Teacher's Handbook on e-Assessment

Geoffrey Crisp

A handbook to support teachers in using e-assessment
to improve and evidence student learning and outcomes

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What is e-assessment?

E-assessment involves the use of digital devices to assist in the construction, delivery, storage or reporting of student assessment tasks, responses, grades or feedback.

E-assessment can be undertaken with many devices, such as traditional desktop computers or laptops, with portable communication devices such as smart mobile phones, with digital devices such as iPads or through the use of electronic gaming devices. E-assessment can use a multitude of formats, including text documents or portable document formats, multimedia formats such as sound, video or images; it can involve complex simulations or games; it can also be undertaken by students in groups or individually and it can occur with large numbers of students in a synchronous or asynchronous manner.

Teachers can use computers to construct their assessment tasks, to deliver these tasks to the relevant students and to record and provide feedback and grades to these students. Computers can also be used to analyse the students' responses, both to provide feedback to the student on the quality and relevance of their response, as well as to provide feedback to the teacher on whether the task can differentiate between students with different abilities.

E-assessment can be used to test many different capabilities and skills that are developed by students. There are only a few tasks that might not be suitable for completing and recording electronically, but the number of such tasks is rapidly diminishing as technology becomes more sophisticated and widespread. In many disciplines laboratory equipment can be manipulated remotely and students can undertake real time physical performances that are able to be recorded and used for assessment purposes. We are quickly approaching the stage where our imaginations will be the limiting factor in designing e-assessment tasks.

E-assessment can be part of a learning management system such as *Blackboard*, *Sakai* or *Moodle*; it can be a standalone application such as *Questionmark Perception* or *TestPilot*. Electronic assessments can be located and delivered from a central server and accessed by students anywhere and anytime through the use of a web browser or they can be isolated on local computers or local area networks (LAN) with limited access gateways.

E-assessment is much more than multiple-choice questions. It can involve the use of blogs and wikis, self or peer review; it can use existing social media sites and creator systems associated with Web 2.0; assessments embedded within role plays and scenario-based assessments can be designed; we are able to use virtual worlds such as Second Life to set engaging and sophisticated tasks for students that require the use of multiple capabilities and skills to solve complex problems.

In summary, e-assessment involves a rich tapestry of possibilities that allows us to evidence student learning in a much deeper and often more authentic way than has been possible with traditional paper-based assessments where students have been expected to use limited resources to respond to tasks.

What are the different types of assessment tasks you can set?

There are four basic types of assessments you may set for students – diagnostic, formative, integrative or summative.

Diagnostic assessment is often the most underused of the traditional assessment formats in tertiary education and is too often associated with a negative model designed to identify deficiencies in students' capabilities (Benseman & Sutton 2008). This situation should be changed so that diagnostic assessments are incorporated as an initial component in all courses and are seen as a means of encouraging students' ownership of their learning and assessment. Low stakes diagnostic tasks would establish a baseline for standards within a course; they would allow students to determine their preparedness for their current learning activities and allow teachers to adjust their introductory learning activities so that the majority of the students are able to participate at a meaningful level. Diagnostic assessment tasks also highlight for students the core principles and key concepts that are critical for the learning they are about to undertake. Rather than using

diagnostic assessment to highlight deficiencies in students' knowledge or skills, teachers could take a more proactive approach that reinforces important principles for enhancing approaches to learning.

Formative assessment tasks with timely and appropriate feedback should be used throughout a course; these tasks are primarily intended to have an impact on the current learning of students and most often use feedback to connect the formative task to potential improvements in student performance in subsequent summative tasks. It is usually posited that formative assessment is predominantly about improving learning, whether or not improvements are seen in subsequent summative tasks; however students often view their performance in summative tasks as a measure of how much they have learnt within a course.

Summative assessment tasks are used primarily for progression and certification purposes, as well as a proxy measure of overall learning.

Integrative assessments are designed to promote and measure student self-regulation and the capabilities associated with lifelong learning (Crisp, 2012). Marks and grades could be used in integrative assessments as indicators of standards, even if they are not used to make decisions about progression and certification. Integrative tasks can be for formative or summative purposes. The advantage of identifying an assessment task as being integrative would be to highlight that the primary purpose of the task is to provide feedback (or judgement) on students' abilities to be self-regulated learners, that they are expected to identify and use standards and to apply their learning to future situations by being able to articulate their strategies or decisions in responding to a task or situation. Judgements and feedback on these integrative tasks can come from any combination of the teacher, the student or peers; the key characteristic of integrative assessment is that its primary purpose is to influence students' approaches to future learning.

Integrative assessments have the following characteristics:

- students are provided with opportunities to make judgements about their own learning or performance through review and critique;
- students are provided with opportunities to define standards and expectations in their response;
- students are provided with opportunities to track and analyse their approaches to responding to a problem, issue, situation or performance;
- students are provided with opportunities to integrate prior or current feedback into their response;
- students are provided with opportunities to engage with a meaningful task that has inherent worth beyond just an assessment activity;
- students are rewarded for the quality of their analysis of metacognitive abilities, rather than declarative knowledge.
(Crisp, 2010)

Why might e-assessment be useful to you?

Assessment is a complex activity; meaningful, assessment requires effort on the part of the teacher and student. We can design assessment tasks that are easy to prepare and grade, or we can take the time to design an assessment that has intrinsic worth for both the student and the teacher.

E-assessment offers a range of potential opportunities and advantages for teachers, students and institutions, including:

Efficiency

- Timeliness
- Flexible delivery
- Automatic processing responses
- Effective storage results and grades

Effectiveness

- Immediate feedback
- Analysis of question validity
- New question types

Authenticity

- Access to people and resources
- Can be designed to simulate real world
- Can set complex tasks

Engagement

- Multimodal formats
- Can use virtual worlds
- Can use self and peer review

The quickest benefits to be gained from using e-assessments are associated with diagnostic and formative tasks which provide detailed and timely feedback for students to use in a subsequent task. By requiring students to complete assessment tasks early in the course, you can highlight the key concepts that students must understand in order to build new learning experiences. Diagnostic assessments allow students to benchmark their current level of skill development and capabilities against what is required for the current course. You can use students' responses to diagnostic assessments to gauge which learning activities are appropriate for the first few classes or where you should commence a course so that students are not left behind.

