

1 Evaluation of Academic Integrity of Online Open Book Assessments Implemented in an
2 Undergraduate Medical Radiation Science Course during COVID-19 Pandemic

3

4 **Abstract**

5

6 *Introduction*

7

8 Online open book assessment is a common alternative to a traditional invigilated test or
9 examination during COVID-19 pandemic. However, its unsupervised nature increases ease
10 of cheating, which is an academic integrity concern. This study's purpose was to evaluate
11 the integrity of two online open book assessments with different formats (1. tightly time
12 restricted - 50 minutes for mid-semester and 2. take home - any 4 hours within a 24-hour
13 window for end of semester) implemented in a radiologic pathology unit of a Bachelor of
14 Science (Medical Radiation Science) course during the pandemic.

15

16 *Methods*

17

18 This was a retrospective study involving a review and analysis of existing information
19 related to the integrity of the two radiologic pathology assessments. Three integrity
20 evaluation approaches were employed. The first approach was to review all their Turnitin
21 reports with use of 'seven-words-in-a-row' criterion to identify any potential collusion. The
22 second approach was to search for highly irrelevant assessment answers during marking for
23 detection of other cheating types. Examples of highly irrelevant answers included those not
24 addressing question requirements and stating patients' clinical information not from given
25 patient histories. The third approach was an assessment score statistical analysis through

26 descriptive and inferential statistics to identify any abnormal patterns that might suggest the
27 cheating occur. An abnormal pattern example was high assessment scores. The descriptive
28 statistics used were minimum, maximum, range, first quartile, median, third quartile,
29 interquartile range, mean, standard deviation, fail and full mark rates. T-test was employed
30 to compare mean scores between the two assessments in this year (2020), between the two
31 assessments in the last year (2019), between the two mid-semester assessments in 2019 and
32 2020, and between this and last years' end of semester assessments. A p-value less than 0.05
33 was considered statistical significance.

34

35 *Results*

36

37 No cheating evidence was found in all Turnitin reports and assessment answers. The mean
38 scores of the end of semester assessments in 2019 (88.2%) and 2020 (90.9%) were similar
39 ($p=0.098$). However, the mean score of the online open book mid-semester assessment in
40 2020 (62.8%) was statistically significantly lower than that of the traditional invigilated
41 mid-semester assessment in 2019 (71.8%) with $p<0.0001$.

42

43 *Conclusion*

44

45 This study shows the use of the online open book assessments with the tightly time
46 restricted and the take home formats in the radiologic pathology unit did not have any
47 academic integrity issue. Apparently, the strict assessment time limit played an important
48 role in maintaining their integrity.

49 **Introduction**

50

51 Online open book assessment (test / examination) is not a new assessment method in higher
52 education. It has been used in many online undergraduate and postgraduate courses for
53 years. Students are allowed to use any reference resources for answering questions during
54 the assessments without supervision [1]. It can be conducted in either tightly time restricted
55 (e.g. 2-3 hours for completion) or take home (e.g. 24-48 hours) format [2]. Due to COVID-
56 19 restrictions on gathering and movement for infection control, it has become one of the
57 common assessment methods to replace traditional invigilated assessments [3-5]. The use of
58 the online open book assessment is to gauge individual students' development of knowledge
59 against academic and / or professional standards. This is to ensure that they possess
60 adequate capabilities to meet requirements of their own study and / or work in the future. If
61 they obtain assistance from others to complete their assessments, this is determined as
62 cheating because the submitted works do not represent their own knowledge achievement.
63 In any academic setting, the students must demonstrate honesty, which is known as
64 academic integrity. The unsupervised nature of the online open book assessment increases
65 ease of cheating. For example, the students can approach contract cheating websites, and
66 paid or unpaid third parties (e.g. classmates, friends, relatives, etc.) for the assistance in
67 completing the assessment tasks, breaching the academic integrity requirement [4-8].

68

69 For meeting the academic integrity requirement, various universities provide online open
70 book assessment design guidelines to assist their staff in developing this online assessment
71 appropriately. One common suggestion is to use long questions that require application of
72 knowledge or reflection on personal experience for the assessment, and avoid setting factual
73 recall questions (e.g. multiple choice and short questions, etc.). For example, a long question

74 which requires the students to tailor their answer specific to a scenario (e.g. solving a
75 particular problem, etc.) or to demonstrate their achievement of learning objectives based on
76 their own experience is recommended. Also, limiting the assessment time can reduce the
77 chance for them to seek for the assistance from the other parties [2,8,9]. However, a recent
78 large Australian study involving 14,086 students and 1,147 teaching staff has shown that the
79 students are more likely to cheat in the assessments with the knowledge application and the
80 short completion time (e.g. 3-7 days) requirements. This is because of increased difficulty
81 and pressure associated with the time constraint [6]. That research evidence seems against
82 the aforementioned universities' suggestions to certain extent.

