

# EFFECTS OF STUDENTS' COURSE MATERIALS PAGE VIEWS ON ACADEMIC PERFORMANCE IN ONLINE COURSES

Sze Kiu YEUNG  
Singapore University of Social Sciences  
463 Clementi Road  
Singapore 599494  
skyeung@suss.edu.sg

Wee Leong LEE  
Singapore University of Social Sciences  
463 Clementi Road  
Singapore 599494  
wllee@suss.edu.sg

## Abstract

Students' reading of the course materials had never been measured because no data was available. It was assumed that students who performed better in their learning would have read their course materials more compared to those who performed poorly. The Singapore University of Social Sciences (SUSS) provided course materials in electronic forms in textbooks and study guides. The purpose of this study, based on data from the Academic Year 2020, was to find out was there a correlation between students' reading of the course materials and their performance in 10 online courses. A quantitative approach was used in the study. It was found that a very weak positive relationship,  $r(0.151)$ , existed for students who read the e-textbooks while there was almost no relationship,  $r(0.084)$ , for students who read the study guides when correlated with their performance. Furthermore, a statistical significance existed in the medians of e-textbook and study guide usages between those students who passed the online courses compared to those who failed. This significance could also be found in students' grade-bands. This study will be of interest to institutions with data available on students' readership behaviour. It is relevant to the sub-theme of "inspiring innovations" as it involves data analytics for online learning.

Keywords: online learning, data analytics, reading behaviours

## INTRODUCTION

The Singapore University of Social Sciences (SUSS) provided courses materials to students in digital format. Course materials in each course would normally include textbook(s) and a study guide. Before 2018, students would receive their textbooks in print format while their study guides were available in digital format. The digital version of the textbooks was adopted in 2018 when VitalSource (VS) assisted SUSS in rolling out electronic textbooks or e-textbooks via their platform. In courses that were presented in online-mode, both study guides and e-textbooks were delivered via the VS platform. Students and instructors would read the course materials using the VS electronic reader, known as Bookshelf. The course materials could be read in desktop, laptop and mobile formats in Android, iOS and Windows systems. The digital distribution of the course materials also provided data on students' reading habit. In the Academic Year 2020 (AY2020) when SUSS presented 10 online courses (see Appendix C), students' reading data was used to learn about the following research questions:

### Research Questions

- a) Was there a correlation between students' reading of the course materials and their performance in the 10 online courses?
- b) Was there evidence to indicate that students' reading of the course materials was different between those who passed compared to those who failed?
- c) Was there evidence to indicate that students' reading of the course materials was different between those who passed at different grade-bands compared to those who failed?

## LITERATURE REVIEW

This literature review discussed the measurement of textbook reading, e-textbook adaptation by SUSS and the challenge of using e-textbooks.

### **Measurement of Textbook Reading**

Before the use of digital technology, literature that examined students reading behaviours indicated the use of surveys to capture the data until it was available electronically as illustrated by Thaker, Carvalho & Koedinger (2019) when they studied the reading practice in predicting students' learning in Massive Open Online Courses. The data was logged through the Open Learning Initiative (OLI) systems. They found that there was a correlation between student performance accuracy and the average time students spent on a page. In another paper on using log data to collect students' reading habits, Yin & Wang (2017) explained the following methods: questionnaire-based data collection (QDC), manual data collection (MDC) and automatic data collection (ADC). Before 2010, most studies that examine readership behaviour would be based on the QDC or MDC approaches such as a study done by Berry, Cook, Hill & Stevens (2010) when they reported that "students know it is important to read, know the professor expects them to read, and know it will impact their grade, yet most students still do not read the textbook" (p. 31) when they analysed the data from a survey on textbooks usage.

### **e-Textbook Adaptation by SUSS**

With the introductory of electronic reader (e-reader), data on reading could be captured more efficiently. Early development of e-readers (Wikipedia (A), 2020) from companies such as Sony Reader (2006), Amazon's Kindle reader (2007), Barnes & Noble's Nook e-reader (2009), Google eBook (2010) to Apple's iBooks (2010) made it possible to read and measure e-textbooks.

