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ACEJMC Assessment in a Smaller Program: Addressing Statistical Learning in a Mass Communication Research Course

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The current study investigates the curriculum strategy chosen by one smaller program to address statistical learning. Changes were implemented addressing basic numerical and basic statistical concepts within ACEJMC Standard Two. An exploratory math course that includes short instruction in statistics replaced intermediate algebra as the math requirement, stipulated as the pre- or co-requisite for the mass communication research course. An evaluation instrument was formulated to assess whether prior statistics instruction might be related to higher scores for a course embedded assessment within the research course. Prior math education, as indicated through students' math grades and their ACT/SAT scores, served as a numerical predictor of successful student performance with coursework that requires statistical proficiency. The results support previous studies that found journalism majors tend to score highest, on average, that women tend to outperform men, and that previous math grades and ACT scores tend to be moderate predictors of success.

Much attention has been devoted towards improving the quality of education that a student receives, particularly with respect to those competencies and skills that are widely accepted as essential to a successful career. Regardless of the student's career choice, the basic skills in English and mathematics taught at the secondary education level, as assessed through standardized tests such as the ACT and SAT, determine the entrance course for continued learning in those subjects at the higher education level. For instance, students pursuing a degree in the mass communication discipline are often required to take English courses at the freshman level before taking any courses within their major. English composition courses are prerequisites commonly identified as essential to learning the writing and editing skills of the journalism or public relations profession.

Exactly what type of math instruction should be required, however, and exactly which mathematics course should be the prerequisite is not as

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self evident or consistent within many mass communication programs. Administrators of smaller programs are tasked with selecting curriculum options that include courses that might best prepare their students for their future profession(s), while maintaining standards that meet certain assessment criteria. For those seeking national accreditation from the Accrediting Council on Education in Journalism and Mass Communications (ACEJMC), one objective involves statistical learning (Accrediting Council on Education in Journalism and Mass Communications, 2013).

The current study investigates the curriculum strategy chosen by one smaller program to address this issue, with changes implemented to address basic numerical and basic statistical concepts within ACEJMC Standard Two. An exploratory math course that includes short instruction in statistics replaced intermediate algebra as the math requirement, stipulated as the pre- or co-requisite for the mass communication research course.

Students' previous math education and their standardized math placement score (when available), along with their area of emphasis and gender, were comparatively analyzed against their scores on two graded items that require statistical expertise, embedded assessment administered during the research course. This assessment was performed at a southeastern university (total enrollment of about 8,600) with a mass communication program of approximately 230 students in 2015. The department offers three areas of emphasis for students: (1) broadcasting, (2) public relations, and (3) digital journalism. The data from this study was used as one way to provide evidence of compliance with two standards (#9 and #2) within an ACEJMC self-study report submitted for re-accreditation.

Literature Review

The ACEJMC has made two changes since 2000 that have significantly changed the accreditation process. In 2003 the older Standard Three (Cur-riculum) was integrated with the older Standard Five (Instruction/Evaluation), creating as newer Standard Two: Curriculum and Instruction. The newer Standard 9: Assessment of Learning Outcomes was (arguably) created to replace the "evaluation" portion of the older standard Five. The Accrediting Council has historically identified communication programs in noncompliance with this standard more than any other, since it was first applied to accreditation reviews in the 2005-2006 academic year (Accrediting Council on Education in Journalism and Mass Communications, 1996). ACEJMC has identified which schools, if any, were found in noncompliance for standards that underwent site review since 2008. Site visit reports of 166 programs reviewed between 2008 and 2014 found 35% in noncompliance for Standard Nine [see Table 1], with the assessment standard by far the most likely to be cited (58 of 107, 54%) for a school identified as having noncompliance (Noncompliance findings, 2014).

Standard 9: Assessment of Learning Outcomes

Seybert (2002) identifies assessment of student learning outcomes as a major issue in terms of accreditation that colleges and universities in the twenty-first century need to address (pp. 55, 62). Standard Nine: Assessment of Learning Outcomes is inherently linked to Standard Two: Curriculum and Instruction, which identifies targeted learning objectives Accrediting Council on Education in Journalism and Mass Communications, 2013). ACEJMC Standard Nine: Assessment of Learning Outcomes requires schools seeking accreditation to "regularly assess student learning and use results to improve curriculum" (Reinardy & Crawford, 2013, p. 339). Even administrators not seeking ACEJMC accreditation are cognizant of these considerations, as the schools themselves periodically undergo educational assessment, with reviews of each separate program contributing to such efforts.

