WORKSHOP REPORT

Collusion, Rackets, and Plagiarism in Assessments

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Abstract

Recently, due to the global pandemic, some higher education institutions moved from formal closed-book examinations to emergency virtual assessments (EVAs). These EVAs normally comprised open-book, remote, short time-frame assessments. Most institutions are moving back to formal examinations as effects from the pandemic reduce, but some institutions have created a "new normal" regarding assessments and have opted to remain with open-book, remote, non-invigilated assessments. With these enforced changes, the mathematical sciences assessment setter is tasked with creating assessments which are resistant to collusion, plagiarism and other forms of academic malpractice. Here we discuss some recent examples of issues encountered in the assessment of science and engineering topics without formal invigilated examinations.

Keywords: assessment, cheating, collusion, malpractice, plagiarism,

1. Introduction

Following the spread of the Covid-19 virus in late 2019 and early 2020, the World Health Organisation (WHO) (2020) declared a global pandemic in March 2020. The Scottish Government (2020) reported the first confirmed case of COVID-19 in early March. The first community transmission of the disease was recorded on March 11th (Scottish Parliament, 2020) and the first death just two days later. Citizens of the U.K. were subjected to a "Stay at Home" order by Prime Minister, Boris Johnson, soon after.

Many universities across the world closed their buildings to most staff and students, in line with their government's regulations. Emergency procedures concerning teaching and assessment were enacted. Scheduled teaching was done online, where possible, and in-person class tests and examinations were replaced by online assessments: open-book, remote, examinations. These have been dubbed emergency virtual assessments (EVAs) and created issues concerned with digital poverty, lack of appropriate assessment environments, and lack of support for students with additional learning and assessment requirements (Khan, 2021). Further, the emergence of non-invigilated examinations meant that reported cases of plagiarism and collusion rose significantly (Lancaster and Cotarlan, 2021).

With the effects of the pandemic easing, many higher education institutions are reverting to assessing via formal, invigilated examinations. In most cases, the formal examination removes most of the temptation and ease for collusion, plagiarism, and other academic malpractice. However, some institutions are extolling the virtues of 'authentic assessment' which is sometimes translated to meaning 'no more formal, invigilated examinations'.

For the mathematical sciences assessment setter (and others), it could be asked how does one draft an open-book, non-invigilated, remote, short-time assessment, which is fair, engaging, 'authentic', meets the learning outcomes, and is resistant to plagiarism, collusion, and other forms of academic malpractice? This paper considers some of the varieties of assessment types used in higher education today, how they are being abused, and what form assessments might take in the future.

2. Forms of Assessment and Associated Malpractice

2.1. The Essay/Report

Not just the vehicle for humanities assessment, the essay can also be used to assess science and engineering topics. From a short 1000-word essay on explaining a cryptographic protocol, to the Honours Year dissertation on Diophantine equations, scientific writing can be used to significant effect to tease out students' knowledge on a particular topic. Often, a drawback for science and engineering students is that they are not repeatedly asked to write substantial documents such as a dissertation and thus their writing skills, and ability to cite appropriately,other sources, can raise issues. Programme teams should be mindful of this when considering their assessment maps. Normally, higher education institutions have excellent central support teams who can run bespoke sessions on scientific writing and referencing. It is important that these are advertised and advertised at the appropriate times.

Sometimes, however, the essay-type assessment can provide opportunities for academic malpractice in the form of plagiarism. Module coordinators and Academic Malpractice Panel (AMP) members are sometimes provided with essays with substantial sections of text which have simply been lifted from internet sources, often without appropriate referencing. Academics tasked with marking these pieces of work should be on the look-out for text or citations which do not fit the subject matter at hand, changes in language, and changes in writing level.

Assistance is available in spotting suspected plagiarism through the software Turnitin, an internet-based plagiarism detection service. It is of little use for scientific calculations but is an excellent tool for uncovering cases where similar text has appeared previously in student submissions, academic papers, or online. Suspected plagiarised text is highlighted by the Turnitin software. The text is then connected with proposed original source later in the Turnitin report.

Care must be taken with the software. A recent example made available to the author illustrated that Turnitin had reported around 30% similarity with a student submission at the same institution. However, upon analysing the Turnitin report fully, it transpired that this 30% similarity was across over 100 students at the same institution, with a maximum of 9% similarity from any individual student. Further, parts of this similarity were accounted for in standard title pages and prescribed section headers. It is worth attending any Turnitin training that institutions may provide.

