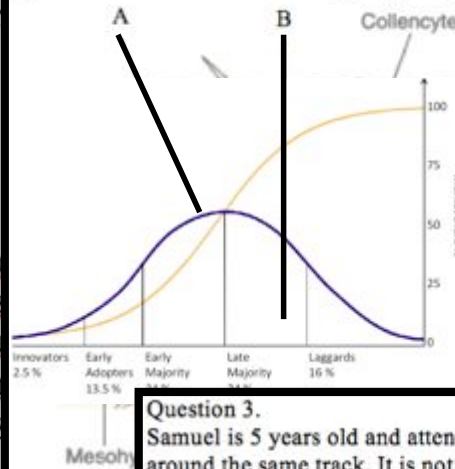
Answer a to f.	Terms
<u>f</u>	I. <u>Paxogen</u>
<u>a</u>	II. <u>Sitabosis</u>
<u>c</u>	III. <u>Fakeasalism</u>
<u>e</u>	

Question 7: Some rationales for punishment are **XEZT** does this mean?

Please write / type your response inside the box below.

The student types their answer here. In this exam, a two row table. The response table row is created cell has a minimum height set (by dragging the box) and a minimum height cell instead of successive carriage returns to set the box height, the next question will be less likely to be disrupted when students type their responses. The initial size of the box should indicate the desired length of the response. The box will automatically expand when it gets full.

Question 5: For the following diagram please provide the names for **THE XING** in the table below.



A	Label goes here. Constructed response question.
B	Blue text makes it easier to see which questions have been answered and which have not!
C	Use minimum row heights to provide plenty of space, but don't use double carriage returns!
D	Doing so means the layout is less likely to be disrupted.

Question 3.

Samuel is 5 years old and attends racing cars 5 days per week. Eamon is 10 years old and rides a superbike around the same track. It is not a selected response item so some text will be expected. In the table below, give two (2) examples of flippant faxadism relevant to his age range (4-6 years), and describe how Samuel and Eamon differ in their abilities to perform faxadism.

[4 marks]

Two different examples of flippant <u>faxadism</u> (one per row)	Describe Samuel's abilities (age 5)	Describe <u>Eamon</u> 's abilities (age 10)
Type here	Minimum heights set for both rows	
		More details about setting heights appear later in these examples.

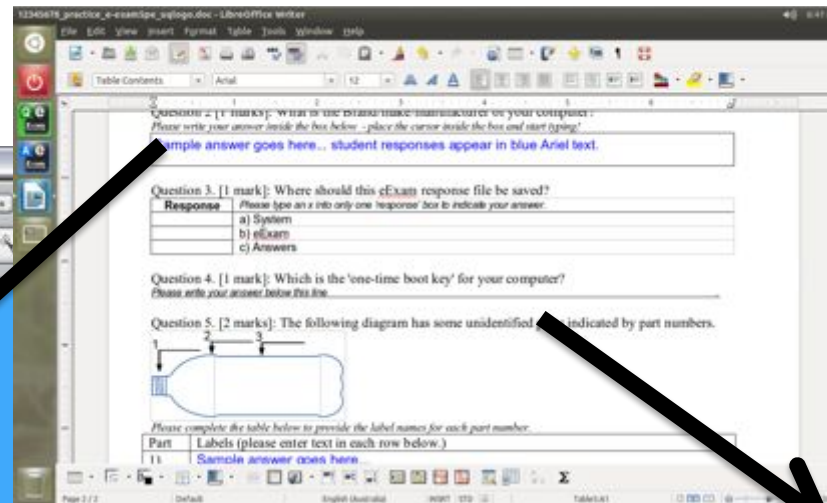
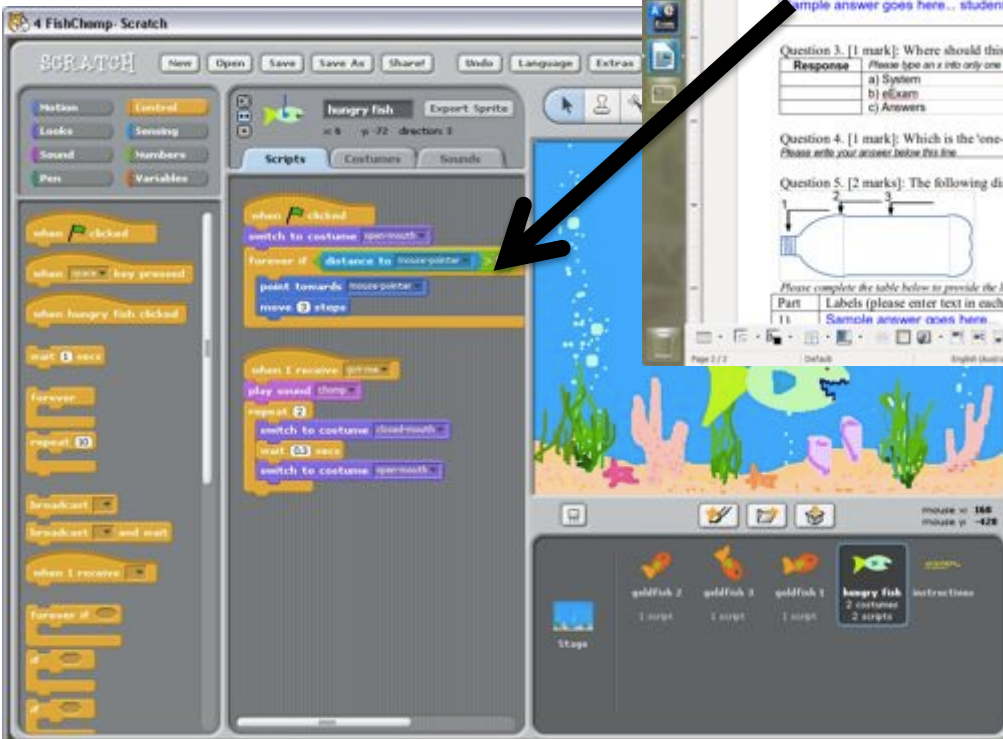
Where we are now: Paper Plus

Word doc, plus apps. Question document with links to launch local apps and resources: graphics, Scratch programming tools, presentation slides, PDFs. All on-board the USB stick.

‘IT in Education’ exams : Andrew Fluck, UTAS.

