Teaching Money and Banking Online: A Comparison with the Traditional Approach

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Abstract

Money and Banking is a junior level course offered at most higher education institutions as part of an economics or business related curriculum. In 1999, the author prepared the course to be delivered over the Internet in an asynchronous manner, during a summer session. The course was offered again with this format during the fall of 2000, and a third time during the spring of 2001. In this paper the author compares the Web-based classes with the classes offered in the traditional classroom format in terms of student performance and students' perception of the course. In general he finds no significant differences, but the evidence seems to indicate that students preferred the online format during the period under analysis. (*JEL* A22)

Introduction

The use of technology in higher education has increased tremendously in the past few years. College instructors who traditionally concerned themselves only with course content now have the additional challenge of having to familiarize themselves with an ever-increasing number of technological innovations that threaten to revolutionize delivery modes. Among these innovations, the Internet, with its immense potential, has a special place. According to a recent survey, 42.7 percent of college courses now use Web resources as a component of the syllabus, as compared with 10.9 percent in 1995, and almost one-third of all college courses have a Web page, up from 9.2 percent in 1996 (Green, 2001, p.3).

The purpose of this paper is to present the author's experience with the online delivery of an upper level economics course. It will start with some background information dealing with institutional and curricular issues, and then it will present the results obtained by two groups of students that enrolled in the course in two different time frames; then it will compare those results with the ones obtained by students enrolled in the same course when it was offered with the traditional classroom delivery mode. Some preliminary conclusions will be presented at the end of the paper.

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The author thanks two anonymous referees for helpful comments. The author wishes to thank Prof. Marvin Wolfmeyer of the Business Administration Department, Winona State University for assistance with the statistical analysis.

Background

Money and Banking is a junior level course offered by the Department of Economics and Finance of Winona State University, one of the four-year institutions in the Minnesota State Colleges and Universities System. It is a required course for economics majors and minors and an elective course for other business related majors and for a few other majors outside of the College of Business. One section of this course is offered every term, and that section has been part of the author's teaching load for the past five years.

Winona State is very interested in the use of technology in higher education. In the fall of 2000, it became a "laptop university." After running pilot programs in different academic departments, the decision was made to ask every student to lease a laptop computer, through an agreement first with IBM and currently with Gateway. Each faculty member is provided with a similar machine and with appropriate software. Besides, a number of grants are offered to faculty to discover ways to enhance course delivery with the use of technology. One such grant is offered in the form of "summer venture funds" that faculty members can use to design new courses or introduce innovations in the way courses are delivered. Summer venture funds were awarded to the author in 1999 to develop a Web-based Money and Banking course, to be delivered during the summer that year. Money and Banking was in fact offered with this format during the second summer session of 1999, which ran from July 12 to August 13 and was offered again during the fall semester of 2000 and a third time during the spring semester of 2001.

The Experiment

The idea that the traditional lecture delivery is rapidly becoming a thing of the past has been repeatedly mentioned on our campus for some time now. One of the main purposes of this experiment, then, was to see if Internet-based delivery would be a viable alternative to the traditional delivery in terms of students' acceptance and performance. There were other reasons to offer the class with this format of practical importance to some students, such as time and space flexibility. Individuals interested in taking the class would not have to be on campus and would not have to log on to the course site at a certain time. During the summer offering, six students out of 26 were not residing in Winona. Five of them were in other cities in Minnesota, and one of them was in Milwaukee, Wisconsin. During the fall semester, most students were on campus taking other courses; only two of them resided in Rochester, where Winona State has a satellite campus. During the spring semester of 2001, all enrolled students were residents of Winona.

By design, the course was to have the same content as the classroom version, the same textbook would be used, and course policies would be essentially the same. Communication would take place mainly through e-mail, although students could stop by the instructor's office during announced office hours. Assignments would be submitted through e-mail, unless they involved graphics. If graphics were involved, students could submit assignments through e-mail attachments, fax, or regular mail or could drop them at the instructor's office. Since no classroom instruction was to take place, course materials were developed to take the place of lectures and were posted on the Web. The course would use asynchronous instruction, which is the primary mode of instructional delivery for distance education courses (Boettcher, 2000, p. 37). Students were allowed to ask questions any time, by any means.