Formative tasks allow students to benchmark their learning against the expectations of the teacher. You can use the students' responses to formative questions to gauge how quickly they can move from one concept or learning activity to the next. In order to encourage students to complete formative tasks many teachers have found it useful to use low stakes summative quizzes for formative purposes by using a databank of e-assessment items and allowing students to attempt the quiz as many times as they wish for formative purposes and only using the highest mark for summative purposes. This has the advantage that students can use the same assessment task for diagnostic, formative and summative purposes thus increasing the efficiency of the assessment process.

What can you do with e-assessment?

There is a growing range of e-assessment resources available for teachers to use, ranging from commercial products, to shareware and freeware resources.

Whilst some resources are commercial in nature, there are many free resources licensed under the Creative Commons scheme. Universities such as MIT and Notre Dame are making their learning and assessment materials freely available, labeling them as 'open courseware'. This approach emphasises that the learning experience at these universities is strongly associated with being an active participant in lectures, tutorials and the

wider university life and is not simply a process of completing assessments after reading or viewing learning materials.

Teachers should explore the use of these new resources as they allow students to present assessment responses in a variety of formats, including written, audio or video. This gives students a wider range of opportunities to evidence their skill development.

A summary of some e-assessment formats is given below.

Animation	Click or move object, simulation
Blog	Journals, video logs, podcasting
Cloze	Fill in key word blanks, can be used for assertion reasoning
Discussion	Asynchronous discussion forum, can be group or individual activity
Free text	Short or extended text responses
Hot spot	Use mouse to click on relevant spot on screen
Matrix	Select one or more responses from list or table, extended MCQ
MCQ	Select option from list, can be true or false, yes or no options
Ordering	Arrange options according to specific order
Pull down	Select options from a pull down list
Role-play	Adopt a persona in a simulated activity, reflect on actions
Self or peer review	Review and critique own work or that of others
Simulation	Interactive applications used to generate results
Virtual world	3D digital representation of world, avatars carry out tasks
Wiki	Online group project that produces common product

What do you need to think about when using e-assessment?

Selected response questions, such as MCQs, are relatively easy to construct (although difficult to design well from a pedagogical perspective) and it is straightforward for the computer to mark these and deliver the appropriate feedback. When e-assessment tasks are marked automatically by a computer there may be issues in determining the comparative equivalence of constructed responses (text, multimedia or numerical) from different students. Short text entry responses are difficult to grade automatically and you must decide beforehand which responses will be regarded as acceptable, including responses using alternative spellings, or the mixed use of upper and lower case text or the use of abbreviations. For online mathematical responses, two different but equivalent responses may be provided by different students, yet both must be interpreted by the computer as being equivalent if students are to be treated fairly. Software such as *AIM* and *Maple T.A.* allows equivalent mathematical expressions to be compared automatically by the computer.

The increased flexibility afforded to students by their being able to complete an e-assessment from any computer can sometimes cause issues with individual student authentication for high stakes exams. Students may be issued with individual passwords or encrypted smart cards; e-assessments may be restricted to particular computers by specifying IP addresses. In addition, live remote monitoring of students through the use of webcams and keystroke biometrics (http://www.kryteriononline.com) can provide secure e-assessments for high stakes exams. For on-campus exams, common invigilation procedures can be adopted and individual students can be identified by photographs on their student cards.

There are a number of standards that have been developed to facilitate accessibility and the interoperability of e-assessments across different computer operating systems and with different web browsers. These include the World Wide Web Consortium standards (http://w3c.org/Consortium); CETIS, the Centre for Educational Technology Interoperability Standards (http://jisc.cetis.ac.uk/); and SCORM, the Sharable Content Object Reference Model (http://www.adlnet.org). QTI, the IMS Question and Test Interoperability standards, are designed to make it easier to transfer information such as questions, tests and results between different software applications (http://www.imsglobal.org). The purpose of these standards is to provide an agreed set of technical specifications for web objects so that users can interact with web content on any common operating system or computer hardware and still have it behave in a predictable manner. As a teacher you need not be concerned with the details of these specifications, but you should know whether the materials you are using, either commercial or sourced under Creative Commons licences, comply with the specifications.

Teachers will need to think about the impact e-assessment formats will have on students with special needs. This can include the ability to physically use a computer or to view or listen to digital content on the computer screen, including students who have some form of sensory or mobile disability that would impact on their physical capability to complete an e-assessment and so prevent them from showing what they had learnt. JISC TechDis provides a variety of services for inclusive educational practices that both institutions and individual teachers will find useful (http://www.jisctechdis.ac.uk/).

21st century learning and assessment environments

Teachers are now expected to provide their students with a variety of learning and assessment experiences; this often means responding to students' needs in a timely manner (Simkins & Maier, 2010). Another recent trend is the ready availability of cloud-based computing; this is where content and software resources exist on remote servers, rather than on local computers. Cloud-based approaches, such as *Google Apps*, allow students and teachers to interact with content, resources and each other, from anywhere in the world; all you need is an Internet connection and a web browser.