Exam doc

Scratch SDK

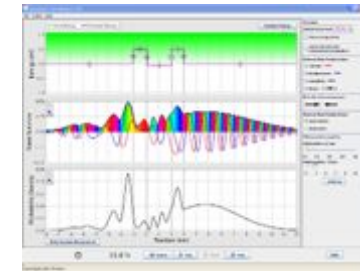


PDF



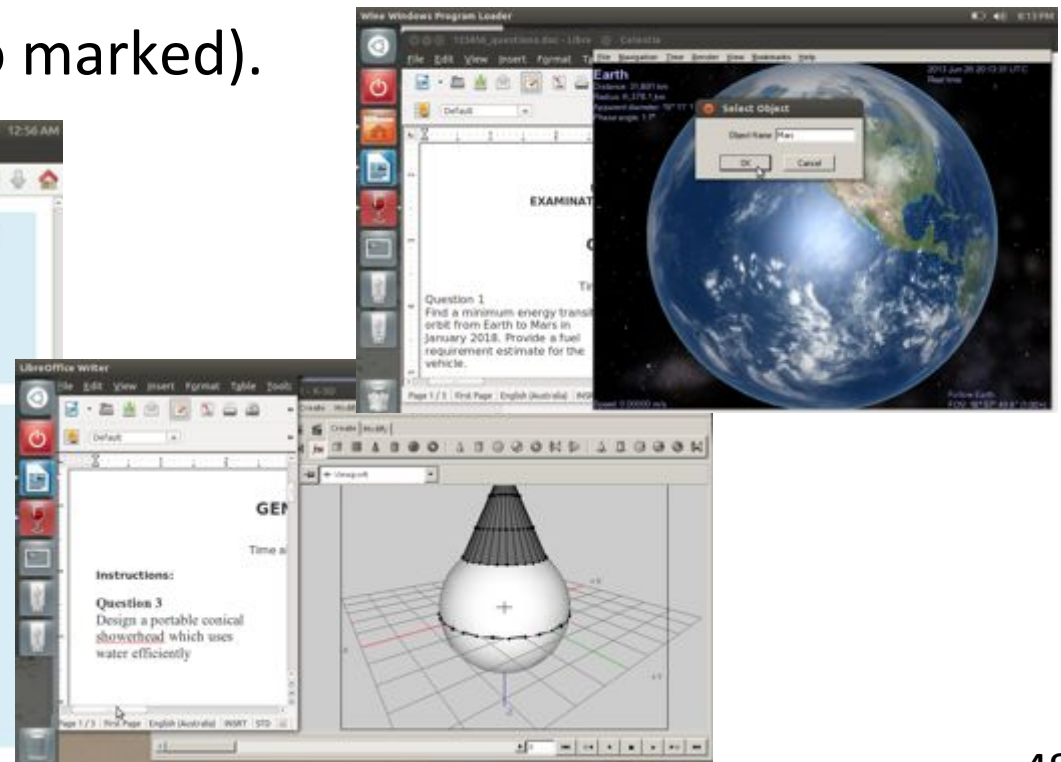
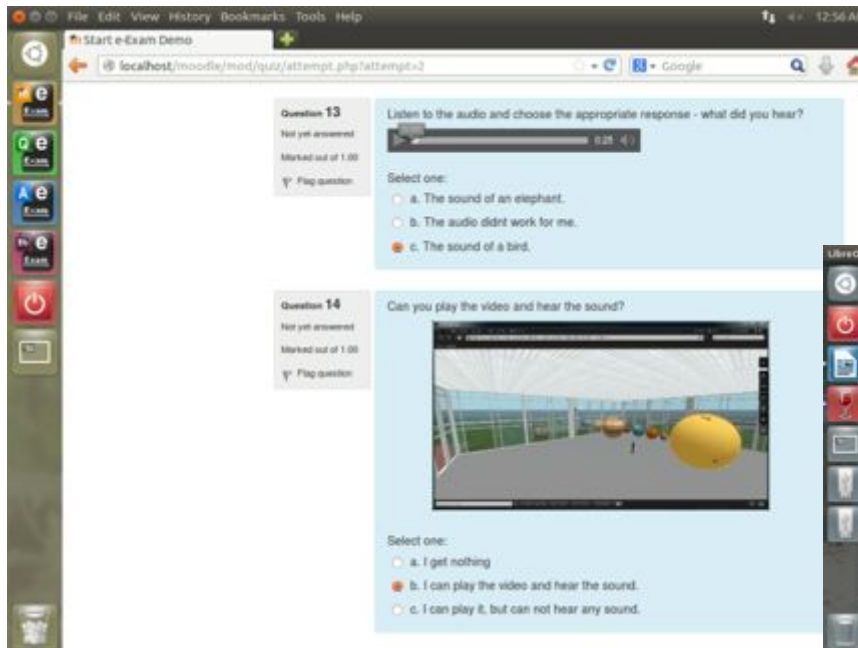
The Future: Post-paper exams

Simulations, tools, virtual experiments, serious games...
Business, history, language/communication, science labs...



'Windows' software via WINE. E.g. CAD / 3D modeling, Celestia.

Moodle quiz with media (auto marked).



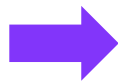
Current e-Exam v5 Workflow

Set-up: prepare exam learning materials



Academic creates exam learning material

Create master USB (tested)



USBs duplicated per student

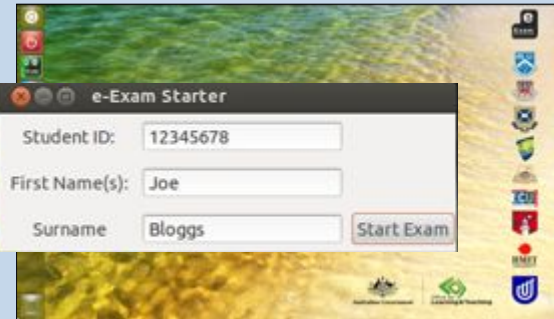
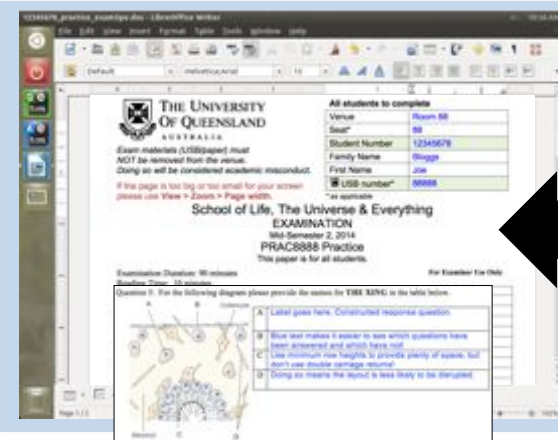
Pre-session: Student laptop setup & practice.



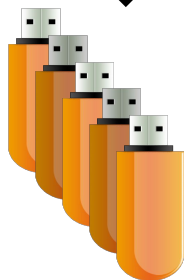
Exam room use



Ubuntu Live USB. Libre Office, Moodle etc



Post session: retrieve responses and assessment



Collect USBs (responses)



Responses retrieved from USBs.



Collated e-responses sent to academic.