Evaluation was done on the basis of assignments, exams, and a team project. A calendar that students were to strictly follow was posted at the beginning of the semester. The first time the course was offered with this format, all exams, three "midterms" and the final, were the "take home" type. They would be posted in the morning of the announced date, and students had to turn in their answers by midnight the same day. When the course was offered during the fall semester

of 2000, the first and final exams were given as in-class exams. All exams were given in the classroom during the spring semester of 2001. The gradual shift from online to in-class format was done to eliminate perceptions of difference in evaluation standards. The team project required students to submit a proposal, an initial outline and literature review, a final outline with specific bibliographic sources for each point of the outline, a first draft, and a final draft. The instructor provided timely feedback in all cases, except in the case of the final draft, which was graded following posted guidelines.

Class Statistics

Table 1 shows the number of students, grade distribution, and GPA of four Money and Banking classes taught during summer sessions between 1997 and 2000. They were all taught in a five-week period, during the second session (SS2) of those summers. Three of those courses were delivered in the traditional way, and one was delivered over the Internet during the 1999 second summer session. The three courses delivered traditionally were similar in terms of content, textbook, evaluation, and number of hours of classroom contact. The online course had the same content and textbook, but there was no classroom contact. Evaluation was done through assignments, exams, and a term paper as well. Assignments and exams were submitted through e-mail and other means, and students had to submit a hard copy of the term paper at the end of the session.

TABLE 1. GRADE COMPARISON: THREE TRADITIONAL, AND ONE ONLINE (99)
MONEY AND BANKING CLASSES OFFERED DURING SUMMER TERMS

Grades	97 SS2		98 SS2		99 SS2		00 SS2	
	#	%	#	%	#	%	#	%
A	2	16.67	4	30.77	6	23.08	2	28.57
B	5	41.67	4	30.77	12	46.15	1	14.29
C	5	41.66	5	38.46	6	23.08	2	28.57
D	0	0.00	0	0.00	2	7.69	2	28.57
F	0	0.00	0	0.00	0	0.00	0	0.00
Totals	12	100.00	13	100.00	26	100.00	7	100.00
GPA		2.75		2.92		2.85		2.43
St. Dev.		0.75		0.86		0.88		1.27

The grade point average (GPA) fluctuated between 2.43 and 2.92. The average GPA for the three traditional classes was 2.70, and the GPA of the online class was 2.85. No students in the four classes failed, and only two online students and two traditional students earned Ds during the summer of 1999 and the summer of 2000. The percentage of Ds seems to be unusually high for the "00 SS2" class. This may be related to the small number of students (seven) taking the class during that period. The grade dispersion, as measured by the standard deviation, was also high for this particular class. The percentage of students getting "good" grades (Bs and As) is higher in the case of the online class. Additionally, this class was, by far, the largest of all the summer classes included in this analysis.

Although the time framework is supposed to be the same during the summer than during a regular semester in terms of hours of classroom contact, during the fall and spring semester students take a class over a 15-week period, as compared with a five-week period during the summer. It is clear that from a student's perspective the summer session appears to be "too short." Very likely, this is not only a matter of perception. During the summer there is less time to prepare for exams and less time to turn in assignments, proposals, and paper drafts. The differences between the two terms are even more pronounced in the case of courses offered online.

TABLE 2. GRADE COMPARISON: THREE TRADITIONAL, AND TWO ONLINE (00 AND 01) MONEY AND BANKING CLASSES OFFERED DURING REGULAR SEMESTER TERMS

Grades	Fall 98		Spring 99		Fall 99		Fall 00		Spring 01	
	#	%	#	%	#	%	#	%	#	%
A	4	22.23	2	15.39	2	18.18	3	10.00	9	32.14
B	8	44.44	3	23.08	3	27.27	13	43.33	8	28.57
C	6	33.33	6	46.15	4	36.36	10	33.33	9	32.14
D	0	0.00	2	15.38	1	9.10	4	13.33	1	3.57
F	0	0.00	0	0.00	1	9.09	0	0.00	1	3.57
Totals	18	100.00	13	100.00	11	100.00	30	100.00	28	100.00
GPA		2.89		2.38		2.36		2.50		2.82
St. Dev.		0.76		0.96		1.21		0.86		1.06

To avoid the comparison between courses offered in periods of different lengths, Table 2 presents statistics for five classes that took Money and Banking during regular 15-week semesters. Two of those classes took the course online, and the other three took it with the regular format. The "blackboard" course management system was used in all classes.

