

Specialists in universities

SUMS
Consulting



Briefing on Digital Assessment

Opportunities to Provide Authentic, Inclusive and Engaging Assessment

Contents

Summary.....	4
Why change?.....	5
What does good assessment look like?	6
Opportunities.....	10
Challenges.....	13
Call to Action	18
Appendix A: Further information	20
Appendix B: Flowchart to consider moving exams online	21
Appendix C: Commercial providers of e-assessment software.....	22

Nick Skelton
SUMS Associate Consultant

Claire Taylor MBE
SUMS Principal Consultant

SUMS is a membership-based higher education consultancy, a registered charity and not-for-profit organisation that provides expert consulting to universities across all professional service areas.

The use of digital assessment or e-assessment has accelerated following Covid-19. On behalf of our members SUMS have considered the latest practice in digital assessment through examining case studies, conference proceedings and academic literature. This paper provides a primer in digital assessment, to guide universities considering their strategies. Further reading can be found in Appendix A.

The paper was written by Nick Skelton and Claire Taylor, consultants working with SUMS' members in this area prior to and during the Covid-19 pandemic. Contact them at n.skelton@reading.ac.uk or s.c.taylor@reading.ac.uk if you'd like to talk about how SUMS Consulting can help you transform assessment.

Summary

Many sectors use technology to create, deliver and grade assessments and examinations. E-assessment software has been widely adopted in language testing, admission exams, school assessment and other areas, with usage dating back thirty years.

Adoption has been far slower within UK Higher Education. Digital techniques have been used for formative assessment but remained rare for summative assessment. Some universities have successfully experimented with digital examinations, but in most, exams remained untouched by technology. The vision of hushed students in large halls, heads down over their scripts, has almost totemic significance. And yet this picture has become increasingly absurd. When else during their studies or career are students expected to produce high quality work scribbling on paper, without any technological aid?

From an institutional point of view assessment is manual and laborious. Marking scales linearly with each student and is a bottleneck in the teaching process. Many academic teaching staff dread the time required for marking and see it as a major chore. Hand written summative assessment puts major burdens on university administration: the requirement to print and hold secure vast amounts of paper, and above all the physical space demands for examination rooms. And yet we all continued, as we always had.

Covid-19 changed everything. In the post-pandemic lockdown, an early decision was made to cancel school A Level and GCSE examinations nationwide. In August this approach unravelled, when school students protested against the allocation of grades by algorithm. There was obvious unjustness in an approach where a student's individual performance mattered little. In contrast universities still carried out end of course assessment, with students sitting exams remotely on computer from home. Students were able to receive their degree, with a grade that reflected their own work and performance. HE can be proud of what it achieved. Universities demonstrated the expertise and adaptability in the sector, and the commitment of staff determined to offer the best for their students.

Following this enforced experiment, the HE sector looks more favourably on digital assessment tools and is likely to move faster than previously thought possible. But universities undertaking digital assessment projects need to carefully consider their objectives. There may be an initial instinct to change as little as possible, but in 2020 we found that simply transposing a closed-book assessment from pen-and paper to computer was not the best course of action.

Allowing access to computers during examinations introduces new challenges and exacerbates existing concerns, such as detecting collaboration amongst students. It also provides new benefits, such as access to discipline-specific software that students will use in their careers, making assessment more relevant and engaging.

We need to consider the specific characteristics of digital systems and redesign assessment to benefit from these.

Forward-thinking institutions should use this opportunity to reconsider their whole assessment system. Digital assessment provides improvement opportunities for all concerned. Institutions can reduce paper, space and logistical headaches storing and distributing scripts. Teaching staff

can reduce the time required marking, and no longer have to struggle to read handwriting. Students find the process of digital assessment more authentic and less stressful, with access to spell checkers, screen magnifiers and other accessibility tools.

A move to digital assessment gives us an opportunity to rethink the purpose of assessment and the values embedded within it. A perfect digital assessment system is not possible - but a paper-based system is also far from faultless.

Why change?

Case Study: Early Adopter

There is great cultural significance in university final examinations, with a strong component of ritual and routine, even if most institutions no longer require students sitting examinations to wear full academic dress! Assessment is a high-stakes activity, and universities are very risk averse in their approach to major processes. This has deterred adoption of e-assessment in the UK, where we are behind other countries.



Innovation in assessment has started small scale. It is often led at departmental level or pioneered by incomers to the HE sector bringing fresh perspectives. The University of Bath School of Management was a keen early adopter, first piloting e-assessment in 2018. The experience at Bath was that students were somewhat nervous about sitting a digital exam for the first time, but after the event most substantially preferred it over pen and paper examinations.