1. Students enter room.
2. Given USB.
3. Boot laptop.
4. Do exam.
5. Return USB.
6. Leave room.

E-exam processing station

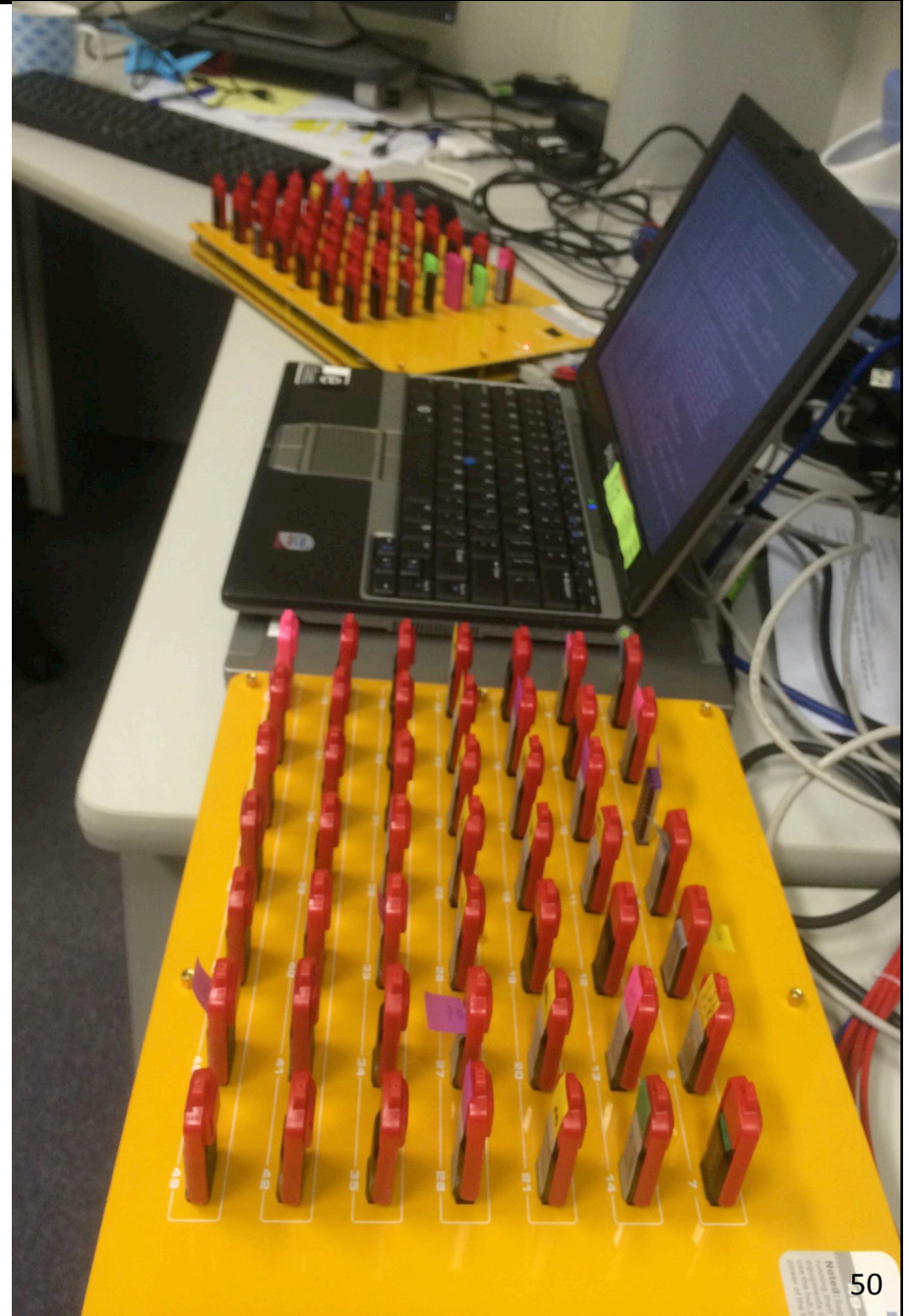
Prototype using commodity components.

Using an old laptop it can handle 98 USBs at once.

Helper scripts to

- Initial 'burn' OS to each USB
- Place exam materials.
- Retrieve exam materials.
- Set-up for the next exam.

User friendly interface planned.



e-Exam: Walk Through

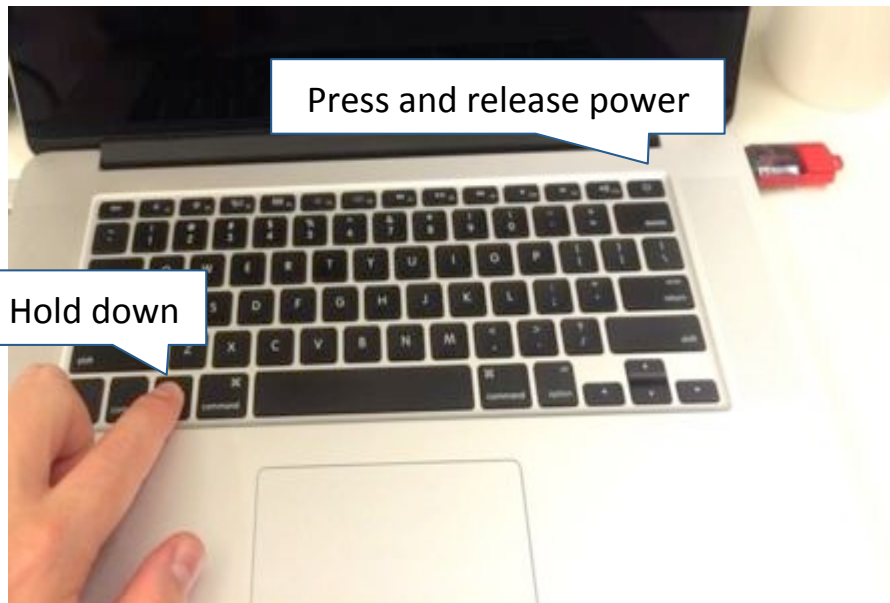


Walk Through

1. Start with the computer turned OFF. Then insert USB stick

Apple

2. Hold down ALT *then* power on.

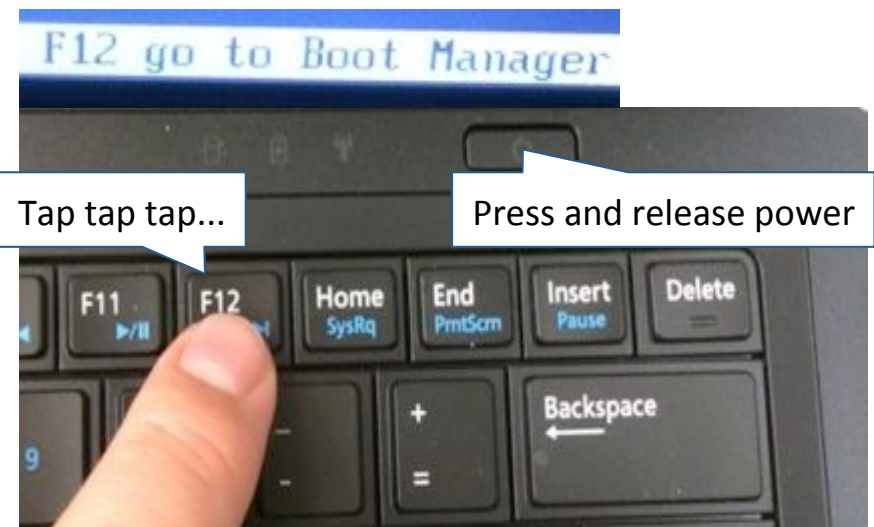


Keep holding ALT until you see...