Grade point averages fluctuated between 2.36 and 2.89. Both the lowest and highest averages were obtained by classes taking the course with the traditional format. The average obtained by the classes that took the course online fell between those two values. A higher percentage of students got As in one of the courses offered with the online format. The percentage of students getting low grades (D and F) was consistently low. Failing grades were given only on one occasion, and, on the other hand, there was a traditional class in which all grades given were C or above. As in the case of the courses offered during the summer, the number of students enrolled in the online classes was substantially higher.

A final grade comparison between all students who took the course in the classroom format and all the students who took the course online is done in Table 3. The results of all the classes mentioned before, six traditional and three online, are included in this table. The main difference between the two grade distributions seems to be the higher frequency of good grades, As and Bs, among students in the online classes. In the traditional classes Cs are more frequent. Low grades (D or less) were obtained by a higher percentage of students who took the class online as well (9.52 vs. 8.11). However, no failing grades were given to students taking the class online. Remarkably, the grade point averages of both groups of students turned out to be very close (2.71 for the online students and 2.66 for the traditional ones), and the grade dispersion very similar.

As the online course was developed, the author proposed to offer students two advantages: one, the explanations normally given during the course of a lecture would be available to students, and they would have repeated access to them; and two, students would not have to log on to the

class site at any particular time, but whenever their schedules allowed them to do it. It was assumed that the possibility of asking questions using e-mail or the telephone was a good substitute for the possibility of asking questions during a lecture delivery. The evaluation scheme was considered absolutely neutral in the case of assignments and the research paper, which accounted for 60 percent of the grade. In the case of exams, though, a case could be made for the non-neutrality of this evaluation instrument. Traditional students had to take in-class closed-book exams, after listening to classroom lectures and explanations. Students enrolled in the online classes took all take-home exams the first time the class was offered with this format during the summer of 1999, two take-home exams out of four during the fall of 2000, and all in-class exams during the spring of 2001. On the other hand, online students did not have the benefit of "live" explanations by the instructor. As mentioned before, the shift to in-class exams was implemented to avoid the perception of differences in evaluation standards.

TABLE 3. GRADE COMPARISON: SIX TRADITIONAL, AND THREE ONLINE MONEY AND BANKING CLASSES

Grades	Traditional		Online	
	#	%	#	%
A	16	21.62	18	21.43
B	24	32.43	33	39.28
C	28	37.83	25	29.76
D	5	6.76	7	8.76
F	1	1.35	1	1.19
Totals	74	100.00	84	100.00
GPA		2.66		2.71
St. Dev.		0.94		0.94

Analysis

Non-neutrality of exams would have been reflected in significantly higher grades for the advantaged group of students, whichever that might have been. The previous analysis seems to reveal a higher dispersion of grades in the online classes. Even though the standard deviations of the two grade distributions are virtually identical, as indicated in Table 3, there is a higher percentage of both high grades (As and Bs) and low grades (Ds and Fs) among online students.

To investigate the possibility of significant differences between the two grade distributions, a formal comparison of the two populations, traditional students and online students, was done using three statistical tests. The first one was a Z-test to test the difference in population means. The central limit theorem states that the difference in two sample means is normally distributed for large sample sizes ($n \geq 30$) regardless of the shape of the populations. The null hypothesis for this case would be:

$$H_0 : \mu_1 - \mu_2 = 0$$

and the alternative hypothesis,

$$H_1 : \mu_1 - \mu_2 \neq 0,$$

where μ_1 and μ_2 are the means of the respective populations. Traditional students are considered to be a sample from population one, and online students from population two. For α.= 0.05, the critical value for this two-tailed test is

$$Z_{\alpha/2} = \pm 1.96.$$

On the other hand, the calculated Z value is -0.35, and therefore the null hypothesis cannot be rejected. There seems to be no difference between the means of the two populations. Further details on this test and other tests are given in Appendix A.