83

84 For the author's institution similar to other universities worldwide [3-5], the traditional
85 invigilated assessments were not allowed during the pandemic (first half of 2020). Every
86 unit (subject) coordinator needed to rush at converting the original invigilated assessments
87 to other suitable alternatives. The most common alternative was the online open book
88 assessment. This is because it would be unnecessary to change the original assessment
89 questions if they were in line with the universities' online open book assessment design
90 guidelines, addressing the tight time constraint [2,4,8,9]. The author was a coordinator of a
91 radiologic pathology unit (Medical Radiation Pathology 2) for third year medical imaging
92 and radiation therapy students of an Australian Bachelor of Science (Medical Radiation
93 Science) course. Originally, this unit had three traditional invigilated assessments including
94 a 50-minute mid-semester test, a 50-minute end of semester test and a 2-hour final
95 examination. For meeting the unit learning outcomes and registering body's (Medical
96 Radiation Practice Board of Australia [MRPBA]) professional capability requirements [10],
97 each of the two tests had six long essay questions which required the students to interpret six
98 cases with patients' clinical histories and multimodality medical images (including general

99 radiography, fluoroscopy, mammography, ultrasound, computed tomography, magnetic
100 resonance imaging and nuclear medicine), and construct written informed opinions about
101 medically significant findings in a timely fashion. The final examination had five long, 19
102 short and 12 multiple choice questions.

103

104 To mitigate COVID-19 impacts, it was decided to remove the final examination from this
105 unit since the first and the second halves of this unit contents were covered by the mid-
106 semester and the end of semester assessments. It was unnecessary to have one more
107 assessment to evaluate the students' capabilities. Also, due to the authentic nature of the two
108 tests [10,11], no change was made to the original papers for their online delivery except the
109 end of semester assessment duration. This change of the duration was required by the
110 university that any online assessment administered after 1st May 2020 must have a duration
111 of at least 4 hours and open for a minimum period of 24 hours. This arrangement allowed
112 the students to handle any potential technical problems such as internet interruption
113 encountered during the assessment. The end of semester assessment duration became 4
114 hours and it was open for 24 hours for the students to download the online paper and submit
115 the completed work to a Turnitin dropbox (Turnitin, CA, USA) for cheating detection and
116 marking. Both online assessments had same numbers of questions (six long essay
117 questions), answer requirements and marks allocated to each but just covering different
118 body systems. These settings were also the same as those of previous year's traditional
119 invigilated 50-minute mid-semester and end of semester assessments. Levels of difficulty of
120 2019's and 2020's assessments were similar although their questions were different.

121

122 Despite the recent research findings showing the assessments with the knowledge
123 application and the short completion time requirements being the facilitators of the

124 assessment cheating [6], these arrangements were recommended by different universities for
125 maintaining the integrity of the online open book assessment [2,8,9]. It is worthwhile to
126 investigate any impact of the assessment durations on the integrity of the online open book
127 assessment with the knowledge application requirement. This study's purpose was to
128 evaluate the integrity of the two online open book assessments with different time limits
129 implemented in a radiologic pathology unit of a Bachelor of Science (Medical Radiation
130 Science) course during the pandemic. It is expected that this study's outcomes can provide
131 further insights about the appropriate time limit for avoiding the cheating in the online open
132 book assessment, which has become the common assessment method in response to the
133 pandemic [3,4,8].