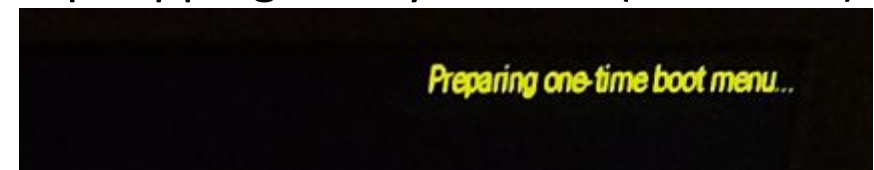


Other/Windows*

2. Power on while tapping 'boot key' (e.g. F12 or...)



Keep tapping until you see...(or similar)

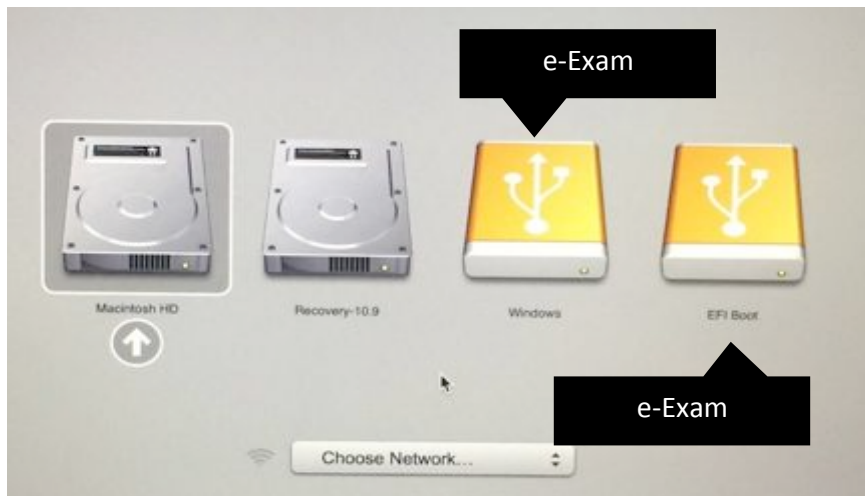


*Win 8: first need to disable secure boot.

Walk Through

Apple

3. Select a yellow icon.
EFI boot or 'Windows'



Could be either one! So just try.

If you get

Boot error

Try the other one!

Other/Windows

3. Select USB device.



It might be labeled something else and probably won't be first.

Walk Through



4A. Some system messages may appear, if so just wait.

```
ata_id(292): HDIO_GET_IDENTITY failed for '/dev/sdb': Invalid argument
```

4B. Exam system starts.

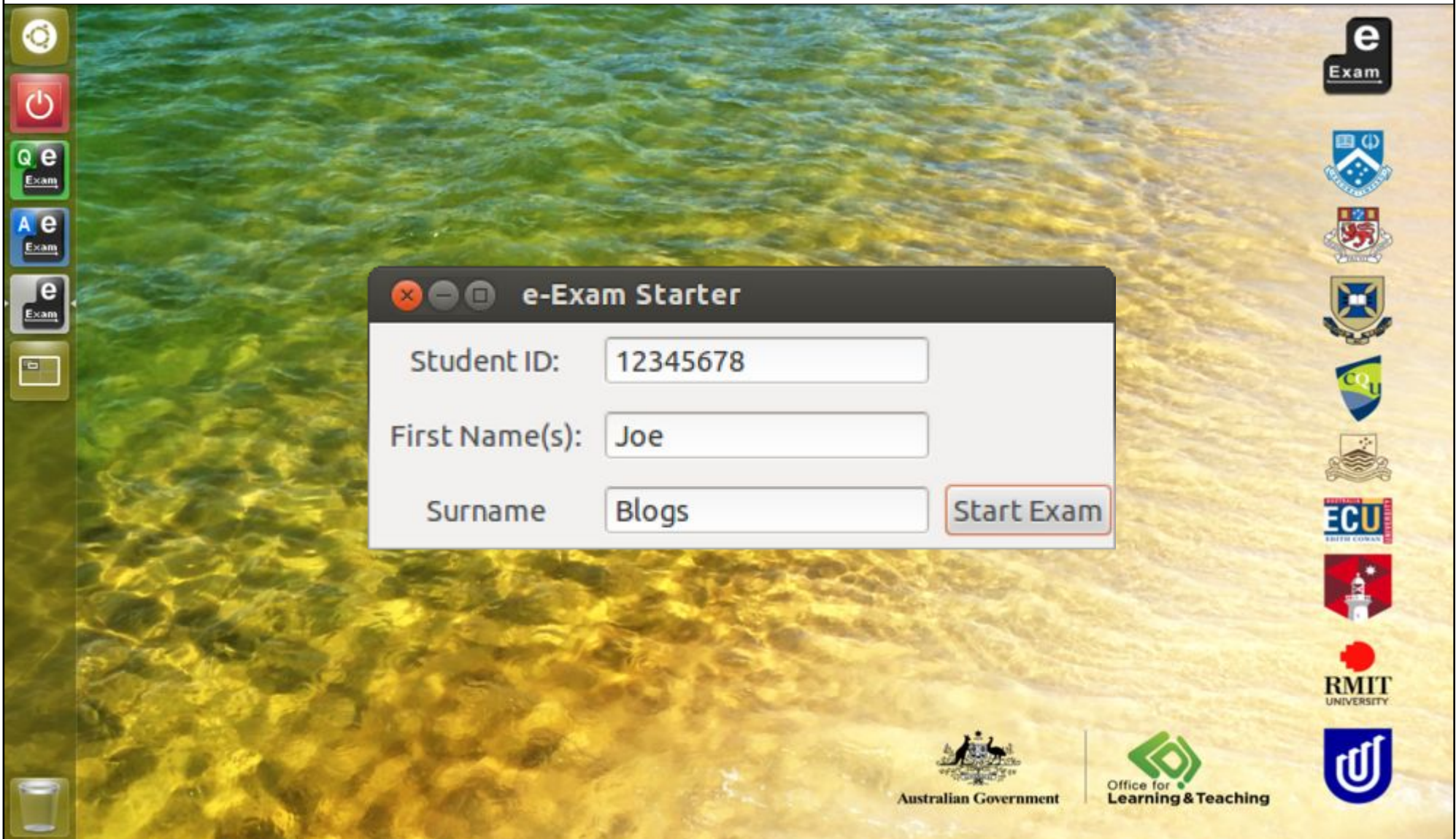


5. Arrive at e-Exam system desktop.



Walk Through

6. Student now types in their student ID number and name* (can be disabled).
Click Start Exam. (what happens next dependent upon chosen exam mode)



Walk Through (Document mode)

7. Exam file opens ready to enter exam details and responses.


Note: original file copied and student number prefixed to file name.