For SUSS to engage with VitalSource (VS) in providing e-textbooks to its students, it was because VS had closed collaborations with the publishers in higher education. In 2007, the major publishers formed a company known as CourseSmart to distribute e-textbooks for higher education. They included Bedford, Cengage Learning, Freeman & Worth Publishing Group (Macmillan), McGraw-Hill Education, John Wiley & Sons, and Pearson. The e-textbooks were read from a web-browser or mobile devices developed by CourseSmart. In 2014, CourseSmart was acquired by VS (Wikipedia (B), 2020) and because these publishers provided 9,000 e-textbook titles they accounted for 90% of core textbooks in higher education (Murray & Perez, 2010). Unlike other universities, when a student enrolled in a SUSS course, he/she would receive the course materials comprising a study guide and textbook(s). Up to 2018, textbooks were distributed in printed format and study guides were in digital format. For courses that were presented in online-mode, both study guides and e-textbooks were distributed from the VS platform. Data would be available for SUSS to conduct research studies. Separately, SUSS also consulted a company from the UK known as Kortext but integration with our internal systems was a challenge.

### **The Challenge of Using e-Textbooks**

While e-textbooks are now used widely in higher education, a recent report from the Asian Development Bank explained the hesitancy of countries pursuing with e-textbooks. In South Korea, the country halted the transition from paper textbooks to e-textbooks as it feared the students' over-exposure to digital devices. Their students would continue to use a mixture of printed and digital materials as reported in 2018. In Hong Kong, the Education Bureau stated that textbooks still have their explicit values and they will not be replaced by e-textbooks in the years to come. For now, no national education system had moved entirely digital and the best digital practice was to use both printed and digital materials (Smart & Jagganathan, 2018).

With mobile technologies, the advantage of e-textbooks with the ability to read on-the-go without the need to bring printed textbooks was obvious. However, students did find a preference for using a printed textbook. The main problem was that students needed to read from screens and the lack of instructors' support in using e-textbooks (Gu, Wu & Xu, 2014). In terms of learning, there was the cognitive-load problem in that comprehension of digital texts compared to printed-paper texts suggested that students required higher reading time with e-textbooks when compared to paper (Daniel & Woody, 2013) even though there was no significant difference in learning

performance between the two formats (Gu et al., 2014). In terms of user acceptance, students of all ages overwhelmingly preferred printed textbooks (McGowen, Stephens & West, 2009). For in-depth reading, people still preferred paper than digital (Liu, 2005). However, the Pandemic of 2020 caused students worldwide to use digital resources but no data was readily available to date to support this claim.

## METHODOLOGY AND DISCUSSION

The methodology was based on quantitative research with data processing and data analytics. The VS platform provided data for one academic year (AY2020) that needed to be merged with the SUSS data. Before the data could be analysed, various steps in manipulating the data was required including data wrangling and checking normality before statistical tests could be applied. While the statistical elements with graphs and tables were illustrated below, their outcomes were discussed based on analysed data.

Two sets of data were retrieved from different sources. The first related to e-textbook and study guide data that was held on the VS platform while the second related to students' performance that was stored in the SUSS system. The VS data contained "Total Page Views" while the SUSS data captured the "Final Rank Score" for all students in the 10 online courses in AY2020.

### Data Wrangling

While the data from SUSS had students' Personal Identification (PI) number, the data from VS did not have this variable. It only provided the student's name. In AY2020, the 10 online courses from VS had 1,966 records for e-textbooks and 2,034 records for study guides. These records had to be mapped with the SUSS data. The mapping could only be performed if each student's PI number could be found for the VS data. With a combination of Excel's function (i.e. vlookup) and manual mapping, it was found that 1,582 and 1,950 records were identified for e-textbooks and study guides, respectively. Empty or redundant data was removed in the mapped data (i.e. without PI number and removing Test Students and Reference Users). The statistical analyses would use the data that was mapped between VS and SUSS systems as shown in Figure 1 (i.e. the "after" data that was mapped).