"I wanted to send an email after a digital exam I took this morning to note how great it was completing the exam on a computer. Academically, I felt I was more able to express my thoughts for the essay question in a clear and concise manner. Psychologically and physically, I feel way less drained than having written for two hours which is great for students who have exams back to back etc. I think a lot of students felt the same and I thought it was worth emailing about and would love to see more exams done like this in the future."

- 2nd year management student at the University of Bath

The teacher perspective was also positive. Staff were concerned about their technical confidence in operating the system and they required initial training and support. But as experience grew, staff appreciated the adaptability and flexibility of the digital system, with options such as question banks. Like students, staff also hugely appreciated the move from handwritten scripts to typed scripts. The ability to assess work without struggling to decipher handwriting was an important practical relief for staff.

From an institutional point of view, there were logistical and environmental benefits in dispensing with the need to print and store examination papers securely, and then preserve and distribute the scripts.

Remote exams during lockdown: the great experiment of 2020



UK universities adapted remarkably well to lockdown, with both teaching and assessment continuing remotely in most institutions and subjects. How was this possible? There was substantial educational research and expertise within universities, combined with willingness to share best practice information across the sector. We also benefited from the inherent flexibility in the UK HE system of autonomous HE institutions. Universities adopted solutions that worked in their local circumstances, rather than having a one size fits all approach imposed nationally.

Educational researchers and practitioners made a convincing case that assessment redesign was the best way to continue assessment during lockdown. It was possible to conduct examinations remotely, with students completing these in their own homes. Assessments were redesigned so that they were conducted as open book, with students able to refer to reference materials. These questions were more complex than previously set, and arguably better tested the advanced analytic skills expected in higher education. See Appendix B for an example flow chat for the decision to move exams on line from the University of Bergen.



Various strategies were employed to reduce the risk of collaboration between students - different students could be allocated questions from a bank of possible questions, or questions could be seeded and personalised, with the student expected to refer to their personal data or circumstances in their answer. Other pre-existing systems were used to highlight potential similarity in submitted work. The use of essay mills was reduced through tight time windows.

Few if any institutions deployed complex new IT systems at scale. This was not the time. Work with what you have was a sensible, pragmatic strategy: if institutions did not already have a dedicated e-assessment tool, then the existing VLE could be adapted for this purpose, with students uploading their exam scripts to that.

What does good assessment look like?

The assessment lifecycle

The following figure illustrates the assessment lifecycle. At the heart is the institution's assessment strategy. To the left are the key processes and to the right are the key enablers which support the assessment lifecycle.



This paper mainly focuses on the digitisation of the delivery and submission of assessment and its impact on design, marking and feedback provision. There are other opportunities through digitisation of later stages of the assessment process.

Assessment values

SUMS has identified core values which should be found in any assessment system. Digital systems can deliver against these values:

- Engaging** Students who spend more time studying will learn more. Effective assessment tasks should therefore engage students, ensuring they spend appropriate time on the task. Assessment should communicate high expectations, engage students in productive activities, and distribute effort evenly.
- Empowering** Assessment, and in particular feedback from assessment, should empower students. It should clarify what good performance is, facilitate self-reflection and self-assessment, and encourage self-esteem.
- Effective** If a particular assessment is reliable, assessors acting independently using the same criteria would come to exactly the same judgment about a given piece of work. Assessment in most subject disciplines involves inherently subjective judgements, so it is not possible to achieve complete reliability. Consider whether an assessment is robust: does it actually assess what you want it to? Does it adequately cover the curriculum? If you want to test students' ability to analyse a novel situation and apply their knowledge, does the question actually test that, or does it merely test their ability to recall and regurgitate?

Authentic	Authentic assessment is relevant to real-world scenarios. It is recognisable, purposeful, not merely abstract. Historically, HE assessment has probably been based too much on theoretical knowing rather than practical doing; if we want to test students ability to do, we need to make the assessment authentic to real-world scenarios they may encounter in life and career. Providing situations the students recognise, with an obvious purpose to the task, will help students to demonstrate their ability. Digital platforms offer the potential for students to use authentic tools - e.g. design students can use CAD software.
Equitable	Assessment should be inclusive of students, whatever their needs, cultural background, or protected characteristics. Digital assessment offers the option for students to use the same screen reader, dyslexia tools, or other assistive software technologies they use day to day.
Trustworthy	Examinations need to be secure, so that we can trust that the right candidate is taking the assessment, that the work submitted is their own, and that the work conforms to rules (e.g. on access to reference sources or technical aids). Ultimately if exams are not secure there is a risk that trust in HE qualifications will be eroded.
Efficient	Assessment is a major bottleneck in the whole university process. It should be carried out with a responsible view of the resources consumed. Digital tools offer potential to save time, space, and environmental resources. Assessment should also be efficient in terms of testing learning outcomes (e.g. are some learning outcomes never tested while others are tested repeatedly?)