Further, Turnitin is not fool proof, and there are instances where students have attempted to circumvent the software checks by paraphrasing sections of text (there are online tools available for this – sometimes with unintended humorous consequences), using synonym replacement software (also not without possible unintended meaning changes), changing document types, using translation software, and, more concerning, using essay mills.

Essay mills are companies that provide original pieces of writing to students. Some companies will offer students the option of a piece of writing which will score a certain grade to not arouse suspicion. Recently, the U.K. government have sought to make the use of essay mills illegal via the Skills and Post-16 Education Bill (Department of Education, 2021). Nevertheless, academics should still be vigilant to uses of these companies. This can be done by considering changes to language used (from previous assessments), being aware of sudden grade/level jumps, or being aware of strange consistencies in assessments from a student cohort.

In a recent example made known to the author, the referencing for each figure in a series of reports seemed reasonable when viewed as a single submission. However, when viewed as a collective, the consistency of having figures referenced in such a manner aroused suspicion. Investigating

these specific cases further uncovered that citations did not match the subject matter, and often the subject matter was not aligned with the assessment brief. In this example, it was uncovered that each essay had been procured from a third party. Unfortunately, many markers may miss small tell-tale signs of misconduct, especially when a high volume of marking has been allocated.

More recently, academics have been made aware of ChatGPT, a chatbot which can provide real-time answers to simple questions, short essays, and even poetry. The freely available (at the time of writing) prototype software has been created by OpenAI, an artificial intelligence company founded by, amongst others, Elon Musk. Artificial Intelligence is a multi-million-pound industry, and it has recently been reported that Microsoft have announced a multibillion-dollar investment in OpenAI (BBC, 2023). Currently, not without potentially inaccurate answers, the software can be mistreated for the creation of sentences or paragraphs which answer specific questions. For example, the author asked the software "What is a cryptographic protocol?". Within a minute, the software had made the following answer available:

> "A cryptographic protocol is a set of rules and procedures for secure communication in the presence of third parties, known as adversaries. These protocols use various cryptographic techniques, such as encryption and digital signatures, to provide confidentiality, integrity, authenticity, and non-repudiation for the communication. Cryptographic protocols are widely used in various applications, such as secure communication, secure electronic transactions, and secure computer networks."

This response seems appropriate, but when ChatGPT was asked to integrate x*ln(x) with respect to x, the software provided the response x*ln(x) – x + C, complete with a step-by-step breakdown of how this "solution" was achieved.

Academics have already begun testing the software further, with it being reported that the software could pass an MBA examination (Terwiesch, 2023).

Whilst software like this poses a problem for academics using short (or long) essays in assessment, it is not necessarily a new problem, as students could always hire others to write for them. However, the speed (and current lack of associated cost) of the prototype software is worrying. The solution to the simple mathematics question perhaps more so, but for different reasons.

Of course, not all topics and courses can be appropriately assessed via an essay or dissertation. We now consider examinations and coursework which are more numerical in nature.