12345678_practice_exam5pp.doc - LibreOffice Writer 9:34 AM

File Edit View Insert Format Table Tools Window Help

Default Arial 12

Practice Examination, 2016 Practice Exam – PRAC8888

 UNIVERSITY

Exam materials (USB/paper) must NOT be removed from the venue. Doing so will be considered academic misconduct.

Remember 'File > Save' often. Shortcut "CTRL S"
If the page is too big or too small for your screen please use View > Zoom > Page width.

All students to complete	
Venue	Exam Hall
Seat*	8
Student Number	12345678
Family Name	Blogs
First Name	Joe
USB number*	88

* as applicable

School of Life, The Universe & Everything
Practice Examination 2016
PRAC8888 Post Paper Example Exam
This paper is for all students.

Examination Duration: <as long as you like> minutes
Reading Time: <as long as you like> minutes

For Examiner Use Only	
Question	Mark

Page 1 / 2 First Page English (Australia) INSRT STD Table2:B7 134%

Walk Through (Document mode)

8. Read questions and type responses into areas indicated.

12345678_practice_e-exam5pe_uqlogo.doc - LibreOffice Writer 6:41 PM

File Edit View Insert Format Table Tools Window Help

Table Contents Arial 12

Question 2 [1 marks]: what is the brand/make/manufacture of your computer?
Please write your answer inside the box below - place the cursor inside the box and start typing!

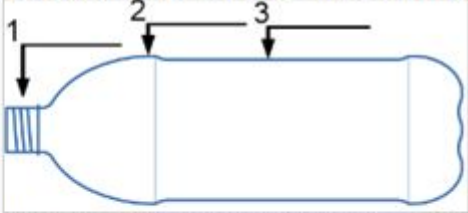
Sample answer goes here... student responses appear in blue Ariel text.

Question 3. [1 mark]: Where should this eExam response file be saved?

Response	Please type an x into only one 'response' box to indicate your answer.
	a) System
	b) eExam
	c) Answers

Question 4. [1 mark]: Which is the 'one-time boot key' for your computer?
Please write your answer below this line _____

Question 5. [2 marks]: The following diagram has some unidentified parts indicated by part numbers.



Please complete the table below to provide the label names for each part number.

Part	Labels (please enter text in each row below.)
1)	Sample answer goes here...

Page 2 / 2 Default English (Australia) INSRT STD TableS:A1 134%

Walk Through (post-paper)

8.1 in 'post-paper' exams: Make resources available (PDFs, Videos, images) and use specialist software tools to construct responses. Launched via links in the document.

12345678_practice_e-exam5pe_uqlogo.doc - LibreOffice Writer 6:41 PM

The screenshot displays a desktop environment with several overlapping windows. At the top, the title bar of the LibreOffice Writer window reads "12345678_practice_e-exam5pe_uqlogo.doc - LibreOffice Writer" and shows the time "6:41 PM".

- LibreOffice Writer:** The main window shows a document with a "Part One" header and a diagram of a person with a speech bubble. A sidebar on the left contains a "Bookmarks" list with entries from "blogoscoped.com", "creativecommons.org", and "gamesforthebrain.com".
- Adobe Reader:** A window titled "googlechromecomic.pdf - Adobe Reader" is open, showing a document page.
- Google Chrome:** A browser window is visible in the background, showing a page with a search bar and navigation buttons.
- VLC media player:** A window titled "SAM_0232.AVI - VLC media player" is playing a video of a woman with blonde hair in a public square.
- Scratch:** A Scratch script editor window is open, showing a script with blocks like "when green flag clicked", "wait 1 secs", "forever" loop, and "switch to costume".
- FishChomp:** A game window titled "FishChomp" is visible, showing a fish character and a "green flag" button.

At the bottom left, there is a "Scheduler" window with a table of transactions:

Date	Description
12/10/02	Alimentation : Epicaria
12/10/02	Alimentation : Confiserie
12/10/02	Alimentation : Boulangerie
12/10/02	Alimentation : Bar
12/10/02	Crédit Bitare
12/10/02	CAR Orly-Caupain
12/10/02	Lepain Sylvestre
01/02/03	Ahmed Donsaha-Saplan

Below the table, there is a "transaction form" section.

Walk Through

9. Remember to save (CTRL S). When done use File > Exit.

[there is a 2 min 'auto recovery' save]

The screenshot shows the LibreOffice Writer interface. The title bar reads "12345678_practice_e-exam5pe_uqlogo.doc - LibreOffice Writer" and the system clock shows "6:41 PM". The menu bar includes File, Edit, View, Insert, Format, Table, Tools, Window, and Help. The File menu is open, displaying options such as New, Open... (Ctrl+O), Recent Documents, Wizards, Close, Save (Ctrl+S), Save As... (Ctrl+Shift+S), Save All, Reload, Versions..., Export..., Export as PDF..., Send, Properties..., Digital Signatures..., Templates, Preview in Web Browser, Page Preview, Print... (Ctrl+P), Printer Settings..., and Exit (Ctrl+Q). The document content includes:

2 [1 marks]. what is the brand/make/manufacture of your computer?
Please type your answer inside the box below - place the cursor inside the box and start typing!
answer goes here... student responses appear in blue Ariel text.

3. [1 mark]: Where should this eExam response file be saved?
Please type an x into only one 'response' box to indicate your answer.

Response	a) System
	b) eExam
	c) Answers

4. [1 mark]: Which is the 'one-time boot key' for your computer?
Please type your answer below this line

5. [2 marks]: The following diagram has some unidentified parts indicated by part numbers.