The following table summarises how these values are delivered in traditional and digital models.

Value	Traditional assessment model	Digital assessment model
Engaging	A mixture of coursework and examinations is used to give students engaging problems to study	With the easier logistics of digital systems, assessment in the traditional examination season could instead be distributed more regularly throughout the academic year.
Empowering	Students can become involved in their own assessment, given opportunities to reflect and self-assess in the classroom.	Formative assessment can be incorporated more easily throughout the course. Computer-based rubrics can provide better feedback for students.
Effective	Standard marking criteria are provided, and a sample of scripts are moderated.	The marking process may be more structured, with the system enforcing the use of standard criteria.
Authentic	Questions will be worded to reflected real-world scenarios.	Students may use industry-standard software tools relevant to their discipline in the assessment.
Equitable	Reasonable adjustments can be made, e.g. providing accessibility tools, additional time or access to a scribe.	Students have additional opportunities to use their own laptops and their own accessibility software. Access to technology is a norm rather than an exception.
Trustworthy	In-person invigilation is used to ensure students abide by the rules of an examination.	Digital systems can randomise the order of questions or select questions from a larger pool. Remote invigilation is a possibility.
Efficient	Students are gathered in one space at one time, and the exam can be supervised by a small number of staff.	Students can sit the exam from anywhere, reducing the requirement for space on campus. Scripts can be distributed digitally for marking and moderation to any location.

The following section outlines the opportunities available to those implementing digital solutions.

Opportunities

Using rubrics to improve feedback to students

Research shows that students who get good feedback learn better. Students want feedback on their assessed work: they want it to be delivered on time, and to give them meaningful advice on how to improve. For many institutions (dis)satisfaction with feedback is a major factor in overall NSS scores.

Good feedback is linked to the expectations set out for a student, it is actionable and prioritized. Rubrics are a commonly used tool to improve assessment and feedback. Rubrics are intended to provide more objectivity than a traditional marking scheme. The combination of a well-designed rubric and good e-assessment tool can provide better feedback for students while also saving time for the assessor - substantial benefits for both.

Traditional Mark Schemes	Rubrics
<p>A traditional mark scheme might provide a model answer, and a number of indicators of what should be included in an answer. The teacher assigns a numeric score depending on how closely the answer matches each of the indicators.</p>	<p>In contrast a rubric provides more specific criteria which a student answer is expected to match. Point scores are pre-assigned for each of the criteria. The teacher assesses if the answer does or does not match each of the criteria - if it does the student gets each point.</p>

Rubrics benefit both teacher and student: they score the answer and simultaneously provide feedback. When assessed work is returned the rubric shows the student what else could have been included in their answer to achieve the maximum grade.

A good digital assessment tool will guide a teacher in constructing a rubric and provide a certain discipline to the process. The teacher marking the script will note which of the criteria an answer matches. The points score and grade are automatically calculated. The potential speed improvements are huge: one study found that digital rubrics were 200% faster than hand grading without a rubric, 300% faster than hand grading with a rubric, and 350% faster than typing feedback into a system.

Rubrics can be used to improve paper or digital assessment, but there are additional benefits only possible with digital tools. Some digital tools allow the teacher to adjust the point scores in a rubric halfway through marking a pile of scripts, the tool will retroactively apply that to previously scripts and recalculate marks. Tools can also provide reports for teachers, giving them feedback to improve their teaching. If the rubric shows that student answers were commonly lacking in one particular point, that is an area where the teacher needs to provide further clarity in future.

Algorithmic marking - potential automated marking at scale?



Rubrics increase objectivity but still require human markers to make an assessment. For certain types of assessment, e.g. multiple-choice questions, or arithmetic, there is a single right answer. Digital tools can algorithmically mark such answers, providing instant grading and feedback at scale. This is useful for students to monitor their own progress in formative assessment.

But be cautious of software which claims to offer algorithmic marking of free text answers. Such algorithms are likely to do little more than spot keywords. Students have been known to spot this and provides answers which are simply lists of keywords, learning little other than how to beat the system.