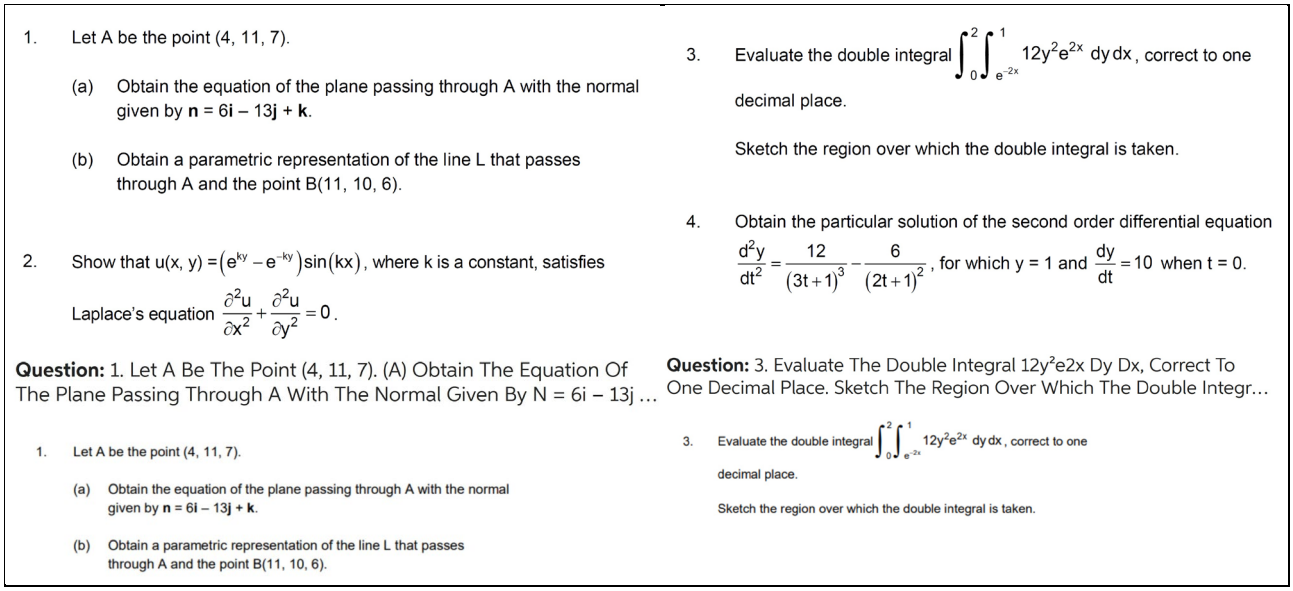
2.2. The Remote Examination

In most science and engineering topics, material has been assessed via formal, closed-book, invigilated examinations for many years. Assessment questions would be centred around regurgitating subject knowledge in short descriptive questions or longer essay-type questions or applying required knowledge in contextualised problem-solving questions. The opportunities for collusion and plagiarism in these events is reduced, and with invigilation, the opportunity for malpractice in other forms (such as the use of pre-prepared notes or sharing of solutions) is also reduced. That being said, invigilators must be mindful of developing technology which may be used to circumvent the invigilation process.

With the move to EVAs and, in some cases, non-emergency virtual assessments, the science and engineering examination questions which are not essay-based can be subject to malpractice. Standard questions in low-level "service-teaching" calculus assessments, for example, where the knowledge and application of techniques is being assessed, can simply be answered via a host of

computer packages (such as Maple, MATLAB, Mathematica, *et cetera*) or even websites such as Wolfram Alpha. Examiners should be on the look-out for "skipped working" which suggests that the student has not worked through the solution without external aid.

However, issues with remote assessments run deeper. For higher-level scientific assessment questions, which cannot simply be inserted into a computer algebra package, some students have sought alternative workarounds. Students have reported working together on examinations, either face-to-face, or have shared solutions via WhatsApp, Snapchat, Facebook Messenger, and Discord. Further, websites which offer "assistance with homework" such as Chegg, CourseHero, and AnswerHappy can provide worked solutions, for a small fee, to scientific questions within as little as 30 minutes. This means that students can upload remote examination questions to these types of websites and receive worked solutions in plenty of time for rewriting and submitting as their own work (or even sharing via the aforementioned social media platforms). An example of such potential malpractice can be seen in Figure 1.



1. Let A be the point (4, 11, 7).

   (a) Obtain the equation of the plane passing through A with the normal given by $\mathbf{n} = 6\mathbf{i} - 13\mathbf{j} + \mathbf{k}$.

   (b) Obtain a parametric representation of the line L that passes through A and the point B(11, 10, 6).

2. Show that $u(x, y) = (e^{ky} - e^{-ky})\sin(kx)$, where k is a constant, satisfies Laplace's equation $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$.

3. Evaluate the double integral $\int_0^2 \int_{e^{-2x}}^{1} 12y^2 e^{2x}\, dy\, dx$, correct to one decimal place.

   Sketch the region over which the double integral is taken.

4. Obtain the particular solution of the second order differential equation $\frac{d^2y}{dt^2} = \frac{12}{(3t+1)^3} - \frac{6}{(2t+1)^2}$, for which y = 1 and $\frac{dy}{dt} = 10$ when t = 0.

Question: 1. Let A Be The Point (4, 11, 7). (A) Obtain The Equation Of The Plane Passing Through A With The Normal Given By N = 6i – 13j ...

1. Let A be the point (4, 11, 7).

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Question: 3. Evaluate The Double Integral 12y²e2x Dy Dx, Correct To One Decimal Place. Sketch The Region Over Which The Double Integr...

3. Evaluate the double integral $\int_0^2 \int_{e^{-2x}}^{1} 12y^2 e^{2x}\, dy\, dx$, correct to one decimal place.

   Sketch the region over which the double integral is taken.