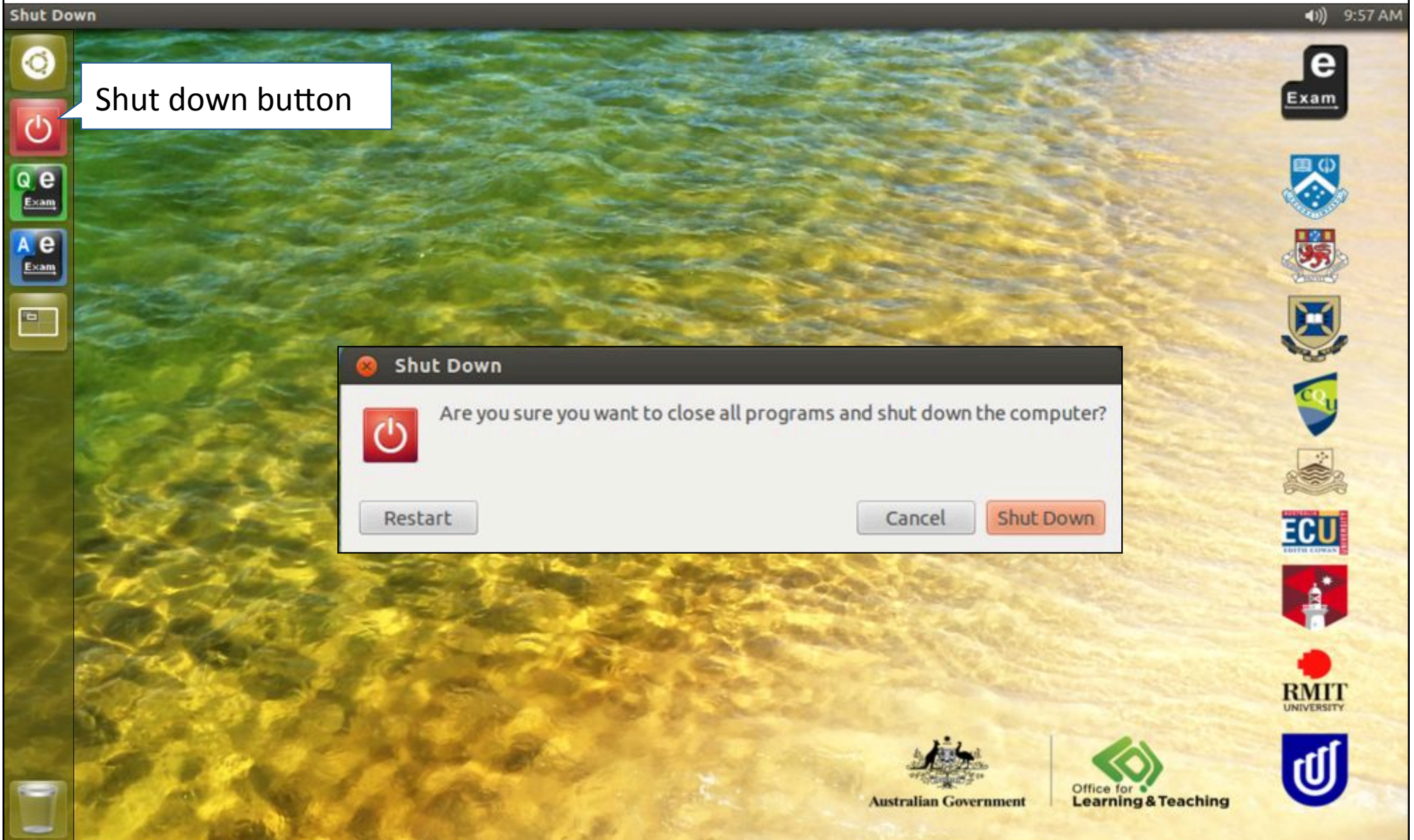
Please complete the table below to provide the label names for each part number.

Part	Labels (please enter text in each row below.)
1)	Sample answer goes here...

The status bar at the bottom shows "Page 2 / 2", "Default", "English (Australia)", "INSRT | STD", "TableS:A1", and "134%".

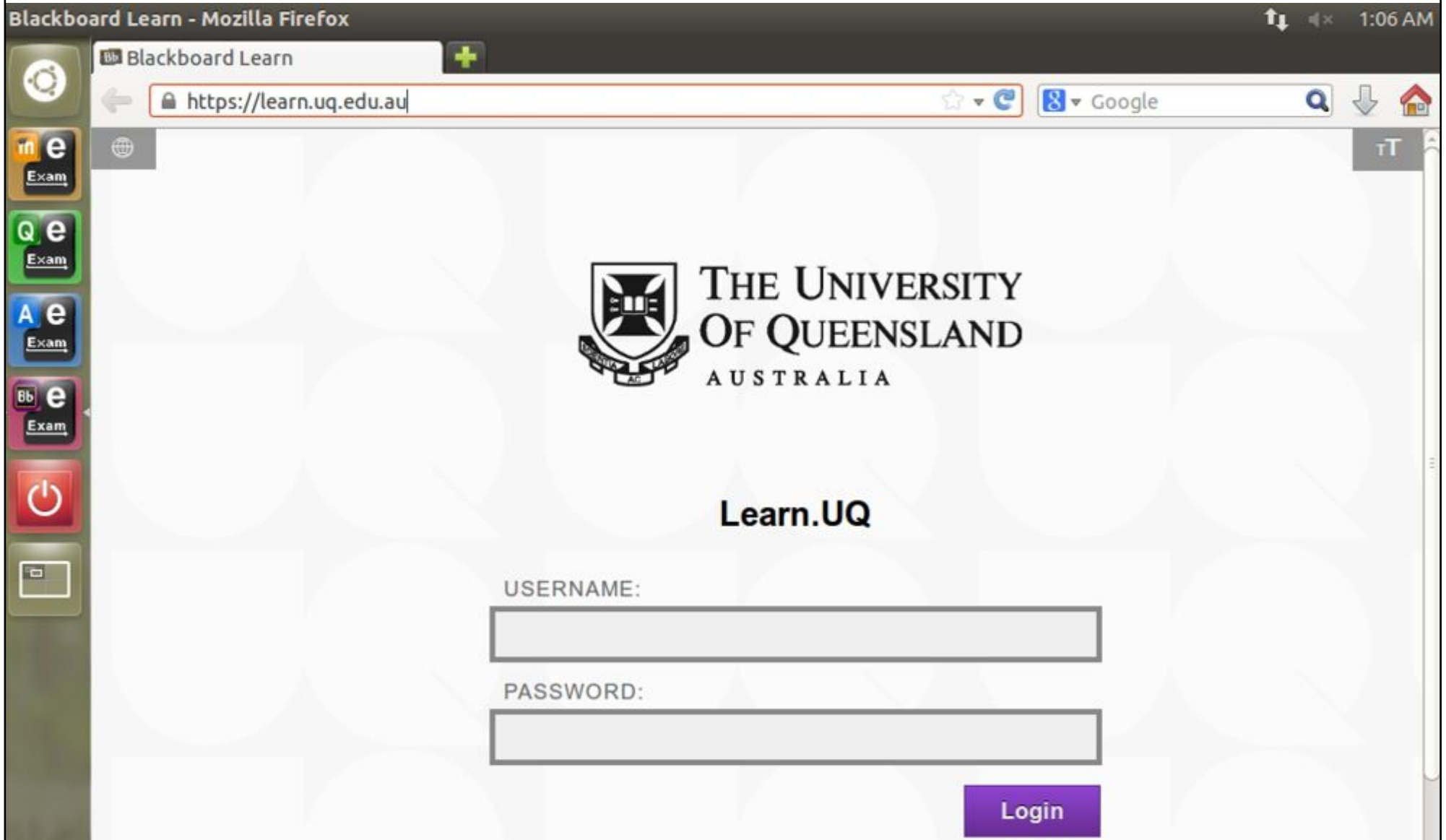
Walk Through

10. Shut down the system. When the system has powered off, hand in the USB Stick.



e-Exam: LMS Gateway Mode

Start laptop with USB. Instead of launching a document, it opens a web browser.
Network connections only possible to pre-defined destination – e.g. UQ Blackboard