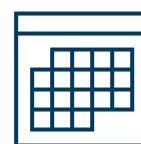
Improvements to distribution of scripts for marking and moderation

Purpose-built e-assessment software improves the whole assessment workflow, including design, delivery, marking and feedback. With pen-and-paper examinations scripts can be easily collected in the exam hall, but distribution to markers and moderators is logistically difficult. This introduces delays into the process and limits what can be done. A moderator will typically receive only a sample of scripts, an external examiner may see even fewer, perhaps only those discussed at an exam board.

Digital delivery of exam scripts is a standard function of e-assessment software. Distribution is quicker and more reliable, without the risk of paper copies being damaged or mislaid. Most e-assessment software was created for non-UK markets, and the software may not completely match existing workflows in UK universities. Consider changing your workflow to match the system if required.

The impact of digital assessment on the academic calendar

Traditionally summative assessment is concentrated in a short period at the end of the academic year or semester. Large spaces usually used for teaching are reset for assessment. The examination season is prolonged, partly to avoid an individual student sitting too many exams close together, partly due to a simple lack of space.



Universities who move from pen and paper to fully remote exams may need much less timetabled space for exams. This offers new ways to arrange the assessment calendar. Some students cram successfully for a final assessment, others might benefit from smaller, more regular summative assessments throughout the year.

The impact of digital assessment on assessment policy and regulations

It is important to update University regulations to reflect changes to assessment procedures.

These include:

- Extenuating circumstances policies and processes must be updated to include information for students who cannot, for technical reasons, sit their exam
- Technical regulations concerning hardware and software to support special needs in assessment should be expanded to cover all students using digital devices in assessment
- Policies for duration and frequency of summative assessment are predominantly based on written exams in exam halls
- Policies on the mechanics of attendance (dress, equipment, punctuality, identification, leaving the hall, numbers of invigilators etc.)
- Policies and ownership of the delivery and accuracy of papers.

The impact of digital assessment on quality assurance

The institution, external regulators (QAA, Ofsted etc.) and professional, statutory and regulatory bodies (PSRBs) will want assurance that moving to digital assessment does not impact negatively on the quality of assessment. In particular, institutions should be able to demonstrate that the mechanism of assessment:

- Delivers, or is compatible with the delivery of, the purpose of the assessment (assessment of, for or as learning)
- Allows students to demonstrate the relevant learning outcomes whether knowledge, skills or competency based
- Is secure (reduces opportunity for academic misconduct) and reliable (not liable to interruption)
- Is equitable or that mitigations have been identified and delivered to any students disadvantaged by it and that students are familiar with the mechanisms and mitigations
- Is acceptable to the wide range of stakeholders of assessment.

Some features of digital assessment will appeal to regulators. E-assessment software includes checkpoints and audit trails through the assessment workflow which can help in demonstrating that the correct processes were followed.



Adoption of digital assessment mechanisms may require modules and programmes to be revalidated: this process has been accelerated during Covid-19 but institutions should ensure that questions such as the above have been considered and document how their move to digital has maintained or enhanced the quality of assessment.

Challenges

Providing quiet space, power, and connectivity: a challenge both on and off-campus

For the 2020/21 academic year universities may be considering whether to host examinations on campus or remotely. It is difficult to predict how prevalent Covid-19 will be in May 2021, but it seems likely that at least some students will be self-isolating, due to either infection or other health conditions which place them at enhanced risk.



Flexibility must therefore be a paramount requirement in any new process. If you are investing in e-assessment software, consider a platform which can operate on both institution-owned computers in a traditional examination hall and on student-owned computers remotely.

Scenario	Advantages	Disadvantages
Remote digital exam with candidates at home	Assessment can take place even during lockdown Less space is required, which gives flexibility in when exams can be held	Some students may not have quiet space, computers and reliable Internet connections to sit the exam
Digital exam on campus	Invigilation is easier, increasing trust in the assessment	The logistics of providing sufficient socially distanced space, computers, power and reliable Wi-Fi is a substantial barrier for the institution

Wherever the exam is held, space, power and connectivity is a challenge. When on campus it is the institution's responsibility to provide reliable power and networking. Doing this in spaces used for other purposes during the rest of the year is a significant challenge for Estates and IT colleagues and could require substantial investment.



When exams are held remotely with students at home, that responsibility is shifted onto the individual student. This raises issues of digital exclusion: some students may not have the computers, connectivity or even a suitable quiet space at home.

In 2020 many universities devised a remote examination process with built-in flexibility to mitigate this. For example, rather than all candidates starting an exam simultaneously, candidates were able to start the exam at a time of their choosing within a particular window, when they had a space at home to themselves without others using their computer and broadband. Some universities lent laptops and 4G mobile broadband dongles to students who were unable to provide their own.

