

APPENDIX. DIFFERENT LEVELS OF CONTROLS TO MITIGATE CHEATING BEHAVIOR AMONG STUDENTS

Control Measures	Description	Strengths	Limitations
Elimination			
Complete removal of online assessment	Converting online assessment to face-to-face assessment or eliminating the need for assessment.	<ul style="list-style-type: none"> The most effective control measure that will avert all risk of cheating in online assessment. 	<ul style="list-style-type: none"> This measure will not be applicable in situations where face-to-face session cannot be conducted (e.g. distant learning, asynchronous learning, campus lockdown due to pandemic or other disasters). Assessment may still be required for the purpose of certification and for the differentiation of performance among students.
Substitution			
Open-resource assessment	The nature of the assessment task is one where access to information is required.	<ul style="list-style-type: none"> This obviates the need to regulate accessibility to online or even hardcopy resources. Helps create an authentic environment where information is freely available. 	<ul style="list-style-type: none"> This measure will not be able to circumvent cheating behavior through illicit communication with a third-party. It limits the type of questions that can be asked. It will not be appropriate in situation where answers are readily obtainable from a single resource.
Formulating open-ended questions	Assessment questions are redesigned to create divergent responses. Therefore, no two students should derive the same answer.	<ul style="list-style-type: none"> This approach disincentivizes the students from cheating. Monitoring of responses can simply be administered by plagiarism checks. Such questions also evaluate student on a higher order of learning on Bloom's taxonomy scale: synthesis of new ideas. 	<ul style="list-style-type: none"> This assessment tool may not be applicable for foundational courses. Grading will become more laborious and could be untenable for a large class setting. Open discussion with one another cannot be prevented.
Converting to take-home assignment	Take-home assignments are characterized by a more generous timeframe. Students have full access to information, including discussion with others in	<ul style="list-style-type: none"> In addition to the advantages listed for open-ended questions, this approach removes the anxiety of a time-limited assessment. 	<ul style="list-style-type: none"> While plagiarism checks can still be administered to reduced copying of each other's work, such assessment can still lead to a convergence of ideas.

	constructing their responses for the task.	<ul style="list-style-type: none"> • It facilitates self-directed learning and the integration of knowledge from different resources. 	<ul style="list-style-type: none"> • Generally, it remains difficult to differentiate student abilities and student's performance will distribute narrowly as compared to a closed-book assessment.
Conducting online oral examination (<i>Viva voce</i>)	A virtual face-to-face examination where questions are asked on the spot and students provide responses verbally.	<ul style="list-style-type: none"> • Direct engagement provides an effective deterrence against cheating. • Questions can be adaptive as examiner can tailor subsequent questions based on earlier responses. 	<ul style="list-style-type: none"> • A very time-consuming process, especially for a large class. • Different sets of questions may be required if students are spaced out by time.
Engineering			
Reduce time	The timeframe for the assessment is reduced such that there is insufficient time for students to either refer to illicit resources or to discuss with one another.	<ul style="list-style-type: none"> • This approach avails different types of questions for assessment to increase the instructors' flexibility. • Questions can be tailored to facilitate grading (for example, MCQs can be graded electronically and hence reduce labor). 	<ul style="list-style-type: none"> • Increase the anxiety for the students taking the assessment. • Students abilities will now be differentiated by speed and accuracy rather than by their intrinsic understanding. • It is still possible for collusion among students to take place, and hence compromises assessment integrity.
Internet lockdown	Testing software like Exemplify allows internet lockdown so that students cannot access any other materials during the assessment.	<ul style="list-style-type: none"> • This approach allows the instructor to ask questions where answers can be readily derived from online resources. 	<ul style="list-style-type: none"> • Students can get around the lockdown by using a second device with online access. • It will not restrict access to hardcopy information.
Forward-only function	With the use of certain testing software, the platform can be programmed to restrict students from returning to an earlier question.	<ul style="list-style-type: none"> • This approach disincentivize the students from cheating as they cannot stall the examination process while waiting for answer from a different source. • It gives flexibility for the instructors to construct questions whereby an earlier question can provide hints to the answer for a latter question. 	<ul style="list-style-type: none"> • It is still possible for collusion among students to take place, and hence compromises assessment integrity. • It creates unnecessary anxiety for the students, especially when there is accidental omission or careless mistakes.
Question randomization	Question appearing in random sequence, or having the options	<ul style="list-style-type: none"> • Raising the barrier for cheating through discussion, without increasing the 	<ul style="list-style-type: none"> • Students who are determined on collusion can still exchange information during the assessment.

	randomized in a multiple-choice setting.	workload for the instructors setting the questions.	
Multiple sets of questions	Creating distinctively different sets of questions for different students taking the same assessment.	<ul style="list-style-type: none"> This approach is applicable for a variety of question types, hence offering flexibility for the instructors. Cheating is disincentivized because students do not see the benefit of cheating. Increased workload for the instructor to create additional questions. It remains difficult to ensure parity in questions. 	<ul style="list-style-type: none"> Students who are determined on collusion can still exchange information during the assessment.
Administrative			
Education on academic integrity	Starting the students right by going through formal education on academic integrity. Such education can be targeted by providing specific illustration of cheating in online assessment to create a deterrent effect.	<ul style="list-style-type: none"> The is a principle-driven approach that addresses the heart of the problem. It provides an overarching value system that transcends academic integrity in different context. This approach is useful in both preventive and rehabilitative applications. 	<ul style="list-style-type: none"> Effectiveness of approach depends on the value system of the individual students. Negative peer influence can still sidestep the correct responses among some individuals.
Self-declaration on academic integrity	A reminder against cheating behavior that liberates the institution to apply sanctions to reinforce this measure.	<ul style="list-style-type: none"> This is a just-in-time reminder that reinforces the value system for compliance. It promotes self-examination as a behavioral change with longer term benefits. 	<ul style="list-style-type: none"> Like educational approaches in general, it exerts differing impact on individuals depending on value system and peer influence.
Applying sanctions for wrongful behaviors	Sanctions serve as a warning to safeguard against recurrences.	<ul style="list-style-type: none"> This approach reinforces education and self-declaration on assessment integrity. 	<ul style="list-style-type: none"> Requires concrete evidence of cheating for sanctions to be applied. In most of the cases, such infringements may not be detectable. This approach may also not be effective against the most recalcitrant student offenders.

Protective			
Online proctoring	This is an evolving area. The most widely implemented approach right now is the use of Zoom-based proctoring where an additional device can be used to monitor students' activities, much like a closed-circuit TV.	<ul style="list-style-type: none">• Proctoring provides a visual record of student activities.• All forms of assessment that are previously administered in the classroom can be achieved here.	<ul style="list-style-type: none">• However, it is no easy to monitor all students simultaneously.• Online communication of the students may still evade detection.• Such monitoring creates anxiety for the students.• There are concerns about infringement of privacy.