The screenshot shows a Mozilla Firefox browser window titled "Blackboard Learn - Mozilla Firefox" with the time "1:06 AM" in the top right corner. The address bar contains "https://learn.uq.edu.au". The page content features the University of Queensland Australia logo and the text "THE UNIVERSITY OF QUEENSLAND AUSTRALIA" and "Learn.UQ". Below this, there are two input fields labeled "USERNAME:" and "PASSWORD:", and a purple "Login" button at the bottom right. On the left side of the browser window, there is a vertical sidebar with several icons: a globe, a power button, and a folder icon, along with four "Exam" buttons labeled "me", "qe", "Ae", and "Bb".

e-Exam: LMS Gateway Mode

Use Blackboard test settings for control. Best to have separate Exam server.

Blackboard Learn - Mozilla Firefox 1:09 AM

Blackboard Learn Google

https://learn.uq.edu.au/webapps/portal/frameset.jsp?tab_tab_group_id=3_1


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Welcome Courses **Community** Staff Help How-Tos and Tutorials Statistics

Preview Test: Example test - e-exam mode

Description	Example test to try marking (Normally the description of the test for students would appear here)
Instructions	Normally the instructions for students would appear here
Timed Test	This Test has the time limit of 1 hour. You are notified when time expires, and you may continue or submit. Warnings appear when half the time, 5 minutes, 1 minute and 30 seconds remain. <i>[The timer does not appear when previewing this Test]</i>
Multiple Attempts	Not allowed. This Test can only be taken once.
Force Completion	Once started, this Test must be completed in one sitting.

Question Completion Status:

 Moving to another question will save this response. Question 1 of 19 > >>

Question 1 10 points Saved

e-Exam: on-board LMS Mode

Start laptop with USB. Launches a web browser to login to an on-board Moodle. Moodle account created-on-the-fly. Network connections NOT possible.

File Edit View History Bookmarks Tools Help 12:55 AM

Start e-Exam Demo

localhost/moodle/mod/quiz/attempt.php?attempt=2

e-Exam

Home / My courses / e-Exam / e-Exam Demo / e-Exam Demo / Start e-Exam Demo

QUIZ NAVIGATION

John Smith

1 2 3 4 5
6 7 8 9 10 11
12 13 14

Finish attempt ...

Information
Flag question

All questions in this demonstration exam, except for number 7 which an essay question, are computer marked.

This demonstration displays all questions on one page, permits multiple attempts and provides feedback on correct and incorrect responses after the completion of the exam.

These settings can be changed as needed.

Question 1
Not yet answered
Marked out of 1.00
Flag question

Moodle is the most popular LMS in the world today.

Select one:

True
 False

Question 2
Not yet answered
Marked out of 1.00

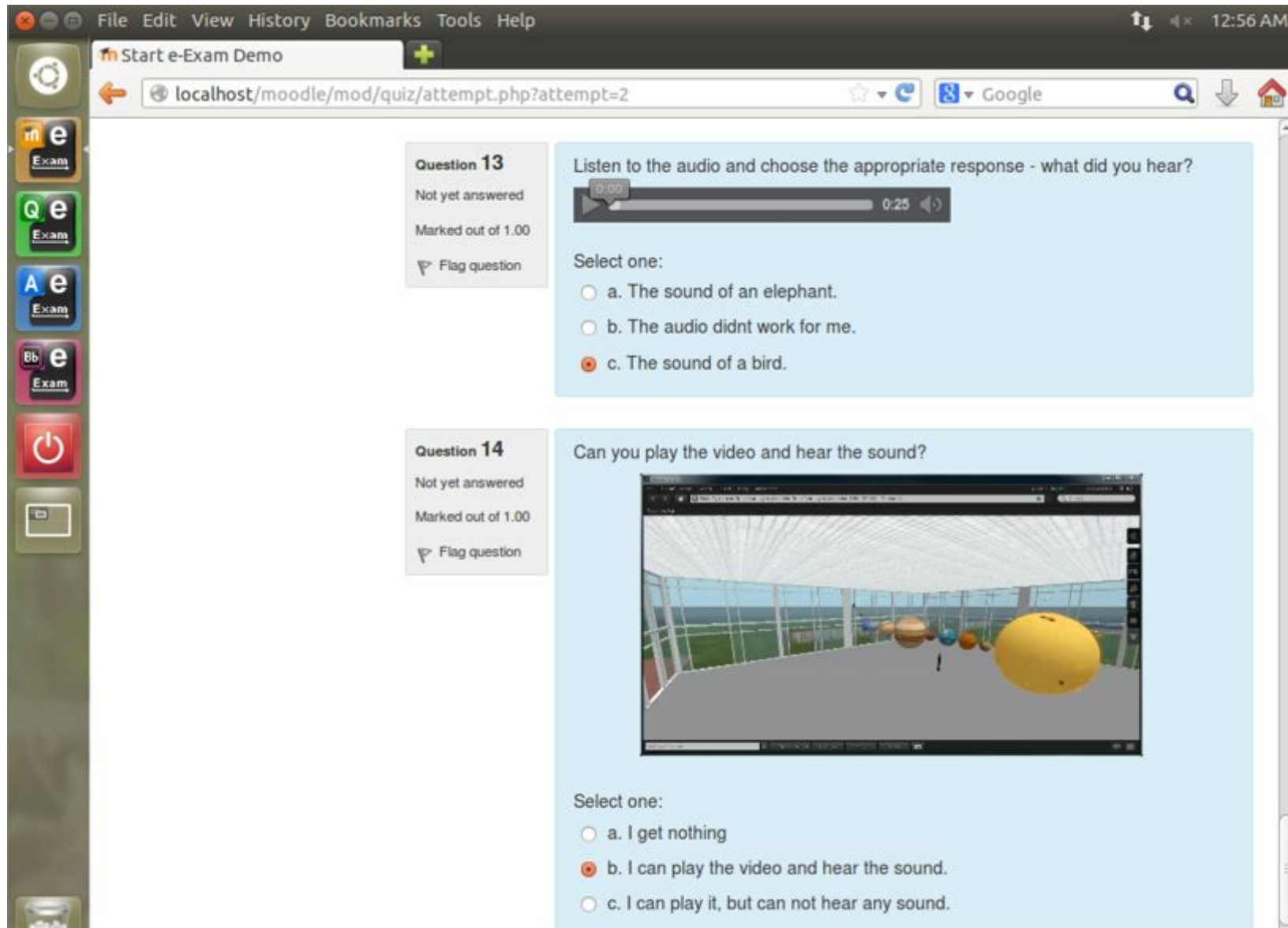
What do you call a question format in which students must uniquely associate a set of prompts with a set of options?