134

135 **Methods**

136

137 This was a retrospective study involving a review and analysis of existing information
138 related to the academic integrity of the online open book mid-semester and end of semester
139 assessments of the radiologic pathology unit that the author was its coordinator. Number of
140 students enrolled in this radiologic pathology unit in 2020 was 48. Thirty (63%) students
141 were female and 18 (38%) were male. Their mean age was 23 years, ranging from 20 to 40
142 years. Institutional review board approved this study and granted a waiver of consent on 4th
143 August 2020. The approval number was HRE2020-0432. The mid-semester assessment in
144 April 2020 was tightly time restricted with its duration of 50 minutes. The end of semester
145 assessment in June 2020 allowed the students to spend a maximum of 4 hours to complete
146 the assessment anytime within the 24-hour window. The assessment papers were available
147 for the students to download from the university's learning management system
148 (Blackboard Learn, DC, USA) within the specific timeframes. The timeframes for the mid-

149 semester and the end of semester assessments were 50 minutes and 24 hours respectively.
150 The students were required to use their own computers to enter their answers into the
151 assessment paper documents and submit the completed papers to the Turnitin dropboxes
152 available on the Blackboard within the timeframes. No technical strategy was implemented
153 to prevent the students spending more than 4 hours to complete the end of semester
154 assessment. However, they were informed that the assessment paper submission was an
155 implied declaration of only a maximum of 4 hours used to complete the assessment. The end
156 of semester assessment could be considered the take home assessment [2]. Although
157 technical strategies such as Blackboard Test function could be used to enforce the
158 assessment time restriction, the author's institution discouraged their staff to use it for
159 preventing the Blackboard server overload.

160

161 The Turnitin is a text matching system able to highlight any texts within an electronic
162 document matching those in existing publications and previously submitted works by other
163 individuals such as students for detecting any potential collusion [12]. The Turnitin is not
164 capable to detect the other cheating types involving the contract cheating websites, the
165 students' friends or relatives. However, according to recent research findings [13],
166 experienced markers can differentiate between genuine student works and those completed
167 by the third parties for most (96%) of the time. Marking of the two assessments involved the
168 unit coordinator, which was the author, and a co-teacher. Each had 18 years of teaching and
169 marking experience in higher education. Also, the author was an undergraduate medical
170 imaging course coordinator and the co-teacher was a consultant radiologist in the past.
171 Currently, the author is a member of his university's central and faculty student discipline
172 panels and an inquiry officer for academic misconduct incidents. The co-teacher is a
173 professor in medical imaging. The unit coordinator was responsible to mark all questions in

174 the two assessments except two questions set by the co-teacher. The co-teacher marked his
175 own questions and double marked a few randomly selected papers from the two assessments
176 for post-marking moderation. The other types of cheating not detected by the Turnitin
177 should be identified through this rigorous marking process.

178

179 Three approaches were employed to evaluate the integrity of the two assessments. The first
180 approach was to review all answer texts highlighted in each assessment Turnitin report. If a
181 highlighted text had seven or more consecutive words to express an idea that matched those
182 in another student's submitted paper and the idea could be expressed in a different way, this
183 would indicate a potential collusion based on the 'seven-words-in-a-row' criterion.

184 However, when seven or more consecutive words were technical terms, this was not
185 considered a collusion. An example of this was T1 and T2 weighted magnetic resonance
186 images [12,14,15]. As per the author's university academic integrity guidelines [16], no
187 'safe' level of the Turnitin similarity score was set for the collusion detection in this study.
188 This is because the similarity score is generated through dividing the number of highlighted
189 words by total number of words of a document. Even a paper with a similarity score of 1%
190 may have seven or more consecutive words matching another person's work when the total
191 number of words is not small.

192

193 The second approach was to search for highly irrelevant assessment answers during marking
194 for detecting other cheating types not covered by the Turnitin. The literature has indicated
195 that the assessment assistance provided by the contract cheating websites, their friends and
196 relatives tends to be unable to address the specific assessment requirements, leading to the
197 highly irrelevant answers [5,13,17]. Each question of the assessments required the students
198 to determine the imaging modalities and techniques such as contrast phases for all given

199 images with justification. Also, they needed to identify abnormalities shown on the given
200 images and suggest a diagnosis based on both imaging findings and given patients' clinical
201 information (e.g. blood test results, etc.). Presence of the highly irrelevant answer would be
202 an indication of potential cheating.

203

204 The third approach was an assessment score statistical analysis through descriptive and
205 inferential statistics to identify any abnormal patterns such as high assessment scores that
206 might suggest the cheating occur. The descriptive statistics used were minimum, maximum,
207 range, first quartile, median, third quartile, interquartile range, mean, standard deviation
208 (SD), fail and full mark rates. T-test was employed to compare mean scores between the two
209 assessments in this year (2020), between the two assessments in the last year (2019),
210 between the two mid-semester assessments in 2019 and 2020, and between this and last
211 years' end of semester assessments [4,17-19]. 2019's enrolment number of this radiologic
212 pathology unit was 47. GraphPad InStat 3.06 (GraphPad Software Inc, CA, USA) was used
213 for the statistical analysis. A p-value less than 0.05 was considered statistical significance.