The following table summarises potential mitigations.

Scenario	Quiet space	Internet connection	Computer with power
On-campus digital exam	Provided by institution	Provided by institution	May be provided by student or by institution
Location-independent digital exam	Typically provided by student	Provided by student	Typically provided by student
Mitigations	Consider providing a small exam space on a campus for students who prefer this	Ensure e-assessment software can cope with interrupted connections	Consider loaning laptops to students without one

The most uniform solution is that the institution provides everything: digital exams, held in an exam hall on campus, where the institution provides the device and Internet access. This ensures that everyone has a device, that the devices are secure, the space is quiet, and the connection is reliable. However uniform solutions can be inequitable: students with particular needs may also prefer to use their own device, with their own accessibility software.

Consider giving students some choice in how they sit the exam. You could offer a choice of sitting an exam remotely at home or in an examination hall on campus. Most students will choose the remote option, providing substantial space savings, while you still accommodate students without a suitable home environment. If you conduct digital exams only on campus, with students bringing their own computer, provide a further 10% of university-owned computers ready in the exam hall. Students can then switch devices if their own computer fails.

Addressing the challenge of plagiarism

Contracting cheating and essay mills remain a live concern in HE, and the move to remote exams in 2020 exacerbated fears. However careful assessment design reduces the risk that students collaborate on their answers to a digital exam onsite or offsite. Techniques include:

- Allocating a subset of questions from a larger question pool
- Asking the same questions but in random order
- Questions which expect students to draw on their personal experiences in their answer
- Personalised questions including data which is unique to a student (e.g. a mathematics student could be asked to use their candidate number as part of a problem).

Digital tools can also be used to flag substantial similarity between student answers (e.g. with the widely deployed Turnitin). Software is also becoming available which compares the writing style of a piece submitted for assessment with known prior samples of a student's work. Any software tool is only an aid and will suffer from post false positives and false negatives. Experience suggests that tools may flag up cases to be looked at further, but a lengthy investigation process is still needed.



There has been much interest in remote proctoring tools (remote invigilation tools), but somewhat less adoption of them. Remote proctoring tools can include features for:

Feature	Purpose
Initial authentication	Check that the student sitting the exam is who they say they are
Browser lockdown	Prevent students using the Internet to look up answers
Live or recorded webcam	A view of the student and a portion of their surroundings
Gaze detection	Are students focusing on the screen in front of them, or perhaps another device out of the webcam view?
Keyboard pattern analysis	does input from the keyboard indicate that students are actually creating their own work, or just transcribing it?

The most widely adopted remote proctoring feature is initial authentication - the ability to take a photo of student ID documentation before the exam starts and compare that with the students' own face. This is a valuable function but needs to be handled carefully. If you take photos of a student passport or driving licence students will have concerns about what happens to that data.

The other components are even more problematic. Browser lockdown tools can be overcome with instructions readily available online. Students may perceive a live webcam view into their home as intrusive and disconcerting. Gaze detection and keyboard analysis can lead to false positives, e.g. students with disabilities being flagged up as behaving abnormally. They may also have a chilling effect: students who are told they must gaze unblinkingly into the screen to avoid being flagged as cheating will not perform at their best.

Some UK institutions have used remote proctoring software only when an external accrediting body has required it. Some have adopted a simple remote proctoring solution without specialist software: students set up a smartphone with camera some distance from them and their laptop, to provide a wider view. Others have avoided remote proctoring completely.

If you are considering remote proctoring, think whether it will actually meet its objectives, whether its use is proportionate, and what unintended effects it may have. Consult your students carefully: help them understand what data is collected, how it is stored and how it is used.

Selecting suitable software for e-assessment

Use existing non-specialist platforms

The 2020 pivot to remote examinations happened quickly and there was little time to deploy new software from a standing start. Most UK universities used existing software such as their VLE for the assignment and submission of *take-home exams* (open book essays carried out remotely in time limited conditions). Students wrote their script in a word processor and then uploaded it to the VLE for submission. In some subject areas this approach does not work well, for example, mathematics due to the difficulty in entering mathematical notation. Some used standard software in innovative ways (e.g. conducting an aural music exam via Zoom) or

adopted low-tech approaches (e.g. students wrote their answers on paper and then took photographs of their scripts for submission).