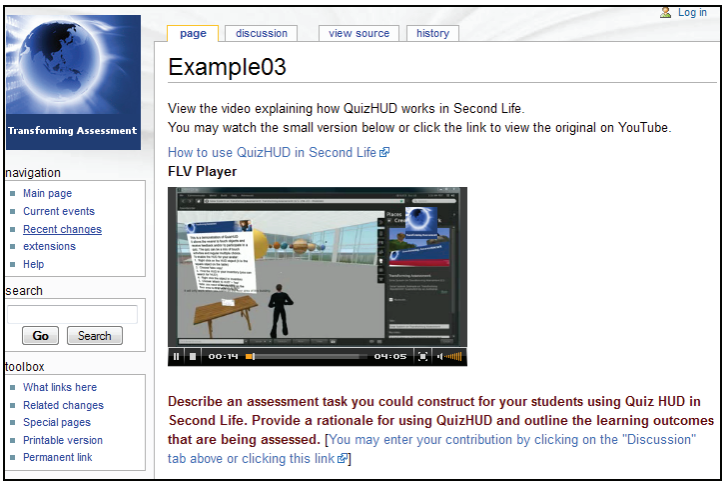
The role of being a student is also changing as students become more mobile and can access their educational experiences globally. Since quality content and learning experiences are becoming more ubiquitous, students can remain in their local town or city and still be part of a global classroom;

students do not have to travel physically to experience different learning environments. This ability to remain in a local physical environment and simultaneously be part of a global classroom is likely to change the economics of education significantly in the near future (Allen & Seaman, 2010).

There has been a gradual acceptance of the concept of a student-centred classroom with the move to an increased use of technology in the classroom. This includes the use of self and peer review and more group related activities and assessment tasks. Typical learning environment today are more dynamic and interactive than in the past; the roles and actions of teacher and student move along a continuum now defined more by the learning and assessment tasks themselves, rather than formal roles and titles.

Web 2.0 is a term used to describe the collaborative spaces now available through the web; the key feature of Web 2.0 is not the technology itself, but the virtual space that facilitates and encourages a user-centric approach to creativity and peer review (Lee & McLoughlin, 2010). Web 2.0 services that are now available to students and teachers include blogs (*Edublogs*, *WordPress*), wikis (*Wikispaces*, *MediaWiki*), collaborative word processing (*Google Docs*), aggregation tools (RSS, *Bloglines*, *PageFlakes*, *iGoogle*), social bookmarking (*del.icio.us*), shared calendars (*Google Calendar*) and shared image or video content (*Flickr*, *YouTube*).

On the traditional web, users browsed the Internet and viewed static websites; with Web 2.0 services anyone can aggregate or create content and publish insights or interpretations about an issue to a world-wide audience and receive feedback from that audience. Software applications such as blogs, social bookmarking, podcasts or wikis allow students to be active creators, rather than passive receivers of content or the experiences of others. Traditional tertiary education delivery is often associated with the passive transmission of content or the retelling of what others have done. This passive educational environment has the potential to encourage student dependency on the teacher for continual affirmation of whether the student is on the right track, or meeting the teacher's expectations.



Screenshot from wiki with embedded multimedia
http://www.transformingassessment.com

Learning environments are becoming more blended in nature as students make choices about whether to attend all traditional face-to-face sessions or to adopt a mix of asynchronous and synchronous activities. Classes now require a mixed mode approach with some face to face and some online activities such as virtual classrooms or discussions, Skype sessions or avatars meeting in 3D virtual worlds. New types of learning and assessment spaces are becoming available to teachers and students, including online role-plays, scenario-based activities and serious games; virtual or remote laboratories and field trips are now possible.

An interesting example of new approaches to course design is the "Connectivism and Connective Knowledge" course facilitated by George Siemens and Stephen Downes (http://www.connectivism.ca). This course is an attempt to break with common online models as the learning content is not housed in a central location owned and managed by the teacher. The course relies upon content being aggregated using RSS; all students label their contributions with a tag which makes it accessible to other students and course facilitators. During each day of the course a daily newsletter is produced which is an assembly of all the interactions (eg blog posts, wiki updates, bookmarks); all work undertaken in the course is open to everybody.

Assessing 21st century skills

Recent work in the area of employability skills has used the term 21st century skills to describe the abilities required of tertiary graduates (Ripley, 2010).

Table 1. Example of 21st century employability skills (adapted from content by Ripley, 2010)

Ways of thinking
• Creativity and innovation • Critical thinking, problem solving • Learning to learn, metacognition
Ways of working
• Communication • Collaboration (teamwork)
Tools for working
• Information literacy • ICT literacy • Discipline content
Living in the world
• Citizenship – local and global • Life and career • Personal, social responsibility

If students are to master these new skills then teachers will need to set appropriate assessment tasks so that students can collect evidence of their capability and skill development. These capabilities and skills are related to those required for authentic performance in the workplace; the difficult part for many teachers is that to provide assessment tasks related to these skills requires a complete redesign of the current curriculum and the process for designing authentic assessment tasks can be quite time-consuming.

A useful approach to characterising 21st century skills related to technology has been proposed by Mioduser, Nachmias, and Forkosh-Baruch (2008). These authors argue that the knowledge society calls for seven new literacies, as outlined in Table 2.

Table 2. 21st century technology skills (adapted from content by Mioduser, Nachmias, & Forkosh-Baruch, 2008)