The chi-square goodness-of-fit test compares the expected or theoretical frequencies of categories from a population distribution to the observed or actual frequencies from a distribution to determine if there is a difference between what was expected and what was observed. This nonparametric test was applied to the grade distributions under analysis considering the traditional grade frequencies as the expected frequencies and the online grade distribution frequencies as the observed ones. The hypotheses in this case are:

H_0: The observed distribution is the same as the expected distribution.
H_1: The observed distribution is not the same as the expected distribution.

For α = 0.05 and 4 degrees of freedom, the critical chi-square value is

$$\chi^2_{.05,4} = 9.49,$$

whereas the observed value is 2.99. Since this value falls outside the rejection region, H_0 cannot be rejected. See Appendix A for a more detailed description of this test.

Another test performed was the Mann-Whitney *U* test. This test is used when the assumption of a normally distributed population is invalid or if the data are only ordinal in measurement and can further support the results of the previous tests. The two-tailed hypotheses being tested with the Mann-Whitney *U* are:

H_0: The two populations are identical.
H_1: The two populations are not identical.

For α = 0.05 the critical value Z is ± 1.96. The observed value of Z is -1.44, which is outside the rejection region, and therefore H_0 cannot be rejected. (See Appendix A.)

The results of the three statistical tests indicate, then, that the two populations, traditional and online students, are probably similar in terms of the grades obtained in Money and Banking. However, there is still the possibility that exam results might not be comparable. As indicated above, online students took half of their exams as take home exams, whereas the traditional students had to take all in-class closed book exams. Table 4 presents the grade distribution after exam scores have been eliminated. The grades in the table represent 60 percent of the total grade.

The same statistical tests were run for these grade distributions, but similar results were obtained: The null hypothesis could not be rejected at the 95 percent confidence level in any case. No significant disparities in grades were found.

TABLE 4. GRADE COMPARISON: SIX TRADITIONAL AND THREE ONLINE MONEY AND BANKING CLASSES.TEST SCORES EXCLUDED.

Grades	Traditional		Online	
	#	%	#	%
A	13	17.57	19	22.62
B	25	33.78	26	30.95
C	24	32.43	19	22.62
D	12	16.22	13	15.48
F	0	0.00	7	8.33
Totals	74	100.00	84	100.00
GPA		2.53		2.44
St. Dev.		0.97		1.24

At this point, then, it seems that there is no significant difference in the performance of traditional students as compared with online students. A pertinent question is: Was this result to be expected? To be able to answer this question, we need to consider the background of both types of students. If both groups of students have similar background in terms of nationality, gender, ethnic group, age, and, especially, cumulative grade point average, then a similar performance would support the neutrality of the delivery mode.

Exhibit 1 contains information on nationality, gender, ethnic group, age, and cumulative grade point average for both groups of students. The percentage of foreign students enrolled in the online classes is almost twice as large as the percentage enrolled in traditional classes. Online classes attracted almost the same number of male and female students, whereas the traditional classes have a clear majority of male students. The percentage of minority students is similar in both traditional and online classes, and the online classes seem to attract older students: Approximately 13 percent of the online students were 31 or older. However, the percentage of students 25 and older is not that different, 17.57 percent in the traditional classes and 20.23 percent in the online classes. Have these differences had an impact on academic performance? A comparison of the distribution of cumulative grade point averages of traditional students right before they took Money and Banking with that of online students, in terms of the same statistical tests, reveals no significant difference between the two grade distributions. Again, the reader is referred to Appendix A for a more detailed description of the tests.

EXHIBIT 1. STUDENTS' BACKGROUND

Nationality

	Traditional		Online	
	Number	Percentage	Number	Percentage
American	69	93	73	87
Foreign	5	7	11	13
Total	74	100.00	84	100.00

Grade Point Average

	Traditional		Online	
Grades	Number	Percentage	Number	Percentage
A	1	1.35	0	0.00
B	34	45.95	43	51.19
C	38	51.35	38	45.24
D	1	1.35	3	3.57
F	0	0.00	0	0.00
Total	74	100.00	84	100.00
GPA		2.47		2.48
St. Dev.		0.55		0.57

Age

	Traditional		Online	
Age	Number	Percentage	Number	Percentage
20	7	9.46	6	7.14
21	16	21.62	19	22.62
22	25	33.78	22	26.19
23	11	14.86	16	19.05
24	2	2.70	4	4.76
25-30	13	17.57	6	7.14
31-40	0	0.00	8	9.52
41-50	0	0.00	3	3.57
Total	74	100.00	84	100.00
GPA		22.74		24.52
St. Dev.		2.34		6.30