Sector-developed e-assessment software

A few UK universities have a long history of e-assessment software. In the 2000s and 2010s a number of institutions gained funding to develop open-source e-assessment systems, due to a perceived failure of the market to deliver at that time. These included TRIADS at Derby, SCHOLAR at Herriot-Watt, Numbas at Newcastle, Rogo at Nottingham, and Dewis at UWE.

Much of this software was tailored to a specific subject area, with involvement from academics in the field. The E-Assessment in Mathematical Sciences conference, hosted annually by Newcastle University, provides a forum for discussion of innovation in Maths e-assessment, including Numbas.

Commercial providers

Globally there are around 100 suppliers providing e-assessment systems for HE, over 40 suppliers of remote proctoring systems, and about a dozen who claim to offer an end-to-end outsourced solution.

Many of the commercial providers have only entered the UK market in the last five years, but their products are tried and tested in other countries. SUMS anticipates that most universities will decide to procure a dedicated e-assessment platform and use it for the majority of their digital assessment. These platforms are designed to help with the whole assessment lifecycle, question creation, submission of the paper, marking and moderation. Compared to the use of a VLE, these platforms can improve workflow and provide a better experience for both students and teachers.

Providing suitable support for all subject disciplines could remain a challenge: institutions might pick one e-assessment software platform which is suitable for the majority of courses but permit the flexibility for certain disciplines to use an alternative package.

A sample of ten commercial providers with HE customers is given in Appendix C.

Practical tips for the implementation of e-assessment software

- Give students chance to get familiar with the software in advance of any exams. Either use same system for both formative and summative assessment or provide access to a non-assessed dummy exam in advance.
- Give extremely clear instructions to students in advance. Students need to know how and when to access the system, precisely what to do, and exactly when the work must be completed and submitted. Any deviation from expectations causes great stress to students during the exam.
- Digital systems provide binary options, they are less flexible than a human-moderated system in person. If a student turns up to sit a physical exam, and their name isn't on the expected list, an examinations officer will let them sit the exam anyway and work out what went wrong afterwards. With a digital system it is more important to get everything right up front, so double-check your data sources which feed into the system. Also consider what you would do if an exam candidate tries to start the assessment and the system won't let them in.

Staff and student concerns: change management is needed

A strong change management approach is essential when implementing e-assessment. You need to address fears and concerns from students, staff, & accrediting bodies, especially about the technology and data protection involved. People are familiar with pen and paper examinations and understand how they work. It is not obvious what happens behind the scenes in a computer system, so it is essential that the institution explains this transparently.

Map out your stakeholders and work to understand their concerns. Think from the point of view of your students sitting the exam and your tutors marking it. Prioritise their practical experiences above abstract notions of the system. Listen, consult and communicate. Get academics talking with other academics about the benefits of digital examinations, and students talking with other students.



Be very clear with what data is collected, who has access to it, what it is used for, how long it is kept. Stress that people make assessment decisions, not a computer algorithm.

A joined-up approach across the institution is absolutely essential to make digital examinations work. You need a partnership between academic faculties, a large number of professional services (academic registry, IT, and the centre for learning & teaching). But avoid a rigid, idealised, one size fits all implementation. Instead adopt a “tight loose” approach: set out a set of shared institutional principles for how assessment should function but allow discipline-specific variations in implementation. This preserves the autonomy of academics and recognises the mastery they have within their own subject disciplines.

Engage and involve the university leadership team and understand their appetite for risks and benefits. Work to ensure that the project delivers the benefits agreed as most important. Ensure the leadership understand that some issues will occur: a digital assessment system is not perfect, but neither is the alternative.


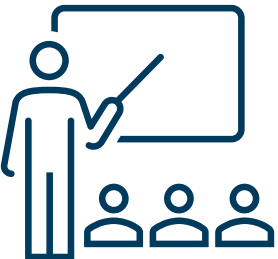

External accreditation bodies may have concerns and could insist on closed-book examinations with some form of remote invigilation. Hold a dialogue with them, understand what their expectations are, and examine options.

The next section provides a call to action to Universities to think about how digital transformation can improve the assessment experience for academic staff, students, and professional services.

Call to Action

Universities are currently considering how to hold exams in 2021. At time of writing Covid-19 cases are again rising again across the UK. Flexibility must be a paramount requirement in any new assessment process. If you are evaluating a new digital platform, consider one which can operate on both computers in a traditional examination hall and on computers for students self-isolating at home.