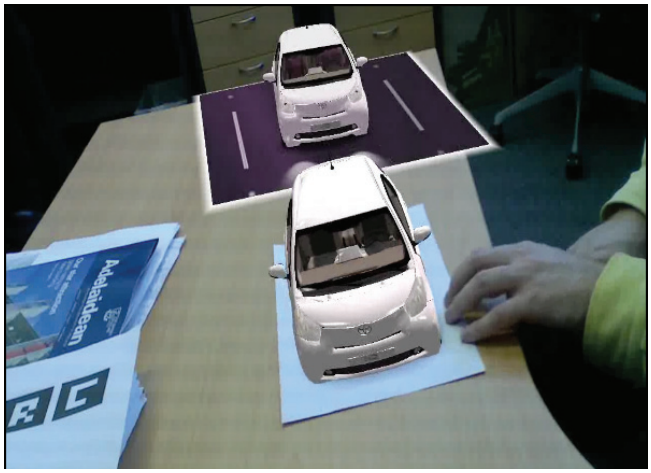
Multimodal information processing	Ability required to understand, produce and negotiate meanings in a culture made up of words, images and sounds.
Navigating the infospace	Ability to know when and why there is a need for information; how and where to find it in, and retrieve it from, infospace; and how to decode, evaluate, use and communicate it in both an efficient and ethical manner.
Interpersonal communication	Ability to be mindful, knowledgeable, and ethical in using of a wide range of communication means, using multiple communication channels, in various interaction configurations, for different purposes.
Visual literacy	Ability to decode, evaluate, use, or create images of various kinds using both conventional and 21st century media in ways that advance thinking, reasoning, decision making, communication, and learning.
Hyperacy	Ability to deal, either as consumers or as producers, with nonlinear knowledge representations.
Personal information management literacy	Ability or process by which an individual stores his/her information items to retrieve them later.
Coping with complexity	Ability to perceive phenomena as complex (recognizing multiple actors or multiple layers), to study and understand these phenomena (devising multiple alternatives and strategies), and to implement the gained understanding for coping with them.

E-assessment can offer new opportunities to assess these 21st century skills through the design of tasks that require Web 2.0 creative activities; interactive tasks that include branching and decision points such as role plays and scenario based activities; and through the use of global communication tools.

Effective use of technology

There will be an increased use of portable and feature-rich physical devices for students and teachers to use to access educational environments. Wireless access to cloud-based learning environments is becoming more common, so that the educational experience of students will be less dependent on physical access to resources. As open source content becomes more available, the main issue for teachers and students will be to determine the quality of the content they access and the quality of the learning experience itself. Measuring the quality of teaching, learning and assessment will become an important consequence of the increased use of an online educational environment. Although online education can provide more widespread access to content and learning experiences, it is the curriculum design that surrounds the content and the scaffolding provided by the teacher that supplies the quality experience for students.

Quality learning, teaching and assessment is dependent on the successful integration of the cognitive, affective and managerial (administrative) domains (Coppola, Hiltz, & Rotter, 2002); this applies whether the environment is online or face-to-face. Numerous guidelines have been written about how to use technology effectively in education (Fry, Ketteridge, & Marshall, 2009; Joint Information System Committee, 2004); however, the issue is not a lack of sources of advice, but rather the practical means to integrate this advice into the current workload of teachers and the limited financial resources allocated to educational enhancement. Online teaching inevitably demands a significant initial investment of time for the teacher, so the reward should be an enhancement in the quality of the learning environment and student outcomes. Over a period of time, the initial increased workload should translate into time efficiencies with les time required to construct subsequent learning



Example of Augmented Reality which uses the real and the virtual

or assessment tasks; teachers should be able to leverage their own previous work, and that of colleagues, to reduce their own future workloads. The effective use of technology should include a strategic approach to designing learning activities and assessment tasks, incorporating a plan to reuse and repurpose materials and curriculum designs, as well as using sound pedagogical guidelines about how students learn (Ablin, 2008).

Some teachers question the efficacy of online learning and assessment. There have been numerous studies comparing the performances of students using traditional face-to-face instruction and those using online methodologies (Means, Toyama, Murphy, Bakia, & Jones, 2009; Shachar & Neumann, 2010). Teachers involved in online learning and assessment have often had to demonstrate that they can produce learning outcomes at least as good as those arising from traditional methodologies. The assumption here is that assessment outcomes from traditional modes of learning should be used as the ultimate benchmark for quality education. This is an assumption that must be challenged. By using the new opportunities afforded by online learning, the assessment tasks themselves are changed, so the same outcomes as those arising from traditional modes of learning would not necessarily be expected. Many standards and norms that are historically associated with learning have been constructed using traditional text-based or face-to-face learning activities and their associated assessment tasks have been determined by the limitations of this educational environment. Digital environments change this situation; we should be establishing new norms and standards associated with 21st century skills and capabilities.

Authentic e-assessment

Role-plays and scenario-based learning

Online role-plays allow students to take on the role of a persona and to respond as that persona in a scenario constructed by the teacher (Linser, Ip, Rosser, & Leigh, 2008). Role-plays are designed as authentic learning and assessment activities; students can interact with other students (through their personas) to collaborate, collude, negotiate or debate an issue. Both role-plays and scenario-based learning provide students with decision points and branching opportunities. Technology allows these decision points to be recorded and a map of a student's decision making capability could be used for grading purposes and for students to understand their own strengths and weaknesses as decision-makers. In scenario-based activities students would normally respond as themselves rather than as a persona, and the branching is more prescribed compared to a role-play. When a scenario-based activity is undertaken, students follow a limited number of set branches and usually arrive at a teacher-defined end point; in a role-play, each group of students can take the activity in a new direction and the end point is often different each time the role-play is run. You will need to determine whether the weighting for the assessment will be on the quality of the student's decision-making and their justifications for those decisions, or whether the weighting will be on the pathway that the student has chosen to solve a problem. Scenario-based activities are usually used where there are preferred pathways that students should follow and the point of the task is to test whether the student recognized the preferred pathway. Role-plays are more often used when students are required to understand different stakeholder perspectives in a complex situation where there are no prescribed pathways, simply different consequences for different stakeholder for each action.