Gender

	Traditional		Online	
	Number	Percentage	Number	Percentage
Male	47	64	42	50
Female	26	35	41	49
NA	1	1	1	1
Total	74	100.00	84	100.00

Ethnic Group

	Traditional		Online	
	Number	Percentage	Number	Percentage
Caucasian	55	74.32	63	75.00
African American	1	1.35	3	3.57
Asian American	11	14.86	8	9.52
Hispanic American	1	1.35	1	1.19
NA	6	8.11	9	10.71
Total	74	100.00	84	100.00

Students' Opinions

The students who took the online version of the course were asked at the end of the term what they liked and disliked about the class. The summer class was asked to e-mail answers to the department's secretary. The other two classes received a questionnaire that was administered in such a way that student privacy was insured. Students did not have to identify themselves in either

case, and they understood that the instructor would read their answers after final grades were given. The answers to a few key questions are highlighted below.

Eleven students from the summer class (out of 26) and all students from the other classes answered the question "What did you especially like about this experience?" Here is a summary of their answers:

Time flexibility	28
Location flexibility	12
Availability of materials	10
Variety of assignments	6
New learning style	4
Using the web	4
Instructor availability	3
Instructor invisibility	1
No answer	1

The most common answer related to the time flexibility the online format allowed them to have. Another feature students liked was the fact that they did not have to be on campus for instruction. Other answers given were the possibility of going over the materials as many times as needed, the variety of assignments, the new learning style, the Web class design, using Web searches and e-mail, how helpful the instructor was in answering questions, and not having to see the instructor so often. A related question asked was: "Was this course what you expected it to be?" All 69 students answered this question in the negative.

The question "What did you especially dislike about this experience?" was also asked. Eleven students that were part of the summer class and all students that were part of the regular semester classes answered this question. Out of 84 students who took the online class, 69 gave the following responses:

Excessive work	22
No classroom explanations	10
No effective communication	5
Team projects	4
Unclear exams/assignments	1
Unclear expectations	1
Instructor's attitude	1
Instructor's time commitment	1
Insufficient feedback	1
No answer	23

On a scale of 1 to 5, worst to best, the instructor received a 3.8 "grade" from the online students. The traditional students gave the instructor a grade of 4.

Even though no questions were asked concerning specific topics within the course, it was obvious that students found topics with institutional content easier to handle. Students never asked the instructor questions about the nature or measurement of monetary aggregates or about the role of financial institutions and the central bank. The majority of the questions posed to the instructor related to the analytical content of the course. Issues related to macroeconomic analysis using the IS-LM model and the conceptual and computational aspects of the money supply process seem to have been more challenging to online students. Classroom explanations might be better for these types of topics.

Conclusion

Although the experience with online delivery of the Money and Banking class is rather limited, there are some indications that it can be an acceptable alternative to the traditional classroom approach. The performance of students enrolled in three online classes, as measured by final grades, is not significantly different from the performance of students who took the class in the traditional format, during the period analyzed. In fact, the grade point average of the online classes is close to that of the classes offered with the traditional format, and the grade dispersion is nearly identical. Formal statistical tests reveal no significant difference in the grades obtained by the two student populations. Additionally, the two groups of students have similar cumulative GPA distributions. Grade point averages were computed and analyzed right before students enrolled in Money and Banking.

From the students' perspective, the most attractive feature of the online delivery mode is the time flexibility that an asynchronous Web-based class allows them to have. The possibility of not having to be on campus is also attractive to some students. On the other hand, a small number of students missed the classroom explanations or lectures and an even smaller number of them complained of the lack of effective communication. It is clear, then, that not every student will readily embrace online delivery. At the same time, the average class size increased substantially when Money and Banking was offered online. It is too early to say if this will become a trend indicative of the preferences of the student body at large.