214

215 **Results**

216

217 All Turnitin reports for the two assessments show no student's answer text had seven or
218 more consecutive words for the idea expression that matched those in the existing
219 publications and the works submitted by the other individuals, suggesting no collusion.
220 However, their overall Turnitin similarity scores were high (mid-semester assessment: 52%-
221 90% and end of semester assessment: 30%-80%). These were contributed by common texts
222 within cover pages of the assessment papers and questions. No highly irrelevant assessment
223 answer was identified during the marking and the post-marking moderation. Nonetheless,

224 some students did not answer some parts of the questions and / or provided incorrect (but
225 still relevant) answers. These phenomena were more common in the mid-semester
226 assessment.

227

228 Table 1 and Figure 1 illustrate the current and previous years' mid-semester and end of
229 semester assessment score statistics. For both 2019 and 2020, the end of semester
230 assessment scores were higher than the mid-semester ones, and statistically significant mean
231 differences are noted ($p < 0.0001$). The mean scores of the end of semester assessments in
232 2019 (88.2%) and 2020 (90.9%) were similar ($p = 0.098$). These indicate no abnormal pattern
233 to suggest any cheating occur in the online open book end of semester assessment [1].

234 However, the mean score of the online open book mid-semester assessment in 2020 (62.8%)
235 was statistically significantly lower than that of the traditional invigilated mid-semester
236 assessment in 2019 (71.8%) with $p < 0.0001$. Other statistics of the online open book mid-
237 semester assessment scores also show noticeable differences (including a lower minimum
238 and a higher maximum leading to a wider range and a greater SD, and a non-zero fail rate)
239 when compared with those of the traditional invigilated mid-semester assessment. The
240 statistically significantly lower mean score, the smaller minimum, and the non-zero fail rate
241 can be considered findings to suggest that no cheating should happen in the online open
242 book mid-semester assessment [18,19]. For the online open book end of semester
243 assessment, a non-zero full mark rate (8.3%) is noted. Nonetheless, neither any student
244 failed nor obtained full marks in the two traditional invigilated assessments.

245

246 'Insert Table 1 about here'

247

248 'Insert Figure 1 about here'

249

250 **Discussion**

251

252 Due to the constantly changing university's assessment policy in response to the COVID-19
253 pandemic, the formats of the online open book mid-semester and the end of semester
254 assessments implemented in the radiologic pathology unit were different. The former was
255 tightly time restricted (50 minutes) while the latter was take home (4 hours to complete the
256 assessment anytime within the 24-hour window). Although the recent large Australian
257 survey study with 14,086 students and 1,147 teaching staff [6] and a personal view article
258 [4] indicate the assessments with the knowledge application and the short completion time
259 requirements are the facilitators of the cheating, this study's results based on the real
260 students' data suggest that no cheating should occur in the two assessments. The apparent
261 contradiction may be due to the assessment time limit [5].

262

263 A previous study has shown a minimum of 6 hours is required for a contract cheating
264 provider to complete an assessment for a student [7]. This implies it should be difficult for a
265 student to ask a contract cheating provider to complete the online open book mid-semester
266 assessment within 50 minutes. Also, it is suggested that appropriate time for prepared
267 students to complete a discussion question within an online open book assessment should be
268 about 15-30 minutes [9]. The appropriate time limit for each assessment in the radiologic
269 pathology unit should be 1.5-3 hours for the six questions. This indicates it was not easy
270 even for the prepared students to complete all mid-semester assessment questions. Hence,
271 this was challenging for any student to use the other cheating approaches such as collusion
272 and asking the friends and relatives for the assistance in this assessment [5]. This study's
273 findings of the higher overall Turnitin similarity scores for the mid-semester assessment

274 ranging between 52% and 90% (contributed by the shorter answers in relation to the
275 common texts within the assessment cover page and questions), and more missing answers
276 for some question parts were also in line with this suggestion.