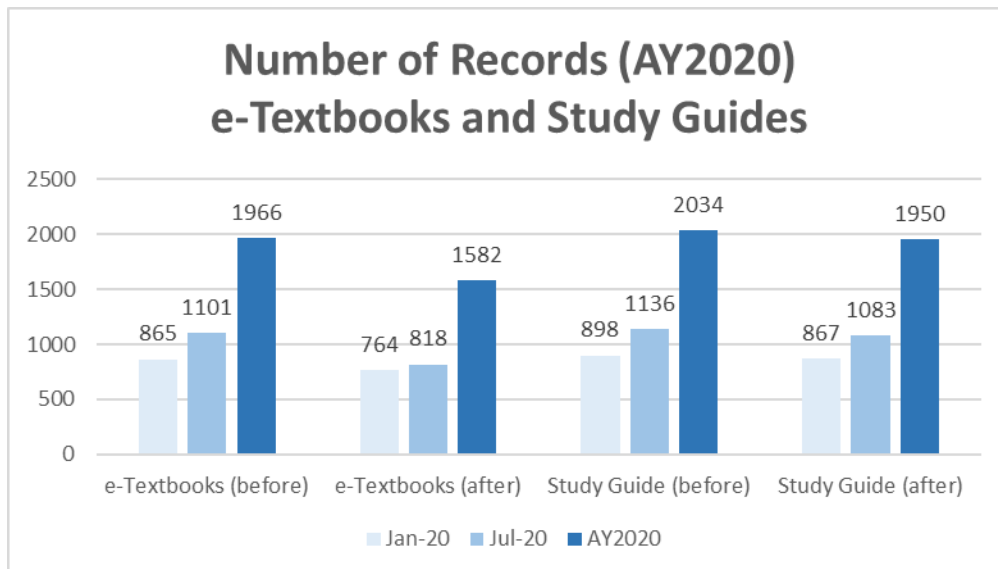


Figure 1. Number of Records for e-Textbooks and Study Guides

### Data Correlation

The first step in analyzing the merged data was to find out if there was correlation between “Total Page Views” versus “Final Rank Scores.” Figure 2 and 3 showed the corresponding scatterplots for e-textbooks and study guides, respectively.

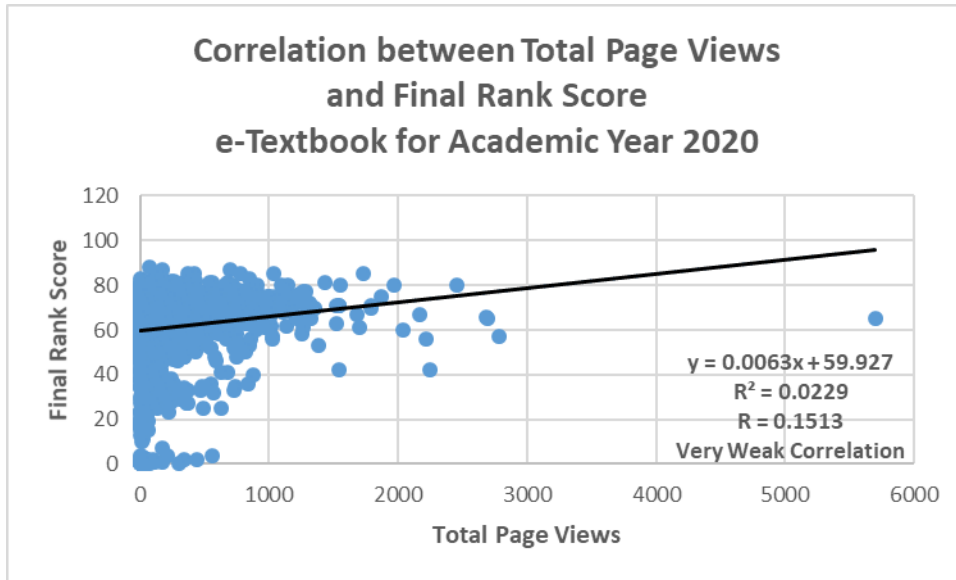


Figure 2. Scatterplot of Total Page Views versus Final Rank Scores for e-Textbooks