If done well, staff, students and institutions all benefit from a move to digital assessment. Digital assessment can provide:

For students	For teaching staff	For the institution
		
<p>More authentic, inclusive assessment with access to standard software used for real-world problems. More constructive and timely feedback</p>	<p>No struggling to read student handwriting. Use of digital systems can speed up the process of marking and simultaneously providing feedback.</p>	<p>Efficiency improvements: less paper and environmental impact, and potentially less physical space if exams are sat from home.</p>

Technology is becoming a necessary part of modern assessment, but it is not a panacea. Do not look to technological promises to prevent plagiarism, first consider assessment redesign instead.

Recommendations for success

- Have a **clear vision** for the purpose of the change. What are the benefits of digital assessment which you intend to deliver?
- Avoid a rigid, idealised, one size fits all implementation. Instead adopt a **tight-loose approach**: set out a set of shared institutional principles for how assessment should function but allow room for discipline-specific variations.
- A joined-up approach across the institution is absolutely essential to make digital examinations work. The university leadership team must be engaged and you need a **partnership approach** between academic faculties and a large number of professional services (academic registry, IT, and the centre for learning & teaching).
- **Engage and communicate** carefully with all stakeholders. Think from the point of view of your students sitting the exam and your tutors marking it. Prioritise their experiences in practice above abstract notions of the system.
- Be very clear with what **data** is collected, who has access to it, how it is used, and for how long it is kept. Hold a community discussion with student representatives before adoption. Be clear that people make assessment decisions, not a computer algorithm.
- Pilot, pilot, & pilot to **build experience and confidence**. In an ideal (non-Covid) situation, you would introduce digital assessment for lower stakes examinations (e.g. end of year 1) before high-stakes final exams.
- Understand your institution's risk appetite. **Accept that some things will go wrong**, and that is ok. Paper-based assessment is not perfect either.

Appendix A: Further information

For a detailed report of how technology can be used to transform assessment across an institution, including the change management approach necessary for success, see *Transforming higher education through technology-enhanced learning*. The Higher Education Academy, December 2009. (Chapter 14: A blueprint for transformational organisational change in higher education: re-engineering assessment practices as a case study. David Nicol and Steve Draper) https://www.reap.ac.uk/reap/public/Papers/Nicol_Draper_transforming_assessment_feedback.pdf

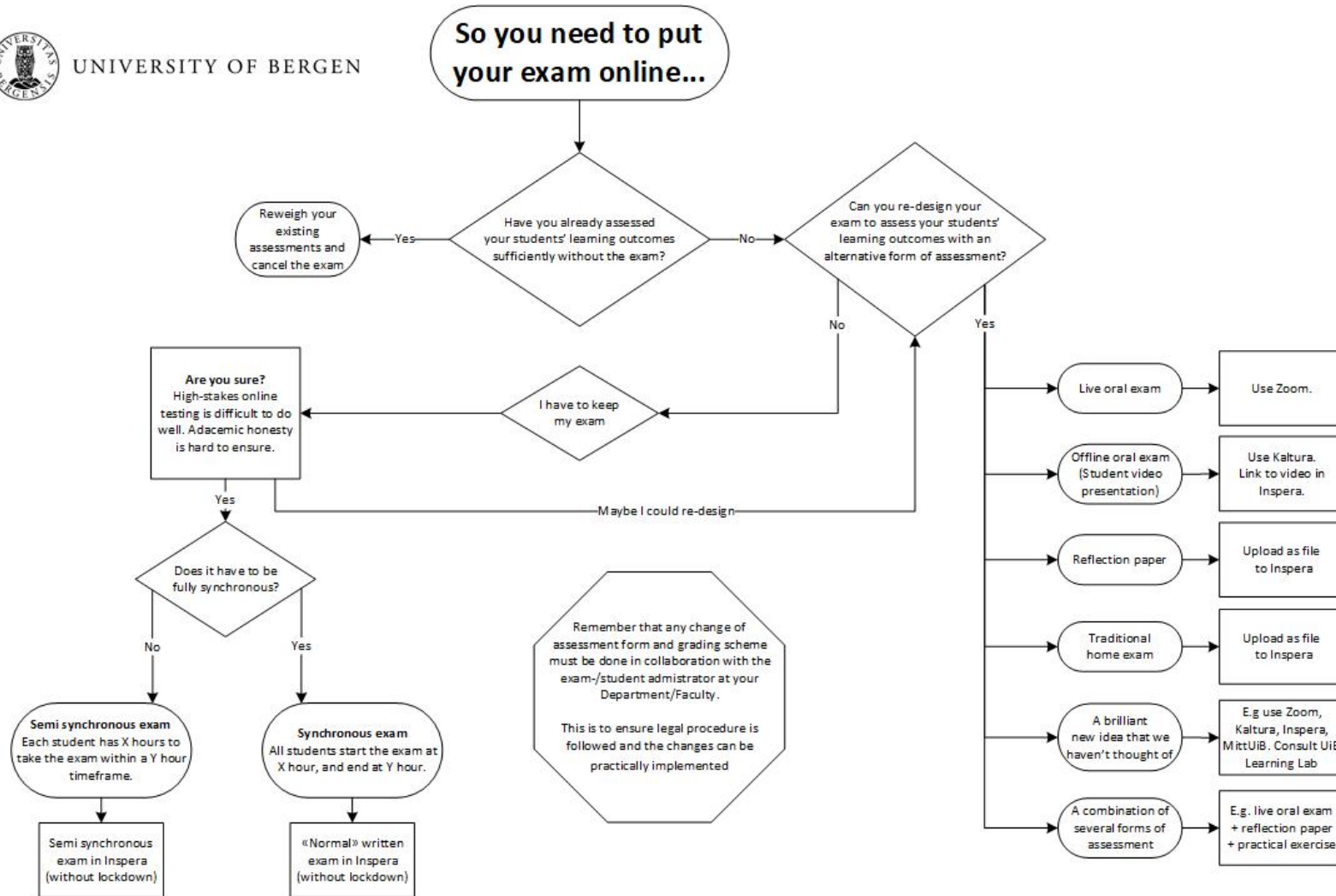
For recent case studies from universities adopting a variety of tools and approaches, read *Assessment rebooted* published by Jisc/Emerge Education, summer 2020 <https://www.jisc.ac.uk/reports/assessment-rebooted>