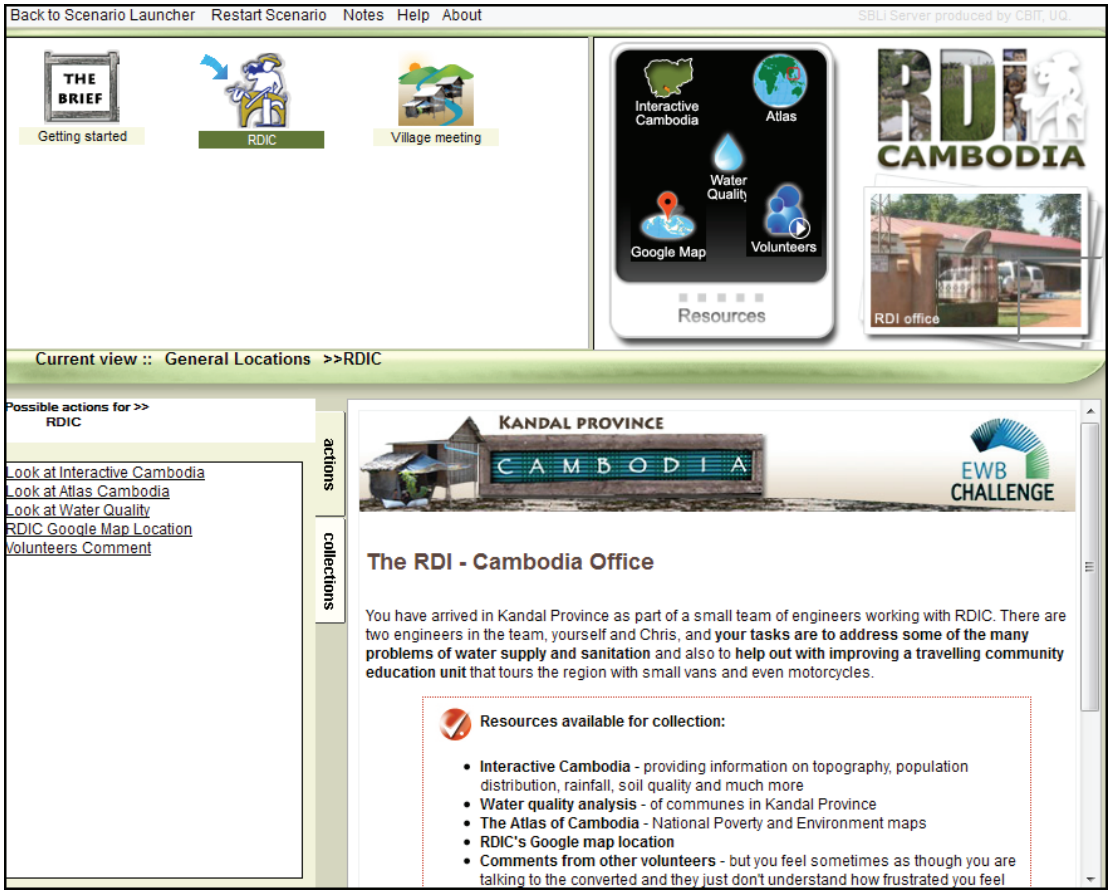
Role-plays offer rich learning environments for students as they can receive timely feedback on their actions in the form of the responses from other personas; students can reflect on the consequences of their decision-making by interpreting whether their actions have had a productive or non-productive influence on other participants in the role-play. An important characteristic of role-plays is their ability to allow students to take on a particular persona yet remain anonymous to other students; permitting students to act out the behavior of their persona without feeling that it is a direct reflection of their own beliefs. Thus role-plays are useful for controversial social or political issues as students can participate fully and explore all options, without their own cultural or social beliefs being compromised.

There are specifically designed software tools for role-plays (http://www.fablusi.com), but they are not essential for designing and running an online role-play. Using a combination of tools from any common learning management system will enable teachers to conduct a role-play (Maier, Baron, & McLaughlan, 2007). Teachers can use group features to define personas, email and discussion board features to allow communication between personas, quiz tools for formative or summative tests, wikis to capture content, blogs to capture student reflections on their decision-making and assignment upload features to capture student assignments. Examples of role-plays using common learning management systems can be found at the *Project EnRole* website (http://enrole.uow.edu.au). Assessment of an online role-play can be conducted using common Web 2.0 tools such as wikis, blogs, discussion forums and e-portfolios.

Scenario Based Learning Interactive (SBLi) is an example of software designed to facilitate the creation and delivery of scenarios for problem-based learning or enquiry-based learning (http://www.sblinteractive.org). SBLi software allows teachers to incorporate multimedia to provide a more authentic experience and quizzes so that students' declarative knowledge can also be assessed in addition to their decision-making capabilities (Stewart, Brown, & Weatherstone, 2009). The assessment of scenario-based learning is similar to role-plays, and should be closely aligned with rewarding the development of valued skills and capabilities, not just those allowing easy scoring.

Serious games

Serious games represent a recent attempt to design sophisticated digital learning and training activities based on principles of participant engagement found in digital games (Aldrich, 2009). Business,



Screenshot from SBLi http://www.sblinteractive.org/

health and military training programs have tended to dominate current serious game-based learning use and these games are often designed to promote drill and practice based activities (Pivec & Pivec, 2010). Serious games have not been widely adopted in higher education, probably because they are associated with adventure and fantasy games in the entertainment industry, and also because the majority of teachers do not have the skills or time to produce high quality, visually appealing games.

The main reason computer games are now being investigated for higher education learning and assessment is the similarities between the characteristics of well designed games and those of well designed learning and assessment activities (Pivec & Dziabenko, 2004). Digital games are designed to be engaging and to keep participants on task. They are characterized by a high degree of interactivity, contain appealing multimedia sequences and have clearly articulated goals, outcomes and rewards. The game player is expected to develop specific skills as they proceed through the game and these skills are used to proceed to higher levels within the game. Game players are provided with constant feedback in response to their actions and they are rewarded at regular intervals to keep them motivated to play; communities of practice evolve around how to master the skills that are required to reach advanced levels in the game. Each player often takes a different path on their journey through the game and players share their experiences and insights with other players. If one were asked to summarize what an effective learning and assessment environment might look like, it would be very similar to this description of the digital game environment. Teachers and institutions should look seriously at designing learning and assessment activities around these key characteristics of games. Engaging students in meaningful activities that encourage time on task would be a significant enhancement to our current approaches to teaching and assessing students.