277

278 In contrast, it might be feasible for the students to use the aforementioned cheating
279 approaches in the end of semester assessment. The students could download the assessment
280 paper immediately after its release and ask someone to assist in completing it within the 24-
281 hour window despite no cheating found in this assessment [7,9]. There were a number of
282 potential factors discouraging the students to cheat in this assessment. For example, the
283 students were aware that the Turnitin was used and able to detect the cheating [17]. Also,
284 the markers were the experienced teaching staff familiar with the cheating detection and
285 their academic abilities [13,17,20]. At the beginning of the course, they were required to
286 complete the university's mandatory academic integrity program [21]. They learnt from this
287 program that the cheating is an unethical behaviour and it may have potential consequences.
288 For example, the contract cheating providers can blackmail them [4,13,20-22]. Furthermore,
289 they might have concerns about quality of the works completed within 24 hours by the
290 cheating providers [7]. Besides, they might not know the cheating approaches for the online
291 open book assessment that were hard to be detected [20]. This is because the assessment
292 method was relatively new to them. Many students did not even know how to appropriately
293 prepare for the assessment [4].

294

295 The statistically significantly lower mean score, the smaller minimum score and the non-
296 zero fail rate of the 2020 mid-semester assessment might be due to the students unfamiliar
297 with this assessment method (Table 1 and Figure 1). Although its maximum score was
298 higher than that of the corresponding assessment in 2019, the higher maximum score might

299 be contributed by a student with more experience, higher intelligence and / or better literacy
300 skills (an outlier) [1,4,5]. It seems the students' mid-semester assessment experience
301 contributed to the improved end of semester assessment results in 2019 and 2020 (Table 1
302 and Figure 1). No statistically significant mean difference is found between the two end of
303 semester assessments, which is in line with the findings of the previous studies [1]. The non-
304 zero full mark rate of 2020's end of semester assessment can be attributed to its longer
305 duration (Table 1). This allowed some students to fully utilise available reference resources
306 and write up comprehensive answers [1,4,5]. Nevertheless, apparently, this longer duration
307 affected its authenticity. An authentic assessment should be able to evaluate students'
308 capability to complete real world tasks [11]. According to the MRPBA, any registered
309 Australian medical radiation practitioners are required to provide the informed opinions
310 about the medically significant findings to appropriate medical personnel in a timely manner
311 [10]. This requirement is particularly important for medical emergency situations which
312 demand practitioners' immediate responses and disallow search for resources [4]. As noted
313 in a study about final year student radiographers' image interpretation performances,
314 average time to interpret one image was 33.25 s [23]. The original assessment time limit, 50
315 minutes appears more appropriate to evaluate the students' ability to meet the MPRBA
316 requirement [10]. However, guidelines for supporting the students in preparing for the
317 online open book assessment should be provided in the future [1].

318

319 This study had two main limitations. This was a retrospective study rather than a
320 randomised controlled trial, which is able to provide more rigorous findings [24]. However,
321 the retrospective study could better reflect the real situations during the COVID-19
322 pandemic, which is complementary to the randomised controlled trial [4,25]. Also, the
323 study's results were only based on one unit (subject) in one Australian undergraduate

324 medical radiation science course although this setting is common for medical radiation
325 science education research. To ensure its rigor, multiple approaches were used to evaluate
326 the integrity of the two online open book assessments [26].

327

328 **Conclusion**

329

330 This study shows the tightly time restricted (50 minutes) and the take home (4 hours within
331 the 24-hour window) online open book assessments, which were implemented in the
332 Medical Radiation Pathology 2 unit (subject) of the Bachelor of Science (Medical Radiation
333 Science) course during the COVID-19 pandemic, did not have any academic integrity issue.
334 Apparently, the strict assessment time limits played an important role in maintaining their
335 integrity despite that other factors (e.g. the use of the Turnitin, the implementation of the
336 academic integrity program, the involvement of the experienced markers, the reputations
337 and the capabilities of the cheating providers, etc.) might contribute to this. As the longer
338 assessment duration increases the chance of the cheating and negatively affects the
339 authenticity of the radiologic pathology assessment, the appropriate online open book
340 assessment duration should be the same as the original invigilated one. If this is not allowed,
341 alternatives such as online viva voce through the Blackboard Collaborate Ultra should be
342 considered for replacing the online open book assessment.

343

344 Caution is necessary when transferring this study's findings to other settings. For rigorously
345 studying the impact of the assessment durations on the integrity of the online open book
346 assessment, a randomised controlled trial should be conducted. This should involve a
347 random assignment of a greater number of students to groups with different time limits for
348 completing the same assessment paper under the invigilated (control groups) and the online

349 open book conditions (experimental groups). Also, more subjects and courses should be
350 covered in the future studies.