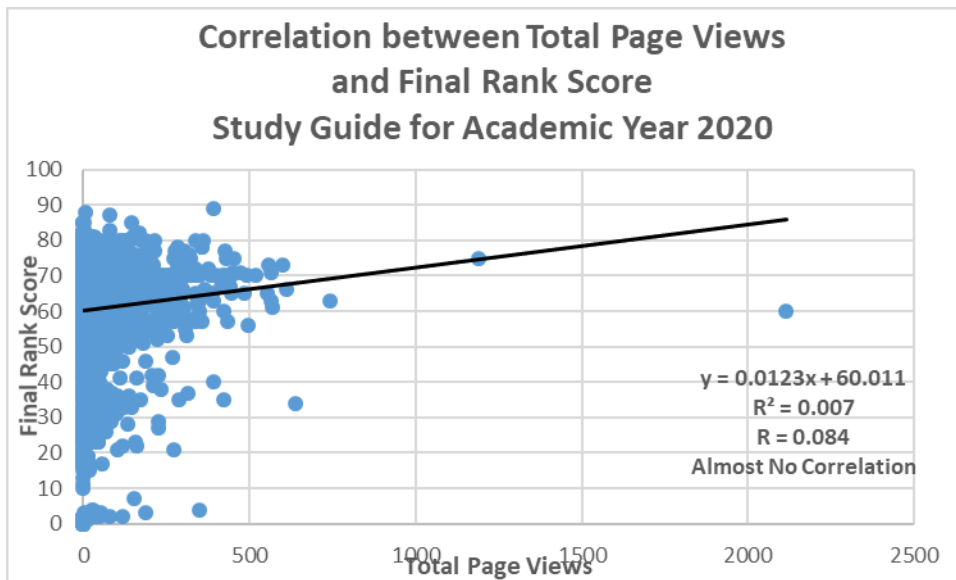


Figure 3. Scatterplot of Total Page Views versus Final Rank Scores for Study Guides

For e-textbooks, the correlation coefficient,  $r$  (0.151), indicated that it had “Very Weak Relationship” between the two variables in a positive manner. However, for study guides, the correlation coefficient,  $r$  (0.084), indicated that it had “Almost No Relationship” between the two variables but the trend was positive. The next step was to perform statistics tests to answer the following question:

Was there a difference in the mean or median of the “Total Page Views” when it was compared according to the following categories:

1. Students who passed compared to those who failed in the 10 online courses; and

- Students who passed according to grade-bands compared those to those who failed in the 10 online courses

### Data Normality

Before applying statistics tests, it was necessary to find out whether the data came from a normal distribution. Graphically, the “Pass” and “Fail” data for both e-textbooks and study guides could be observed from the histograms and the Q-Q plots as shown in Appendix A and B. Diagrammatically, the data did not appear to be normal. The Komolgorov-Smirnov (K-S) Test (Ghasemi and Zahidaisl, 2012; Zaiontz, 2020) confirmed this observation.

Given that the data was not from a normal distribution, the parametric tests based on the Student’s t-Test and the use of Analysis of Variance (ANOVA) would not be applicable to test on the mean from the data. Instead, the non-parametric version, the Mann-Whitney U Tests (also known as the Wilcoxon Sum-Rank Test), was used (Sullivan, 2020; UWE, 2020) to test the median instead.

The descriptive statistics are shown in Tables 1 and 3 for e-textbook and study guides, respectively.

Table 1

Descriptive Statistics of Total Page Views for Pass and Fail – e-Textbooks

Semester	Total Page Views	N	Median	Mean	Standard Deviation	Minimum	Maximum
Jan20	Pass	687	72.0	203.3	376.4	0	5697
	Fail	77	40.0	108.5	160.2	0	739
Jul20	Pass	751	114.0	256.6	364.8	0	2784
	Fail	67	69.0	141.5	181.7	0	835
AY2020	Pass	1438	91.5	231.1	372.2	0	5697
	Fail	144	50.5	123.9	170.7	0	835

The Mann-Whitney U Test was used to test the medians between the two populations of “Total Page Views Pass” and “Total Page Views Fail.” It provided the following hypotheses:

- H0: The population medians are equal  
H1: The population medians are not equal

Applying it to research question (1), we have:

H0: There is no difference in the median scores for “Total Page Views Pass” when compared to “Total Page Views Fail” in the 10 online courses

H1: The median scores between “Total Page Views Pass” and “Total Page Views Fail” are not the same.