Virtual worlds using avatars

Second Life is a well recognized example of a 3D online virtual world that has been adopted widely by many educational institutions (http://www.secondlife.com). 3D virtual worlds can be characterised as multiuser online role-plays; these environments allow participants to be represented

'in-world' in the form of an avatar so that they can explore the simulated world, create their own digital objects and complete specific tasks within this world. Virtual worlds have the potential to facilitate authentic learning and assessment. The main disadvantage of these worlds, from a teacher's perspective, is that creating the 3D virtual environment and scripting learning activities often requires professional expertise. There are a number of commercial and open source software packages for constructing virtual worlds, including *Second Life*, *Active Worlds*, *OpenSimulator*, *OLIVE* and *Multiverse*. The JISC 'Serious Virtual Worlds' report contains a comprehensive list of virtual world platforms used in education and training (de Freitas, 2008).

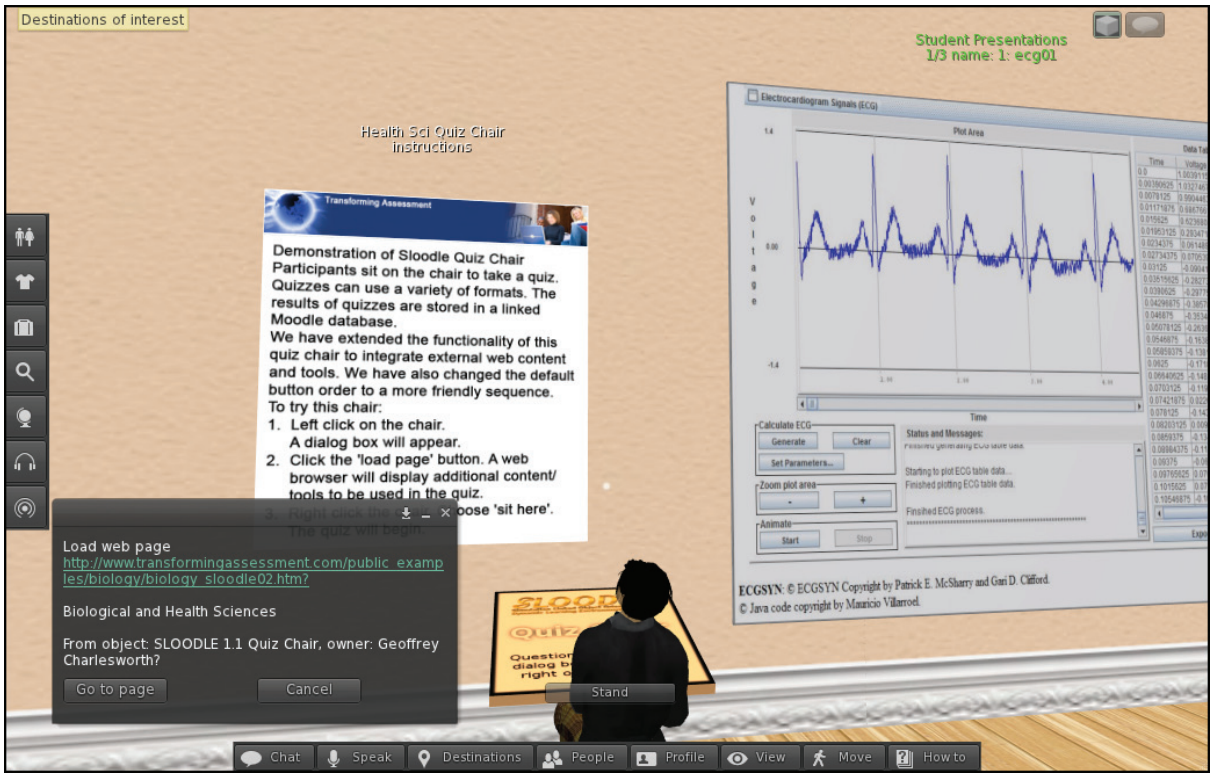
Screenshot from Scripted prim in Second Life
http://www.transformingassessment.com

3D virtual worlds provide an opportunity for students to experience presence and immersion. Presence is the feeling students have about being in a particular environment and context (either by themselves or with others) and immersion is associated with the properties of the system that give rise to the feeling of presence (Dalgarno & Lee, 2010). The fact that students construct avatars, both in physical form and in presentation format, makes 3D virtual worlds different from many of the role-plays discussed earlier. In most 3D virtual worlds, the student will have a close affinity with their avatar; it is a representation of them in the digital environment. The virtual world itself it usually constructed to match the 3D characteristics of the physical world so that students would expect certain physical laws to be adhered to in the virtual world, although clearly some exceptions are permitted (such as avatars being able to fly unaided). Educational activities need to make use of the specific attributes of the 3D environment and students should be given tasks that require navigating the 3D environment or investigating the components of 3D objects or terrains. Many tasks being assigned to students in 3D virtual worlds, when mapped against learning outcomes, could be completed just as effectively in 2D digital environments. So the issue for teachers is to appropriately map the learning outcomes set for the development of specific capabilities with the real attributes of a virtual 3D environment so that the time and resources spent on the activity are appropriate. Design principles associated with experiential learning and task-based learning (Kolb & Kolb, 2005) can be used to design appropriate activities for 3D virtual worlds.