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Appendix A

1. Test of hypothesis about the difference in two population means using data for large samples. According to the central limit theorem, the difference in two sample means ($M_1 - M_2$) normally distributed for large sample sizes $n \geq 30$, regardless of the shape of the populations. It can also be shown that

$$\mu_{M1-M2} = \mu_1 - \mu_2$$
$$\sigma_{M1-M2} = \text{SQRT}\ (\sigma^2_1/n_1 + \sigma^2_2/n_2)$$

where the μs are the means of the respective populations and σ, σ^2 are the standard deviation, variance of the respective populations as well. These expressions lead to a Z formula for the difference in two sample means:

$$Z = (M_1 - M_2) - (\mu_1 - \mu_2)/\ \text{SQRT}\ (\sigma^2_1/n_1 + \sigma^2_2/n_2).$$

Z, of course, is a score from a normal distribution with a mean of 0 and a standard deviation of 1.

The hypotheses to be tested are

$$H_0 : \mu_1 - \mu_2 = 0$$

and

$$H_1 : \mu_1 - \mu_2 \neq 0.$$

The decision rule is:

$$\text{If } -Z_{\alpha/2} > Z_c > Z_{\alpha/2}, \text{ reject } H_0.$$
$$\text{If } -Z_{\alpha/2} < Z_c < Z_{\alpha/2}, \text{ do not reject } H_0$$

Z_c is the score computed from the data and $Z_{\alpha/2}$ is the critical value for a two-tailed with a level of significance α. The level of significance is the probability of committing a so-called Type I error, i.e., the probability of rejecting a true null hypothesis.

1.1 Comparison between the Money and Banking grades of traditional students and online students in terms of the means (GPAs).

$$Z_c = [(2.66\text{-}2.71) - 0]/\text{SQRT}\ (0.88/74 + 0.88/84) = \text{-}0.347.$$

For $\alpha = 0.05$, $Z_{\alpha/2} = \pm 1.96$, non-rejection region is between -1.96 and +1.96. Therefore, the null hypothesis cannot be rejected.

1.2 Comparison between the Money and Banking grades of traditional students and online students in terms of the means (GPAs) excluding test scores.

$$Z_c = [(2.58 - 2.44) - 0]/\text{SQRT}\ (0.94/74 + 1.53/84) = 0.493$$

Again, the computed Z score falls in the non-rejection region and H_0 cannot be rejected.

1.3 Comparison between cumulative grades of traditional students and online students in terms of the means (GPAs)

$$Z_c = [(2.47 - 2.48) - 0]/\text{SQRT}\ (0.31/74 + 0.32/84) = -0.036$$

The calculated Z score falls once more in the non-rejection region.

2. The chi-square goodness-of-fit test. This test compares the expected, or theoretical frequencies of categories from a population distribution to the observed or actual frequencies of a distribution to determine if there is a difference between what was expected and what was observed. The statistic used is:

$$\chi^2 = \Sigma\ [(f_a - f_e)/\ f_e]$$

$$df = k - 1 - c$$

where:

f_a = frequency of observed values
f_e = frequency of expected values
df = degrees of freedom
k = number of categories
c = number of parameters being estimated from the sample data

The hypotheses to be tested are:

H_0: The observed distribution is the same as the expected distribution
H_1: The observed distribution is not the same as the expected distribution
This is a one-tailed test in which the decision rule is:

If $\chi^2_{\alpha,df} < \chi^2_c$, reject H_0
If $\chi^2_{\alpha,df} > \chi^2_c$, H_0 cannot be rejected.

2.1 Comparison between the Money and Banking grade distribution of traditional and online students. Since traditional students are the norm, their grade frequencies are considered the theoretical or expected frequencies. The value of the statistic can be computed from the data as follows:

	E[proportion]	f_a	f_e	$(f_a-f_e)^2/f_e$
Grades	Traditional	Online		
A	.2162	18	18.161	0.001
B	.3243	33	27.241	1.217
C	.3783	25	31.777	1.445
D	.0676	7	5.678	0.307
F	.0135	1	1.134	0.016
				2.986

On the other hand, with $\alpha = 0.05$ and 4 degrees of freedom, since there are five categories, from A to F,

$$\chi^2_{.05,4} = 9.488 > 2.986,$$

and the null hypothesis cannot be rejected.