For discussion of particular approaches and specialist software used for e-assessment in maths, science and engineering, review the talks from the *E-Assessment in Mathematical Sciences* (EAMS) conference, hosted in 2020 by Newcastle University. <https://eams.ncl.ac.uk/>

Appendix B: Flowchart to consider moving exams online



UNIVERSITY OF BERGEN



Online exam flowchart adapted by Magnus Svendsen Nerheim and Robert Gray, copyright 2020 UIB Learning Lab, University of Bergen, is made available under the terms of the Creative Commons Attribution-NonCommercial-Share Alike 4.0 International License, <http://creativecommons.org/licenses/by-nc-sa/4.0>. Adapted from Centre for Innovation in Teaching and Learning, Memorial University (CA) and Gavan Watson. Originally adapted from Brock University's Centre for Pedagogical Innovation (CA).

Appendix C: Commercial providers of e-assessment software

The following table provides a list of ten commercial providers and examples of universities who are working with the software. This list is not exhaustive.

Provider	Narrative	Sample HEI customers
BTL	UK specialist, part owned by Prometric. Established 1985.	Breda, Cardiff, Edinburgh Business School, Robert Gordon, Saxion, Windesheim.
Cirrus	Netherlands owned SME, established 2014.	AKAD, Nyenrode Business School, Radboud, University College Arnhem
Dugga	Spun-out of Stockholm U, backed by Swedish govt R&D agency, Vinnova. License out its proprietary lockdown browser.	Stockholm School of Economics, Royal Institute of Technology, Umeå, HAN University of Applied Sciences.
Digiexam	Swedish venture-capital funded specialist. Targets individual educators with free service.	Lund, City U London.
DigitalEd	Formerly MapleSoft, a Canadian/Japanese company focused on mathematics e-assessment. Mobius product integrated with Moodle, Canvas, Blackboard	Guelph, Gothenburg, Various US Community Colleges.
IAT	Examonline system supports hand-drawn sketches, extended response and diagrams.	Dundee, Birmingham, Oxford (CREDO).
Inspira	Norwegian-originated provider focused on HE. Quickly gained traction in the UK.	Norway Directorate of Education, Uninett, Bergen, Cambridge Assessment, BPP, Bath.
Questionmark	Established 1988. UK/ US origin. Perception product pioneered e-assessment deployment through the 1990s and early 2000s	Cardiff, Dundee, Leeds, Oxford Brookes, Queen Mary (DEAP), Verona, Wolverhampton
TAO	Open source system, part-owned by ACT and CITO.	Alberta U, ACT, Ceneval Mexico, ICFES Colombia
Televic Education	Part of Belgian conglomerate. AssessmentQ solution used by Belgian government and European Parliament.	Zurich, UCL, Ulster.



Reading Enterprise Centre, University of Reading, Earley Gate,
Whiteknights Rd, Reading RG6 6BU
T: 0118 935 7073 | **E:** sums@reading.co.uk | www.sums.org.uk