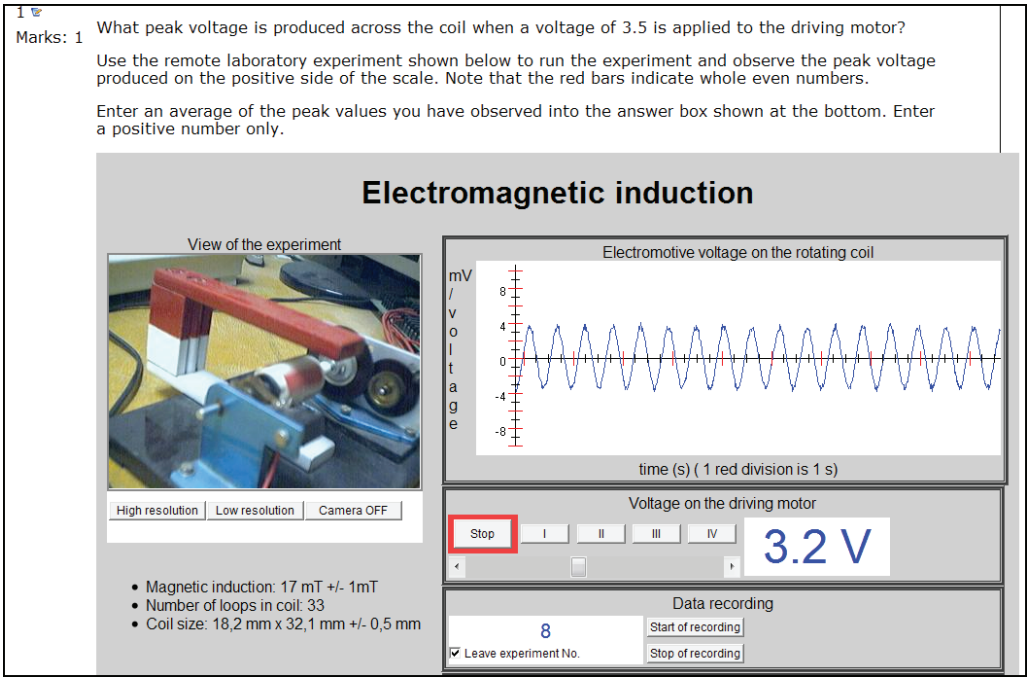
Objects within virtual worlds can be linked to external web pages, as well as to external wikis, blogs or discussion boards, where students can assemble evidence of their learning (Hobbs, Brown, & Gordon, 2009). Many virtual world activities have been constructed with the assumption that students spontaneously develop capabilities simply by entering or moving around the virtual world. Virtual world tasks should be purposely designed around pedagogy that clearly demonstrates the worth of undertaking the activities. Virtual worlds may not be appropriate if students are expected to follow a linear sequence of prescribed tasks; there are alternative technologies that would be more appropriate and less complex, such as Flash simulations or Java applets. Virtual worlds can also be a creative platform for students as they can construct their own objects or explore social, cultural or political issues in a safe space. The assessment of students' actions in virtual worlds needs to emphasise those skills that are specifically developed within this particular environment, rather than skills or capabilities that could be assessed quite readily outside the virtual world.

Screenshot from QUIZ HUD in Second Life
http://www.transformingassessment.com

Assessment tasks within virtual worlds can rely on the use of external tools such as wikis, blogs, discussion forums and e-portfolios, but it is difficult for many teachers to set 'in-world' assessment tasks themselves because the scripting language used to create interactive activities and feedback for students is a professional activity that takes time to master, frequently more time than most teachers would be able to allocate. Teachers need simple tools with which to design a wide variety of assessment tasks within the virtual world, similar to the quiz and survey tools available in learning management systems. An example of a quiz and survey tool that can be used within *Second Life* and *OpenSim* is *SLOODLE* (http://www.sloodle.org). This tool integrates common selected response items from *Moodle* into *Second Life* or *OpenSim* so that an avatar can answer questions at key points within the virtual world (Kemp, Livingstone, & Bloomfield, 2009). *SLOODLE* offers a variety of 'in-world' learning and assessment activities, including a set of tools for designing 'in-world' assessments. The question types are familiar to students and allow them to be tested using the Quiz Chair (selected response questions presented from *Moodle* quiz tool), the web-intercom (chat facility that can be archived in *Moodle*), the Distributor (vending machine distributing content from *Moodle*), the Choice tool (archiving voting in *Moodle*), the Postcard Blogger (students take screenshots of their activity 'in-world', annotate with text and upload to *Moodle* blog) and the Awards system (presentation of *Moodle* grades 'in-world'). The *SLOODLE* system is an interesting example of linking various tools available in a learning management system with a virtual 3D world so that students do not have to move in and out of various online environments. Integrating learning and assessment tools so that



Screenshot from SLOODLE *Quiz Chair in* Second Life *http://www.transformingassessment.com*



Screenshot from a Remote lab http://www.ises.info/index.php/en/ises

a seamless interface is presented to students will replicate key elements of good game design: maintaining flow and keeping students engaged with the task.

More sophisticated approaches to using technology for assessment will be required in the future; the incorporation of evidence-centered assessment design that allows data to be collected from student activities 'in-world' is needed (Shute, 2011). To date, the reporting of a student's performance level and capability is often reduced to a mark or grade; a poor articulation of the student's abilities. Although e-portfolios are becoming more common as a representative sample of students' work, they do not necessarily provide a map of capabilities against defined standards as they are designed to display examples of individual objects. Stealth assessment has been the term introduced to describe the unobtrusive collection of data about a student's ability to complete a particular task (Shute, 2009). This concept of collecting data about the pathways chosen by the student to complete a task, and then being able to convert this data into a meaningful map of the student's capabilities, is an important step in redefining the reporting of student performance. Teachers need to examine new ways to report what strategies students have actually learnt, in addition to discipline content, and so provide employers, and students themselves, with a more sophisticated measure of capability development.