2.2 Comparison between the Money and Banking grade distribution of traditional and online students, excluding exam scores. For this case, the computations are:

	E[proportion]	f_a	f_e	$(f_a-f_e)^2/f_e$
Grades	Traditional	Online		
A	.1757	19	14.757	1.220
B	.3378	26	28.378	0.199
C	.3243	19	27.243	2.494
D	.1622	13	13.622	0.028
F	.0000	7	0.000	
				3.942

The critical value is again greater than the calculated value and the null hypothesis cannot be rejected.

2.3 Comparison between the cumulative grade distribution before Money and Banking of traditional and online students. In this case the computations are:

	E[proportion]	f_a	f_e	$(f_a-f_e)^2/f_e$
Grades	Traditional	Online		
A	0.0135	0	1.135	1.135
B	0.4595	43	38.595	0.503
C	0.5135	38	43.135	0.611
D	0.0135	3	1.135	3.064
				5.313

Once more the critical value is greater than the calculated score and the null hypothesis cannot be rejected.

3. The Mann-Whitney U Test. This test is a non-parametric test used to compare the means of two independent populations. Two assumptions underlie the use of the Mann-Whitney *U* test: 1) The samples are independent; and 2) The level of data is at least ordinal. The two-tailed hypotheses that can be tested with this test are:

H_0: The two populations are identical.
H_1: The two populations are not identical.

The *U* statistics is computed by first arbitrarily designating the two samples as group 1 and group 2. Then the data from the two groups are combined into one group, with each data value retaining an identifier of its original group. The pooled values are next ranked

from 1 to n, with the smallest value being assigned a rank 1. In case of values that are the same, an average rank is assigned to each of them. The sum of the ranks of values from group 1 is computed and designated as W_1 and the sum of the ranks of values from group 2 is designated as W_2. The *U* is computed as follows:

$$U = (n_1)(n_2) + [n_1(n_1 + 1)/2] - W_1,$$

and

$$\mu_U = (n_1)(n_2)/2, \ \sigma_U = \text{SQRT}\{[n_1 \bullet n_2(n_1 + n_2 + 1)]/12\}$$

$$Z = (U - \mu_U)/ \sigma_U.$$

For a given α the decision rule is:

If $-Z_{\alpha/2} > Z_c > Z_{\alpha/2}$, Reject H_0.
If $-Z_{\alpha/2} < Z_c < Z_{\alpha/2}$, do not reject H_0.

3.1 Comparison between the Money and Banking grades of traditional students and online students in terms of the means (GPAs). Considering traditional students group 1, the sum of the ranks of values (grades) is

$$W_1 = 5928$$

and

$$U = (74)(84) + [74(74 + 1)/2] - 5928 = 3063$$
$$\mu_U = (74)(84)/2 = 3038$$
$$\sigma_U = \text{SQRT}\{[74 \bullet 84(74 + 84 + 1)]/12\} = 31.313$$
$$Z_c = (3063 - 3108)/31.313 = -1.437.$$

For $\alpha = 0.05$, the critical value of this two-tailed test is $Z_{\alpha/2} = \pm 1.96$, and therefore the null hypothesis cannot be rejected.

3.2 Comparison between the Money and Banking grade distribution of traditional and online students, excluding exam scores. Again, considering traditional students group 1, the sum of the ranks of values (grades) is

$$W_1 = 5913$$

and

$$U = (74)(84) + [74(74 + 1)/2] - 5913 = 3078$$
$$\mu_U = (74)(84)/2 = 3038$$
$$\sigma_U = \text{SQRT}\{[74 \bullet 84(74 + 84 + 1)]/12\} = 286.99$$
$$Z_c = (3063 - 3108)/31.313 = -0.105.$$

The null hypothesis cannot be rejected.

3.3 Comparison between the cumulative grade distribution before Money and Banking of traditional and online students. The sum of the ranks of values from group 1(traditional) is

$$W_1 = 5822$$

and

$$U = (74)(84) + [74(74 + 1)/2] - 5822 = 3169$$
$$\mu_U = (74)(84)/2 = 3108$$
$$\sigma_U = \text{SQRT}\{[74 \bullet 84(74 + 84 + 1)]/12\} = 286.99$$
$$Z_c = (3222 - 3108)/31.313 = 0.213$$

For $\alpha = 0.05$, the critical value of this two-tailed test is $Z_{\alpha/2} = \pm 1.96$, and therefore the null hypothesis cannot be rejected.