Figure 1. (Top) Four questions which appeared in a remote mathematics examination in Academic Year 2019-2020, and (bottom) questions which appeared on Chegg.com minutes after the aforementioned questions had been released.

Again, vigilance from the assessment setters and markers is required here. A simple, but effective strategy is to be on the look-out for non-standard solutions, perhaps using techniques which have not been discussed in class. Another is to diligently check "study help" websites for uploads. However, it should be questioned whether markers should be trawling through these websites on examination days to see if questions are being uploaded. Further, if questions are being uploaded, should individual academics be paying for the solutions to ascertain if provided solutions are matching submissions, or should this be the purview of institutions' AMPs? It may be a concern of some academics that other academics, or even host institutions, have a 'hear no evil, see no evil' approach.

After the introduction of EVAs, and the concomitant rise of reports of plagiarised materials, some academics have introduced individualised coursework and individualised remote examinations. This has a three-fold attack on combating plagiarism and collusion. Firstly, each student has a distinct set of assessment questions and hence the ability to collude is reduced. Secondly, if students are aware that assessments are individualised, they may be less tempted to submit their questions to "study

help" websites. Thirdly, if students do submit their individualised questions to "study help" websites, then the vigilant marker can identify these to a particular student and then take the appropriate action. Such an example of semi-individualisation can be seen in Figure 2. A naïve student could upload such a question to one of the aforementioned websites, providing their matriculation number at the same time.

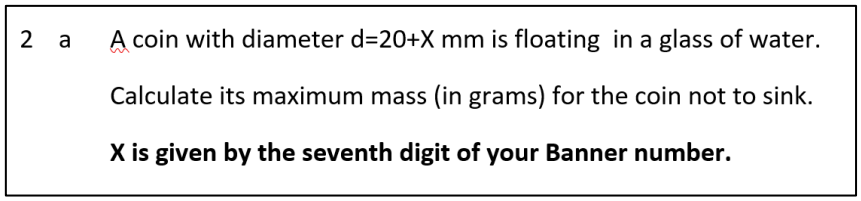

Figure 2. A question posed in a remote examination which is individualised, in part, using the student's Banner (matriculation) number.

Again, with remote examinations, the onus here is on the assessment setter to provide an examination which is resistant to plagiarism and collusion, but there is a significant amount of time which must be spent on this task. Using the example in Figure 2, the assessment is semi-individualised (there must be up to ten different possible questions), which at least gives some variety, but the questions themselves are not completely individualised. However, even with this limited example, we have ten different questions and ten different answers. Extrapolate this over an entire assessment and we have multiple versions of each assessment which simply adds to the workload of the assessment marker. Alternatively, students may be provided with completely independent assessments using a unique data set to be considered, or a unique parameter set used in a Mail Merge (for Word users) or \Merge command (for LaTeX users). An example of a rudimentary parameter set can be seen in Figure 3.

Additional time allocation aside, which is not inconsequential, the assessment setter must be careful to include appropriate parameter bounds so that questions, and solutions, are appropriate, applicable, and error-free.

Individualisation can help reduce the temptation of collusion, but only if the students have been made aware that their assessment has been individualised. The assessment setter must think carefully on the question *do I let my students know of individualisation*? By not doing so, the assessment setter is simply providing means of recognising collusion, rather than removing the temptation. Consider Figure 4, where two students are provided with similar, but individualised questions. What happens when both students provide a solution to the same question? What is more important here, that collusion is reduced, or that identified collusion is increased?