Virtual or remote laboratories and field trips

Virtual laboratory activities and field trips can be simulations that are entirely virtual and designed to provide students with a prescribed range of options, or the manipulation of physical objects by remote access. Both formats are educationally useful as either replacements or complements to expensive laboratory sessions or difficult-to-organise field trips. Students can be given access to remote laboratories or field sites where they can download data to their local computer from a remote sensor for use in learning activities or assessment tasks. Virtual activities allow students to collect and analyze authentic data which means that the tasks can include requirements for students to reflect on the real life consequences of their responses. Remote access to equipment is particularly useful for science and engineering disciplines since access to many relevant and authentic laboratory sites may be impossible because of cost or safety reasons. Access to virtual labs and field trips would be particularly beneficial to institutions in developing countries where expensive equipment for student laboratories is likely to be beyond the budgets of local universities. By allowing free remote access to appropriate laboratory equipment, institutions possessing teaching equipment could provide a valuable service to many students in developing countries. Even in developed countries, there are often inequities in access to laboratory teaching

equipment and free remote access can assist in a more equitable access to a quality higher education experience.

There are continuing discussions about the effects to student learning outcomes of virtual or remote laboratory sessions, compared to hands-on experiences (Murray, Lowe, Lindsay, Lasky, & Liu, 2008). Virtual laboratory sessions can be used as formative activities to ensure that students are adequately prepared for summative hands-on laboratory sessions. This use of virtual laboratories is less controversial than the complete replacement of physical laboratory sessions.

An interesting approach to integrating the educational benefits of virtual and physical laboratories can be found in the TriLab project which offers students a holistic laboratory experience (Abdulwahed, Nagy, & Blanchard, 2008). TriLab requires students to complete virtual, remote and real activities although the format could be adapted to provide options for teachers and students.

Although some virtual and remote laboratory experiments require students to download specialist software to their computers, other computer-based activities require only a recent version of a standard web browser using standard plugins. The JISC-funded RATATAT project (Remote Access to Academic Trials and Testing) demonstrates how Web 2.0 technologies can be integrated with remote laboratory assessment tasks (http://ratatat.pbworks.com). The integration of virtual or remote laboratory sessions with the collaborative tools of the Web 2.0 environment allows teachers to facilitate group and project work. This integration could transform the nature of laboratory sessions in higher education institutions by allowing students to participate in larger, more complex experimental projects that could promote higher level learning.

Many higher education institutions, especially those in developing countries, cannot afford a comprehensive array of expensive laboratory equipment, nor can students necessarily afford to travel to remote locations for field trip experiences. By sharing expensive equipment through remote Internet access, institutions could cooperate to reduce their costs yet still offer an extensive range of educational experiences for their students. Such sharing could involve industry partners and government laboratories which frequently possess more sophisticated laboratory equipment than universities.

An example of an integrated learning and assessment model for remote field trips is the 3D-compound virtual field trip system developed by Lin and Chang (2009). This model makes use of four components; a streaming video server, the use of instant messaging, an automatic marking and feedback system and a dedicated website for student access to resources. Student assessment tasks are linked to specific video sequences or objects in the virtual environment with multiple-choice questions providing timely feedback to students. Students are able to capture still images from the video sequence and incorporate these into their extended written responses to assessment questions. Although this type of integrated approach is still novel, it illustrates the possibilities for new virtual and remote learning and assessment spaces that offer new experiences for students and allow teachers to develop and assess higher level skills.

Glossary

Authentic assessment: assessment that is related to tasks relevant to professional practice or real life.

CETIS: Centre For Educational Technology Interoperability Standards; a UK organisation representing the tertiary education sector on international committees concerned with learning technology standards.

Convergent response: where the student response depends on recalling or restating a generally accepted fact that is held to be true in the discipline.

Criterion-referenced: a scoring method that measures student progress toward specific outcomes or standards. Scores are determined relative to predefined performance standards and are independent of other students' scores.

Diagnostic assessment: used to identify students' prior level of understanding of key concepts or knowledge for the purpose of defining future learning or teaching.

Divergent response: where students are expected to give different responses to a question and the response depends on opinion or analysis.

Formative assessment: where qualitative or quantitative judgements about students' achievements are used to provide feedback to the teacher or student in order to direct future teaching or learning.

High stakes assessment: where the results from an assessment will be used to determine specific outcomes such as completing a program of study, receiving certification, or moving to the next level of a program of study.

HTML: hypertext markup language; a standardized way of preparing web pages for consistent display on the Internet.

IMS: IMS Global Consortium Inc; the body responsible for the QTI specification.

Integrative assessment: tasks whose primary purpose is to influence students' approaches to future learning by providing activities that define and track students' strategies towards problem solving.

Low stakes assessment: where the results from an assessment will not be used for completing a program of study, receiving certification, or moving to the next level of a program of study. Used mainly to provide students with feedback.

RSS: Really Simple Syndication; allows web users to subscribe to a service that updates them automatically when new content is added to a website.

Interoperability: the ability to import and export content and data from one software application to another with minimum changes.

JISC: a UK based organisation which advises the further and higher education sectors on issues relating to the use of information and communication technologies (http://www.jisc.ac.uk).

Learning Design: the conceptual framework underpinning a learning activity and its associated assessment tasks.

MCQ: multiple-choice question; the most commonly used form of selected response assessment, consisting of a stem (the question), numerous options (the choices) and a key (the expected response).

e-Portfolio: a repository containing examples of a student's work. An e-portfolio may be used for assessment purposes and also as evidence of the quality of student's work for employment purposes.

QTI: Question and Test Interoperability; a specification which allows different software systems to exchange assessment data such as questions, responses and results.

SCORM: Sharable Content Object Reference Model; a technical model for describing learning objects so that they can be readily shared across multiple virtual learning environments.

Summative assessment: an assessment where a quantitative judgement about a student's achievement is required. This type of assessment is normally undertaken at the completion of a learning sequence.

URL: uniform resource locator; in common usage it is a description of where to find a resource on the Internet.

W3C: World Wide Web Consortium; an organization which develops specifications and guidelines to assist with interoperability over the Internet.

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