Table 1
2008-2014 Programs Receiving Noncompliance, by Standard

ACEJMC Standard	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	6-yr Total
Standard 9 Assessment	13	12	16	8	4	5	58
Standard 3 Diversity	8	2	6	1	1	0	18
Standard 2 Curriculum	1	1	5	2	0	0	9
Other Six Standards	3	3	4	6	3	3	22
Total Noncompliance	**25**	**18**	**31**	**17**	**8**	**8**	**107**
Programs reviewed	30	34	35	26	18	23	166

Statistics as Often Overlooked

Dunwoody and Griffin (2013) have asserted that journalism schools should be "replete with numeracy and statistical instruction," while finding that many are not (p. 529). The ACEJMC added the ability to apply "statistical concepts" to Standard Two in 2005, requiring programs seeking accreditation/reaccreditation to include evidence of instruction in this area of mathematics. The Accrediting Council revised the curriculum requirements of Standard Two in 2009 to twelve professional values and competencies (Henderson & Christ, 2014, p. 232). The Henderson and Christ (2014) survey of JMC administrators (*N*=176) identified the top three most emphasized within current programs as writing, critical thinking, and technology in that order; no administrators chose statistics (numerical and statistical concepts) as one of their top three most emphasized, by far the "least popular" in this respect (p. 234). When asked which three competencies they thought were the most critical for students graduating in 2020, numerical and statistical concepts received only four votes (2.3%), remaining again at the bottom of the list (2014, p. 236).

Curriculum Standard and Mathematics

A study by Qian (2011) noted that statistics continues to be a "pervasively difficult subject" for college students, while citing "inconsistencies in their reasoning about the most 'elementary' concepts of measures of central tendency and spread" (p. 107) as evidence. Schield (2013) notes that journalists need to be aware that summary data can easily be manipulated and influenced by error, bias, or something as simple as choice of mean versus median reportage (p. 1008).

Many questions arise when contemplating how to address the statistics component within Standard Two: How many mathematics courses should a communications student be required to take? Should the mathematics general education requirement be adapted to include education in statistics? If so, should this course be a prerequisite course for the communication course that will include course embedded assessment (necessary for compliance with Standard Nine, for all values and competencies from Standard Two) that addresses the ability to apply statistical concepts? At what level (of learning) should statistical proficiency be assessed?

Statistics education regardless of discipline. Researchers in various disciplines have undertaken studies (e.g. Kaplan, 2006; Garfield & Gal, 1999) that have documented the growing importance in assessing statistical learning at the undergraduate level, with students majoring in mathematics, business, or the social sciences the primary target audience of documented research efforts. One area of concern relates to external validity of research, with Kaplan (2006) identifying a model of statistical proficiency that notes that conceptual understanding is integrally linked with statistical reasoning and procedural fluency, and that these are three of the five factors necessary to properly address real world problems from a statistical perspective (pp. 12-14). Another of the five aspects of that model is strategic competence. Expert knowledge or fluency is conditional, and without the ability to recognize meaningful patterns, statistical proficiency is not realized (Kaplan, 2006, p. 22).

Garfield and Ben-Zvi (2009) note that studies in statistics education have been performed primarily because statistical reasoning is used in them. Kaplan (2006) defined statistical reasoning as the "ability to make statistically valid conclusions, critique statistical arguments, and discuss the scope of the conclusions generated" (p. 32). For instance, the fact that a student has a calculator is insufficient, unless he/she can identify what is relevant to the solution (and what is not); otherwise, a student may invariably struggle to complete even the most basic statistical analysis, such as determining the mean, mode, or median of a simple distribution.