	A	B	C	D	E	F	G	H	I	J	
1	Master	B00402412	B00303856	B00392681	B00388237	B00387575	B00365214	B00402229	B00390352	B00310726	B
2	A_1	2	3	4	5	6	7	8	9	10	
3	A_2	19	18	17	16	15	14	13	12	11	
4	(A_1+A_2)	21	21	21	21	21	21	21	21	21	
5	A_1A_2	38	54	68	80	90	98	104	108	110	
6	A_2+1	20	19	18	17	16	15	14	13	12	
7	B_1	19	18	17	16	15	14	13	12	11	
8	B_2	2	3	4	5	6	7	8	9	10	
9	a	3	4	5	6	7	8	3	4	5	
10	b	8	7	6	5	4	3	8	7	6	
11	\frac{(a-1)}{a}	\frac{2}{3}	\frac{3}{4}	\frac{4}{5}	\frac{5}{6}	\frac{6}{7}	\frac{7}{8}	\frac{2}{3}	\frac{3}{4}	\frac{4}{5}	\
12	\frac{b}{a}	\frac{8}{3}	\frac{7}{4}	\frac{6}{5}	\frac{5}{6}	\frac{4}{7}	\frac{3}{8}	\frac{8}{3}	\frac{7}{4}	\frac{6}{5}	\
13	e	2	-2	2	-2	2	-2	2	-2	2	
14	c0	2	2	3	4	4	6	6	8	6	
15	c1	6	14	10	6	16	2	19	9	10	
16	+(C_0+C_1)	+8	+16	+13	+10	+20	+8	+25	+17	+16	+
17	+C_0C_1	+12	+28	+30	+24	+64	+12	+114	+72	+60	+
18	h	260	1042	702	420	1690	260	2742	1292	1122	
19	C_0	C_0	C_0	C_0	C_0	C_0	C_0	C_0	C_0	C_0	C
20	+C_1	+C_1	+C_1	+C_1	+C_1	+C_1	+C_1	+C_1	+C_1	+C_1	+
21	+C_2	+C_2	+C_2	+C_2	+C_2	+C_2	+C_2	+C_2	+C_2	+C_2	+
22	+C_3	+C_3	+C_3	+C_3	+C_3	+C_3	+C_3	+C_3	+C_3	+C_3	+
23	i	1	1	-1	-1	1	1	-1	-1	1	
24	j	1	-1	1	-1	1	-1	1	-1	1	
25	k	\alpha_1	\alpha_1	\alpha_1	\alpha_1	\alpha_1	\alpha_1	\alpha_1	\alpha_1	\alpha_1	\
26	l	\alpha_2	\alpha_2	\alpha_2	\alpha_2	\alpha_2	\alpha_2	\alpha_2	\alpha_2	\alpha_2	\
27	C_5	2	4	6	2	4	6	2	4	6	
28	C_6	4	6	8	4	6	8	4	6	8	
29	\frac{1}{2}C_5	\mbox{}	2	3	\mbox{}	2	3	\mbox{}	2	3	\
30	C_7	\frac{1}{3}	\frac{4}{3}	-\frac{2}{3}	-\frac{5}{3}	\frac{1}{3}	\frac{4}{3}	-\frac{2}{3}	-\frac{5}{3}	\frac{1}{3}	\
31	C_8	\frac{2}{3}	\frac{5}{3}	-\frac{1}{3}	-\frac{4}{3}	\frac{2}{3}	\frac{5}{3}	-\frac{1}{3}	-\frac{4}{3}	\frac{2}{3}	\
32	C_9	\frac{2}{3}	\frac{5}{3}	-\frac{1}{3}	-\frac{4}{3}	\frac{2}{3}	\frac{5}{3}	-\frac{1}{3}	-\frac{4}{3}	\frac{2}{3}	\

Figure 3. A rudimentary example of an Excel file created to provide parameter sets for inclusion into LaTeX-created coursework assignments.

QUESTION 1 (10 marks)

The surface S has the equation

$$z = 6x^2y^2 + 12xy^2 - 8y + 35.$$

QUESTION 1 (10 marks)

The surface S has the equation

$$z = 3x^2y^2 + 6xy^2 - 12y + 30.$$

Figure 4. Introductions to two versions of the same question provided to Year 2 calculus students. What happens when one student submits a solution to a different student's question?

Some institutions have considered the use of software which monitors the actions of students during remote examinations, namely remote examination proctoring. However, there remain significant issues with this route when considering cost, digital poverty, bandwidth, and security/privacy concerns. Further, it has also been reported that such software may produce disparities in reports when race, skin tone, and sex is considered (Yoder-Himes *et al.*, 2022).

Crucially, the assessment setter and marker must be aware that, no matter the vehicle of assessment, they must be aware of the temptation of plagiarism, collusion, and other academic malpractice; the opportunities available to counteract this temptation (and associated time-costs); and the opportunities available to discover occurrences of academic malpractice (and associated time-costs).

2.3. Presentations

HEIs are tasked with producing world- and work-ready graduates who are prepared for the 21st century workplace and the fourth industrial revolution Given this; degree programme leaders aim to instil in their graduates the skills required to flourish in this environment. Communication and presentation skills are often highlighted as being sought after by employers. For this reason and recognising that presenting material can illustrate a level of knowledge of a subject, formal presentations of subject matter are also used in HEI assessment settings. Further, presentations can also be paired with groupwork, so that students are also assessed on working with others, leadership, managing conflict, and other useful, relevant skills.