Answer: matching

e-Exam: on-board LMS Mode

Remove non-exam related modules and menus.

Large multimedia is possible due on-board storage.



The screenshot shows a web browser window titled "Start e-Exam Demo" with the URL `localhost/moodle/mod/quiz/attempt.php?attempt=2`. The browser interface includes a menu bar (File, Edit, View, History, Bookmarks, Tools, Help) and a status bar (12:56 AM). On the left side, there is a vertical sidebar with several icons, including a power button and a play button. The main content area displays two questions:

Question 13
Not yet answered
Marked out of 1.00
Flag question

Listen to the audio and choose the appropriate response - what did you hear?


0:00 0:25

Select one:

- a. The sound of an elephant.
- b. The audio didnt work for me.
- c. The sound of a bird.

Question 14
Not yet answered
Marked out of 1.00
Flag question

Can you play the video and hear the sound?



Select one:

- a. I get nothing
- b. I can play the video and hear the sound.
- c. I can play it, but can not hear any sound.

More Questions and Discussion Points

- 1) How well prepared are:
 - Students to BYOD for exams?
 - Academics for taking on new approaches to exams?
 - Institutions to support BYOD in exam venues?
- 2) Transitioning to e-Exams via 'paper-replacement' exams appears the most favoured strategy (e.g. first replicating paper exams in an electronic form before moving on to a mix of rich multimedia, linked software apps, and computer marked questions). Do you agree?
- 3) What kinds of 'post-paper' exams can we envision?
- 4) How can e-Exams enable curriculum transformation?

Ready?

I hope you are excited about the future - and ready to **transform!**



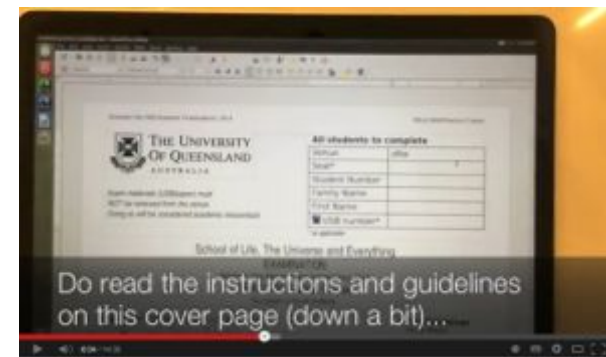
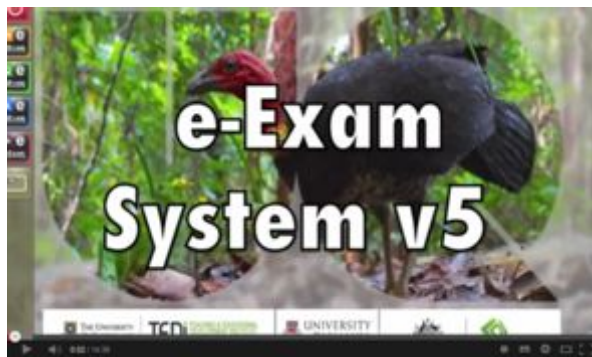
e-Exam Project Resources

More information....

Demo set-up Guide,

Student Practice and User Guide

<http://transformingexams.com>



Demo videos start-up, use and recovery examples.

Apple <http://ta.vu/eexam-demo-a>

'Wintel' (Dell) <http://ta.vu/eexam-demo-d>

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End

Cite this resource

Hillier, M (2016) “OLT e-Exams: Ramping up the authenticity of high-stakes supervised assessment for the 21st century”, Presentation for Macquarie, Sydney, 23 Sep.

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Session feedback survey

<http://ta.vu/e-exam-serv>



References

- Dermo, J. (2009). e-Assessment and the student learning experience: A survey of student perceptions of e-assessment. *British Journal of Educational Technology*, 40(2), 203–214. <http://doi.org/10.1111/j.1467-8535.2008.00915.x>
- Fluck, A. (2013). Implementation of on-campus digital examination practices. Presented at the Transforming Assessment in a Digital Era, Melbourne, Australia. Retrieved from <http://www.eexams.org/stories/Documents/TA%20in%20a%20Digital%20Era%20-%20Fluck.pdf>
- Fluck, A. E. (2011). eExams for Transformation of Higher Education. Presented at the Australian Association for Research in Education Conference, Hobart Tasmania. Retrieved from <http://www.aare.edu.au/data/publications/2011/aarefinal00107.pdf>
- Fluck, A., & Hillier, M. (2014). eExams Transforming Curriculum. In *Now IT's Personal* (pp. 151–158). Adelaide, Australia: ACEC. Retrieved from <http://acec2014.acce.edu.au/sites/2014/files/attachments/eExams%20paperd%20-%20REV2b.docx>
- Fluck, A., Pullen, D., & Harper, C. (2009). Case Study of a Computer Based Examination System. *Australasian Journal of Educational Technology*, 25(4), 509–523.
- Hillier, M. (2014). The Very Idea of e-Exams: Student (Pre)conceptions. Presented at the Australasian Society for Computers in Learning in Tertiary Education conference, Dunedin, New Zealand. Retrieved from <http://ascilite.org/conferences/dunedin2014/files/fullpapers/91-Hillier.pdf>
- Hillier, M., & Fluck, A. (2013). Arguing again for e-exams in high stakes examinations. In H. Carter, M. Gosper, & J. Hedberg (Eds.), *Electric Dreams* (pp. 385–396). Macquarie University. Retrieved from <http://www.ascilite.org.au/conferences/sydney13/program/papers/Hillier.pdf>
- Lim, E. C. H., Ong, B. K. C., Wilder-Smith, E. P. V., & Seet, R. C. S. (2006). Computer-based versus pen-and-paper testing: students' perception. *Annals of the Academy of Medicine, Singapore*, 35(9), 599–603.
- Mogey, N., & Hartley, J. (2012). To write or to type? The effects of handwriting and word-processing on the written style of examination essays. *Innovations in Education and Teaching International*, 50(1), 85–93. <http://doi.org/10.1080/14703297.2012.748334>
- Sorensen, E. (2013). Implementation and student perceptions of e-assessment in a Chemical Engineering module. *European Journal of Engineering Education*, 38(2), 172–185. <http://doi.org/10.1080/03043797.2012.760533>

220 more at: <https://www.zotero.org/groups/e-assessment/items/tag/e-exam>
e-Exams Online Conference Recordings (2014) <http://ta.vu/eAS2014>