### e-Textbooks Non-Parametric Tests for Pass and Fail

As shown in Table 1 for AY2020, the median for “Total Page Views Pass” (Mdn = 91.5) was higher than those of “Total Page Views Fail” (Mdn = 50.5). The Mann-Whitney U test (see Table 2) indicated that this difference was statistically significant,  $U(N_{\text{Pass}} = 1438, N_{\text{Fail}} = 144) = 85980.5, z = -3.360, p\text{-value} (0.001) < 0.05$ , and there was evidence to reject H0 (medians are equal) in favour of H1 (medians are not equal). The median score for “Total Page Views Pass” was not the same when compared to the median score for “Total Page Views Fail” for

e-textbooks. There was statistical significance that students with a “Pass” grade read the e-textbooks more than those with a “Fail” grade.

Table 2

Mann-Whitney U Test for Total Page Views between Pass and Fail - e-Textbooks

	Pass		Fail		Mann-Whitney U Test			
	Mean Rank	N	Mean Rank	N	U	z	p-value	Decision
AY2020								
Total Page Views	803.7	1438	669.6	144	85980.5	-3.360	0.001	Reject H0

The significant level is 0.05 (two-tailed)

The descriptive statistics for the study guide and its Mann-Whitney U Test are shown in Tables 3 and 4, respectively.

Table 3

Descriptive Statistics of Total Page Views for Pass and Fail – Study Guides

Semester	Total Page Views	N	Median	Mean	Standard Deviation	Minimum	Maximum
Jan20	Pass	763	0.0	15.4	45.9	0	552
	Fail	104	0.0	12.4	66.2	0	638
Jul20	Pass	995	49.0	89.5	129.7	0	2115
	Fail	88	45.5	71.6	87.1	0	424
AY2020	Pass	1758	14.0	57.3	108.5	0	2115
	Fail	192	0.0	39.6	81.8	0	638

### Study Guide Non-Parametric Tests for Pass and Fail

Table 4

Mann-Whitney U Test for Total Page Views between Pass and Fail – Study Guides

	Pass		Fail		Mann-Whitney U Test			
	Mean Rank	N	Mean Rank	N	U	z	p-value	Decision
AY2020								
Total Page Views	991.9	1758	825.7	192	140011.0	-3.974	0.000	Reject H0

The significant level is 0.05 (two-tailed)

As shown in Table 3 for AY2020, the median for “Total Page Views Pass” (Mdn = 14.0) was higher than the median of “Total Page Views Fail” (Mdn = 0.0). The Mann-Whitney U test (see Table 4) indicated that there was a difference in the median scores between “Pass” and “Fail” and it was statistically significant,  $U(N_{\text{Pass}} = 1758, N_{\text{Fail}} = 192) = 140011.0, z = -3.974, p\text{-value} (0.000) < 0.05$ . There was evidence to reject H0 (medians are equal) in favour of H1 (medians are not equal), implying that there was statistical significance for students with a “Pass” grade reading the study guides when comparing with those with a “Fail” grade.

### e-Textbooks Non-Parametric Tests for Pass by Grade-bands and Fail

For research question (2), the Mann-Whitney U test was applied with the following hypotheses:

H0: There is no difference in the median scores for “Total Page Views A/B/C or D” when compared to “Total Page Views F” in the 10 online courses

H1: The median scores between “Total Page Views A/B/C or D” and “Total Page Views F” are not the same.

Table 5

Descriptive Statistics: Total Page Views by Grade-bands – e-Textbooks

AY2020	Total Page Views Grade-bands	N	Median	Mean	Standard Deviation	Minimum	Maximum
	A	223	175.0	333.8	408.7	0	2455
	B	894	94.0	228.9	373.9	0	5697
	C	264	44.0	158.8	306.1	0	2784
	D	57	56.0	199.8	393.7	0	2251
	F	144	50.5	123.9	170.7	0	835
	Total	1582	87.0	221.4	359.9	0	5697

Table 6

Mann-Whitney U Test: Total Page Views by Grade-bands Comparison for e-Textbooks

AY2020 Total Page Views	A/B/C or D		F		Mann-Whitney U Test			Decision
	Mean Rank	N	Mean Rank	N	U	z	p-value	
A v F	209.0	223	145.3	144	10489.5	-5.610	0.000	Reject H0
B v F	533.4	894	433.0	144	51909.0	-3.732	0.000	Reject H0
C v F	202.6	264	208.1	144	18497.0	-0.449	0.653	Do Not Reject H0
D v F	101.7	57	100.7	144	4063.0	-0.110	0.912	Do Not Reject H0

The significant level is 0.05 (two-tailed)

As Table 6 shown grade-bands “A” and “B” were significant and they indicated a rejection of H0 (i.e. the medians are not equal) while “C” and “D” were not significant (i.e. do not reject H0 – medians are the same) when comparing with “F,” for the e-textbooks.