Presentations provide an excellent vehicle for evidencing subject knowledge and application. Pre-prepared (and submitted) slides can be checked for plagiarism via Turnitin, and level of input into group presentations can be assessed via the presentation, or via student proformas where they are asked to rate members' contributions. It should be noted that the latter vehicle can provide issues in itself.

Whilst presentations can seem to provide an assessment vehicle which is less obviously open to plagiarism, the marking of presentations can be very time-consuming for the academics involved. Further, assessment setters must take care to ensure that presentations are fair for all students involved, especially when considering aspects such as anxiety, social or otherwise.

2.4. Group work

The aspect of group work is introduced above, in the context of assessing via presentations, but group work can also be used in other assessments such as reports and simple coursework assignments. Whilst an excellent vehicle for practicing the aforementioned graduate skills, there is one drawback to consider when plagiarism arises in a group work submission: what happens when one group member includes plagiarised work in a submission and it hasn't been known to the other group members? Should all be punished equally, since it is the duty of all group members to be aware of what is being submitted under their name, or should there be different levels of punishment? Issues such as these should be discussed in, and, if possible, procedures set in place by the institution's AMP, as discussed in the following section.

3. The Academic Malpractice Panel

The issues surrounding academic malpractice do not stop at how to counteract and how to discover occurrences. Academic question setters and markers must also be aware of their institutions policies on how suspected occurrences of academic malpractice are processed. Further, the policies must be enacted by all concerned in a simple, coherent, and consistent manner.

Occasionally, it is found that an assessment setter/marker may try to deal with a case of suspected academic malpractice "in-house". This could be due to a number of reasons, including sympathy for the student, disdain for paperwork and associated hassle, and recognition on the potential negative effect on module performance statistics. This can often lead to issues further down the line, especially if a student believes that the assessment setter is unfairly treating them. The simplest route, when suspecting possible academic malpractice, is to report to the faculty/institutional AMP.

The AMP takes a variety of forms across higher education institutions and can offer a variety of penalties for students found guilty of malpractice. Penalties include resubmission of material (with or without loss of attempt), notifications on official records, suspension of studies, and expulsion from degree programmes. Due to the stakes involved, AMP meetings which involve assessment setters and (independently) students suspected of academic malpractice can be stressful environments for

all. Students often claim to not be aware of their institution's rules on collusion and plagiarism, they often do not realise the cultural differences in assessments, and often simply do not realise what is expected of them.

Much of this can be combated by having clear and concise information presented to students at the earliest opportunities by senior officials of the institution such as Deans of Faculties, or Chairs of AMPs. By illustrating to students that academics are aware of malpractice, then temptation can be reduced.

Occasionally, students may appeal the decision of the Panel, and for this reason it is important that policies have been enacted, by all, and at all stages, to the letter. Further, it is important that the constituent members of AMPs are representative of the faculty or institution. As noted earlier, being summoned to the AMP can be a stressful experience, which can be mitigated with an appropriate choice of panel members. Recognition of cultural differences can often be key.

4. Next Steps?

Many academics (and higher education institutions) were caught sleeping at the wheel when EVAs were introduced during the pandemic. Due to the move to remote assessments, some academics have become acutely aware of occurrences of academic malpractice, including the use of "study help" websites and essay mills. It is important that occurrences of suspected malpractice are reported through the official channels and that executive members of institutions are made aware of the scale of the problem.

Government officials have made steps to combat the issue, but whilst their focus is currently on essay-mills, companies offering "study help" are still able to assist students in malpractice. Some institutions have taken steps to block such websites from being accessed on campus, but that is of little assistance when students are able to access off-site. It causes further issues for staff members who are willing to monitor these sites for exam-time uploads. Further, due to the vast sums of money involved, (Financial Times, 2021) "study help" companies could be seen to be a little reluctant to work closely with institutions with malpractice concerns.

Suggestions have been made here on individualisation of student assessments, but these can come with an associated time cost. Further, a consistent approach within university departments could be difficult to garner, especially if some colleagues do not agree with the time cost versus benefit argument.

Finally, whilst many science and engineering academics stand steadfastly to the opinion that the formal, closed-book, invigilated examination is the best [and only useful] method of examination, there are an increasing number who are willing to experiment with different vehicles for assessment (e.g. essays, presentations, reports). Whilst there is not the time available to afford every student a *viva voce*, other methods of assessment are available, and do not necessarily need to be vectors of malpractice.

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