Garfield and Gal (1999) identified changes in statistics education assessment, noting that past courses consisted (primarily) of items that measure "mastery of skills, procedures, and vocabulary"(p. 7). As early as the start of the 21st century, however, standardized testing outside the classroom, such as the Advanced Placement Statistics Examination, included the detailed scoring of open-ended statistical problems. Assessment of learning retention is now mandated by accrediting agencies within the business discipline (i.e., Association to Advance Collegiate Schools of Business), with Berenson et al. (2008) asserting that students need to retain concepts rather than formulas and calculations. Business students are often required to develop an understanding of various measures such as "central tendency, coefficient of variation, margin of error, confidence intervals, and correlations"(Berenson et al., 2008, p. 60).

Gender as a determinant. A study by Tintle, Topliff, Vanderstoep, Holmes, and Swanson (2012) in statistics education asserts that retention (of information taught) is regarded as important in introductory statistics courses (p. 22). The Tintle et al. study employed experimental methods and found that females were more willing participants, percentage-wise, than their male counterparts. A study by Bridgeman and Wendler (1991) sampled first-year students from nine universities, while finding that the average grades of women were either equal or slightly higher than the men's average grades, that there was a gender difference with respect to course performance. This finding was not congruent with the average scores on the mathematical scale of the SAT, where men's average scores were higher than their female counterparts by a third of a standard deviation or more.

Statistics and Previous Mass Communication Studies

Area of emphasis as a determinant. Fullerton and Kendrick (2013) note that most advertising students are required to take some form of math course with statistics because of industry demands that include "basic analytical ability" as a requirement (p. 135). They note that the number of math classes, the grade in the last math course, and when that last class was taken tend to better predictors than a student's attitude or perception of anxiety concerning statistics (p. 137). Their survey findings revealed that advertising students were not "overly positive about taking the initiative to seek help" with statistics, and male students were less likely to do so than females (Fullerton & Kendrick, 2013, p. 145). Dunwoody and Griffin (2013) included older College Board data (2001-2005 SAT's) that indicate journalism majors scored better in mathematics than public relations students, while radio/TV (broadcasting) tested the lowest on average of the three concentrations.

The Dunwoody and Griffin (2013) study asserts that current students taking mass communication courses are confronted with situations that require "decision-making in the context of incomplete information" (p. 529). Their survey included 15 statements about statistical reasoning in relation to journalism, with half of the administrators responding indicating that most or all of their journalism students were required to take a course somewhere in the university that contained statistical reasoning instruction, while only a few of these offerings were within their own program (p. 534). The bottom line is that communication programs rarely include statistical reasoning as part of the journalism curriculum, either as a stand-alone course or embedded instruction offered in other journalism courses (p. 533).

Garfield (2003) identifies goals when teaching statistical reasoning that might be assessed, including reasoning about statistical measures, reasoning about uncertainty, reasoning about samples, and reasoning about association (p. 25). The latter three areas where addressed more so in the survey research paper that was the final project for students. Students were required to create survey questionnaires that address hypotheses, formulations that tested their critical thinking skills.

The current study focuses on the first area, reasoning about statistical measures, which was assessed with the level of learning defined by Standard Two language, that students should be able to "apply" statistics, which was necessary to calculate/solve the problems within two instruments: the statistics quiz and the final examination. The student scores provided the dependent variable data for the current study.

Defining Other Independent Variables

The mathematics prerequisite as an independent variable. The curriculum included mass communication research as a core course for all majors, with a prerequisite of junior standing and one mathematics course. The required mathematics course is "MS108: Exploring Mathematics" and includes statistical instruction within its course description, while also satisfying a general education degree requirement for communication majors. Each student's grade in MS108, when available, was used as a third independent variable. Students were allowed to substitute a more rigorous math course, defined as either MS 204: Basic Statistics or MS 302: Applied Probability and Statistics, for their math requirement, and Business Statistics (ST 260) was also identified as a useful preparatory course.

ACT/SAT Scores and Student Performance in Math Courses

Math ACT/SAT scores as predictors of statistical proficiency. Ballard and Johnson (2004) explored the relationship between variables that included: (a) a student's math score on the ACT test; (b) the hardest college math course taken; (c) whether the student had to take a remedial math course; and (d) the student's score on a test of basic math concepts (p. 3).