### Study Guides Non-Parametric Tests for Pass by Grade-bands and Fail

Table 7

Descriptive Statistics: Total Page Views by Grade-bands for Study Guides

AY2020	Total Page Views Grade-bands	N	Median	Mean	Standard Deviation	Minimum	Maximum
	A	268	8.0	61.4	116.2	0	1191
	B	1075	15.0	61.2	117.3	0	2115
	C	343	15.0	45.8	74.0	0	495
	D	72	8.5	39.1	70.9	0	390
	F	192	0.0	39.6	81.8	0	638
	Total	1950	13.0	55.6	106.3	0	2115

Table 8

## Mann-Whitney U Test of Total Page Views by Grade-bands – Study Guides

AY2020 Total Page Views	A/B/C or D		F		Mann-Whitney U Test			Decision
	Mean Rank	N	Mean Rank	N	U	z	p-value	
A v F	245.5	268	209.5	192	21698.0	-2.979	0.003	Reject H0
B v F	651.9	1075	533.7	192	83933.0	-4.224	0.000	Reject H0
C v F	282.2	343	242.6	192	28057.0	-2.943	0.003	Reject H0
D v F	140.7	72	129.4	192	6323.0	-1.129	0.259	Do Not Reject H0

The significant level is 0.05 (two-tailed)

As shown in Table 8, “A”, “B” and “C” were significant and they indicated a rejection of H0 (i.e. the medians are not equal) while “D” was not significant (i.e. do not reject H0 – medians are the same) when comparing with “F,” for the study guides.

### CONCLUSION

This paper attempted to answer the following questions:

- Was there a correlation between students’ reading of the course materials and their performance in the 10 online courses?
- Was there evidence to indicate that students’ reading of the course materials was different between those who passed when compared to those who failed?
- Was there evidence to indicate that students’ reading of the course materials was different between those who passed by grade-bands when compared to those who failed?

In terms of correlation, the data indicated that there was very weak positive relationship,  $r$  (0.151), in e-textbooks and almost no relationship (positively),  $r$  (0.084), in study guides when comparing the students’ total page views and their performance in AY2020. Correlation refers to the relationship between two variables and e-textbook reading did have a very weak effect on performance but the results did not apply to the reading of the study guides. For question (b), there was evidence to indicate that students reading e-textbooks or study guides was significant: that the medians between those who passed compared to those who failed were not the same.

For question (c), there was evidence to indicate that students’ reading of e-textbooks or study guides had different medians between those with a grade-band of “A” or “B” when compared to “F.” The “A” or “B” students’ reading of e-textbooks or study guides were significant. When students were reading e-textbooks, there was no difference between grade-band “C” or “D” when compared to “F.” When students were reading study guides, there was evidence to indicate that a difference existed between those with “C” when compared to “F” but there was no difference between “D” and “F.” The findings for question (c) corresponded to a study that found higher engagement with e-texts resulted with higher grades and that “high-achieving students (A and B grades) made the majority of page views....averaging students (C grades) had substantively less page views....students who had an unsuccessful outcomes (D and F grades) had no activity.” (Abaci, Quick, & Morrone, 2017).

While the data had sufficient records from AY2020, there were outliers with records capturing zero page views (i.e. students not reading e-textbooks or study guides). Removing these data from the analysis, could we identify an alternate picture of readership and performance? Also, reading nine pages or less, for example, would not help a student’s learning. A decision based on a student’s reading of 10 or more pages should be defined instead.



Separately, students may choose to read the study guide in PDF format or from the SUSS Reader rather (i.e. non-VS platforms) than through the VS platform. No data would be available from non-VS platform. For institutions interested in getting insights on readership behaviour and performance and if they have data available on students' reading, they should find this paper relevant.