351

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353

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355

356 **Contributor**

357

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366

367 **Competing interests**

368

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372 no other relationships or activities that could appear to have influenced the submitted work.

373

374 **Ethical approval**

375

376 The institutional review board approved this study and granted the waiver of consent on 4th

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462 Table 1

463 Mid-semester and End of Semester Assessment Score Statistics 2019 and 2020

464

Assessment (Year)		Score (%)		Fail Rate (%)	Full Mark Rate (%)
		Mean	SD		
Online Open Book (2020) N=48	Mid-semester	62.8	11.5	6.3	0.0
	End of Semester	90.9	8.2	0.0	8.3
Traditional Invigilated (2019) N=47	Mid-semester	71.8	8.7	0.0	0.0
	End of Semester	88.2	7.6	0.0	0.0

465 Max, maximum; Min, minimum; N, sample size; SD, standard deviation.

466 Assessment passing score: 50%.

467 P-values of mean score comparisons by t-test: <0.0001 (2 assessments in 2020); <0.0001 (2
468 assessments in 2019); <0.0001 (2 mid-semester assessments); 0.098 (2 end of semester
469 assessments).

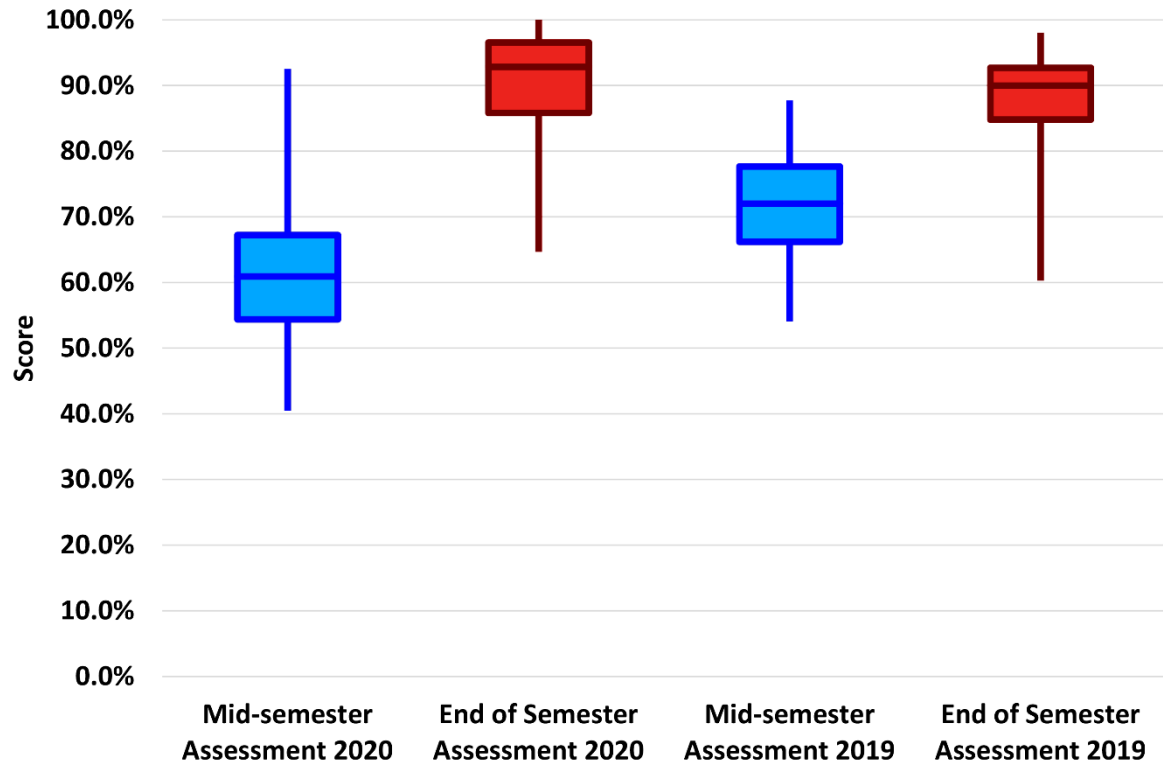
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471 Figure Caption

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473 Figure 1. A box plot of the mid-semester and end of semester assessment scores in 2019 and

474 2020. Assessment passing score: 50%.



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