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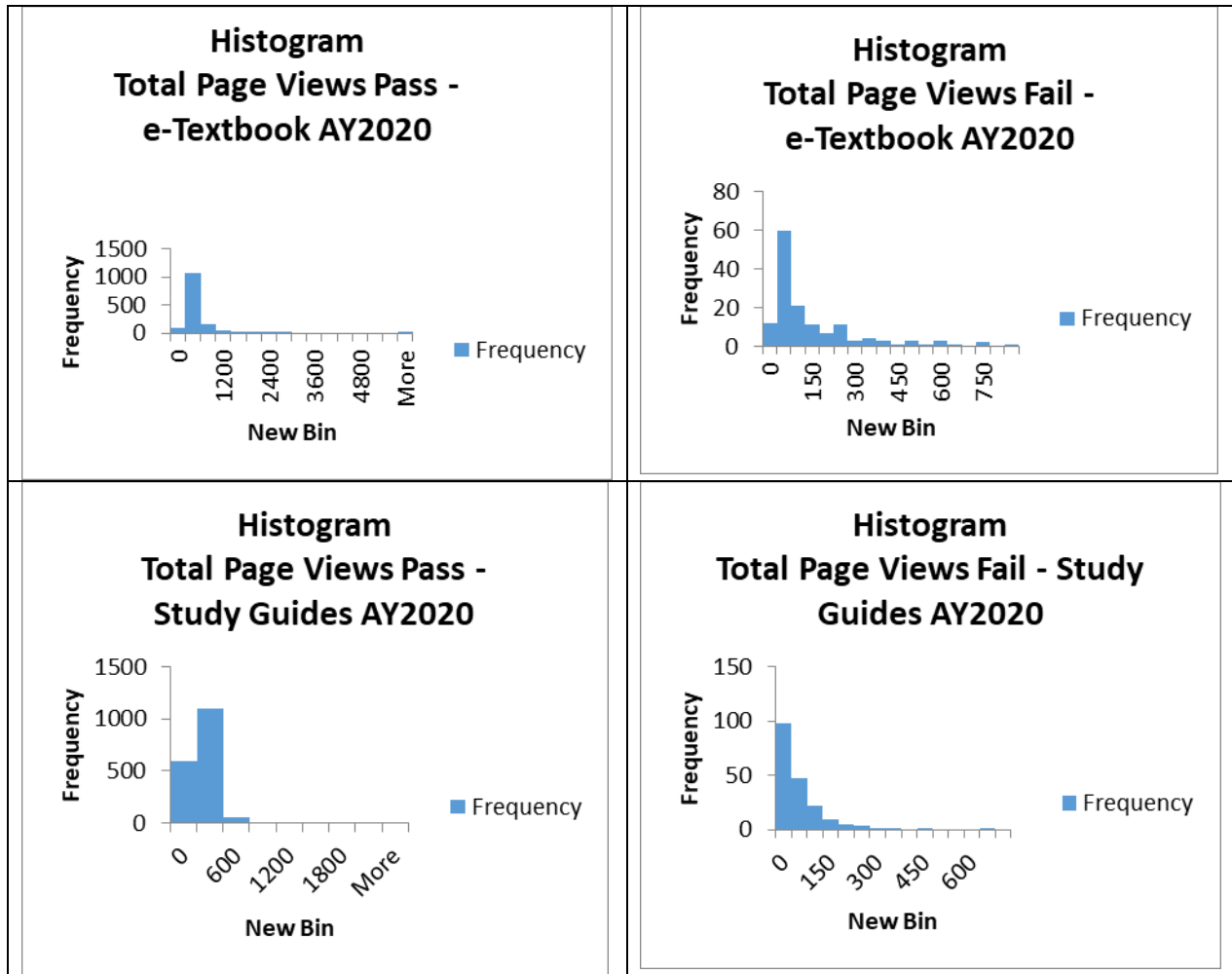
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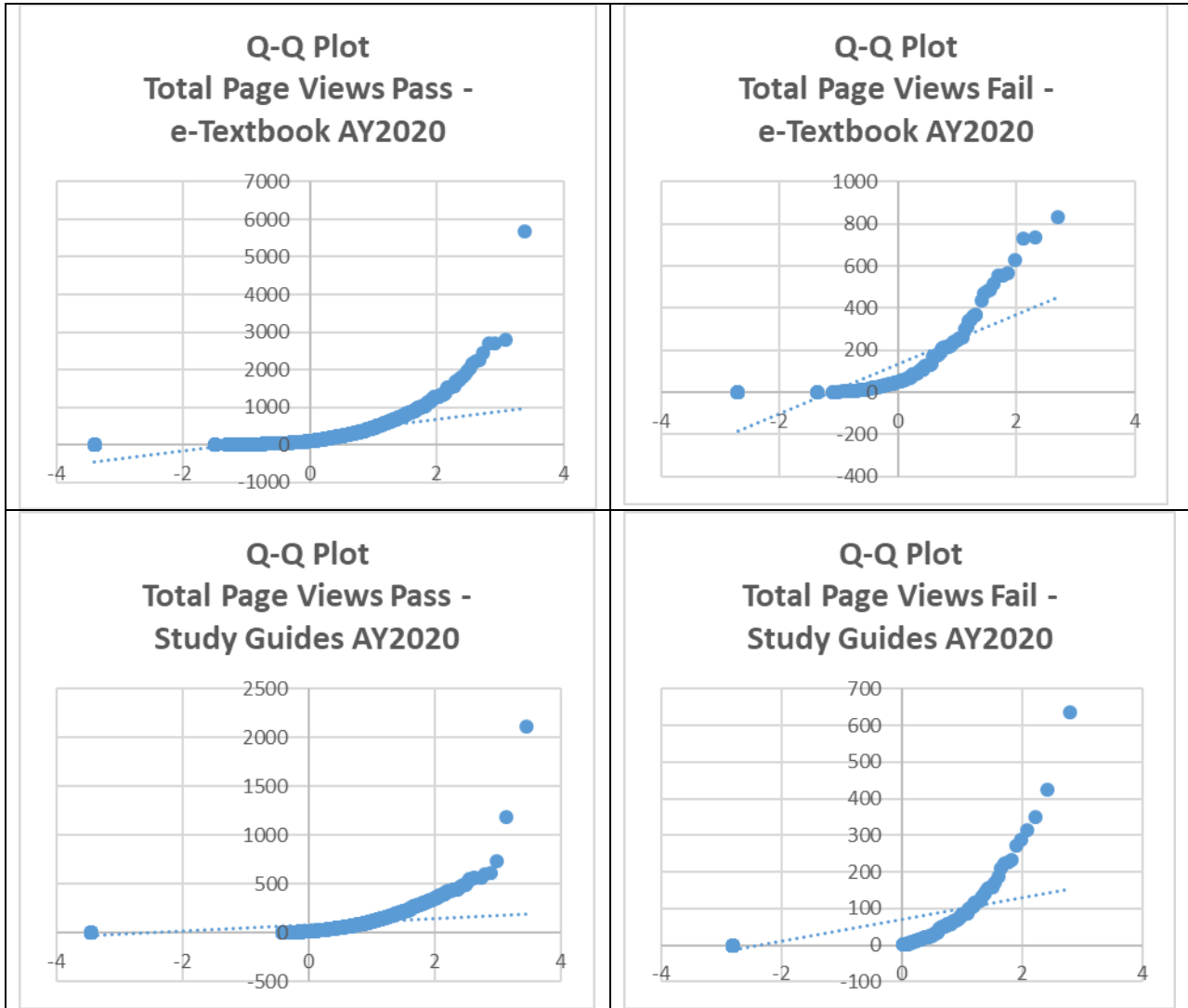
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APPENDIX A: Histograms for e-Textbook and Study Guide



APPENDIX B: QQ-Plots for e-Textbook and Study Guide



**APPENDIX C: 10 Online Courses in AY2020**

Online Course	Course Title
BUS103v	Organisational Behaviours
BUS105v	Statistics
BUS107v	Quantitative Methods
BUS354v	Customer Relations Management
BUS357v	Starting and Managing a Business*
BUS360v	Product Service Innovation and Design*
BUS362v	IT-Enabled Business Transformation
BUS363v	Total Quality Management*
BUS371v	Doing Business with China
MKT202v	Marketing Management

\*Presented in Jan20 semester only.