Dupuis et al. (2012) examined the relationship between ACT/SAT scores in mathematics and which college math course(s) students attempted first, as well as what kind of grade they earned in those courses. Their literature review noted that mathematics preparation for many college-bound students is inadequate, while noting evidence that mathematical reasoning and statistical reasoning are distinct cognitive processes (p. 5). Both the ACT and SAT organizations have had success in providing evidence that a student's math score on a standardized placement test is a significant predictor of grade in basic statistics courses, while this relationship does not necessarily extend to advanced courses such as calculus.

For the purpose of the current study, variable relationships were adapted to the following: (1) whether the student had already taken a math course that included statistics education, and if so, what grade they earned; (2) whether the student needed to take a remedial math course in order to qualify for the required one; (3) a students' score on math portion of the ACT or SAT test. Previous studies in the literature review have already suggested (4) gender (Bridgeman & Wendler, 1991; Tintle et al., 2012; Fullerton & Kendrick, 2013) and (5) area of emphasis within communication (Dunwoody & Griffin, 2013) as possible independent variables. All of the aforementioned independent variables were considered in relation to each student's score on a basic statistics quiz in the research course as well as the student's score on the statistics portion of their final exam in research. In an effort to explore what sort of mathematics instruction might best prepare students for the mass communication research course, research questions and hypotheses were proposed to guide analysis in the current study.

Research Questions and Hypotheses

RQ1. Is there a relationship between a students' grade in the mathematics course that satisfies their major requirements and how well the student performed on course-embedded assessments that address statistical proficiency?

RQ2. Is there a relationship between students' ACT/SAT scores and their performance in their college mathematics course?

RQ3. Is there a significant difference in test scores/grades earned by students based on gender?

RQ4. Is there a significant difference in test scores/grades earned by students based on area of emphasis within communication?

H1. Students with higher math ACT/SAT scores received higher scores on the statistical component within the final exam.

H2. Students who earned higher grades in their math prerequisite received higher scores on the statistical component within the final exam.

H3. Females received higher scores on the statistical component within the final exam, compared to their male counterparts.

Methodology

The current study attempts to determine possible predictors of a student's success in a mass communication research course. This course has been previously cited as key to assessment of learning outcomes in the curriculum areas of research and statistics, to be used for providing evidence that might be included in an ACEJMC (accreditation) self-study report. Two potential predictor variables cited in the literature review are grade(s) earned in the math prerequisite course and ACT/SAT score(s). Ballard and Johnson (2004) identified possible independent variables for inclusion in the current study, where defining math prowess is concerned. Because there was no one standardized math placement test with scores available from all students, the researchers chose to create a coding schema that was used to accurately enumerate how well the student's previous math class had prepared them for the statistical components of the research course instead.

Math Prerequisite and Coding the Math Grade Variable

In 2006, the communication department math requirement was revised to a course entitled "MS108: Exploring Mathematics" (Department of Communication). This was within a smaller program attempting to comply with the various instructional objectives, and the change could be construed as one effort to improve the curriculum (complying with Standard Nine as well). The course description defines MS108 as, "an introduction to mathematics with topics useable and relevant to any person. Topics include elementary logic, problem solving techniques, use of quantitative techniques, statistical reasoning, and modeling" (Department of Mathematical, Computing, and Information Sciences). The participants' grades earned in this class were available, except for several exceptions that will be elaborated on in the following section. The available grades in MS108 served as the natural starting point for their study. See Table 2 for coding system that was operationalized to attain a numerical value (referred to as "coded108") that reflected a student's math preparedness with respect to prior math courses.

The above instrument produced the "coded 108" variable, a numerical reflection of a student's math proficiency prior to the research course that takes into account the sundry options available to communication students. This calculation is an ordinal variable, a ranking that begins with a designated interval value for the grade earned in their math prerequisite course and takes into account whether a student needed remedial math (by subtracting), as well as those who took a more advanced statistics course (by adding).

ACT/SAT scores as math prerequisites. The MS 108 math course had a prerequisite of Intermediate Algebra (MS100) with "a "C" or better or satisfactory score on ACT/SAT or departmental placement test", which the math department defined as a minimum score of 20 (ACT) or 480 (SAT). Any student scoring less is required to take a remedial math course as a prerequisite, as shown in Table 3. This provided the justification for the one point deduction as contributing to the coded108 numerical value.

As evidence that there are different lines of thought concerning what satisfies the mathematics requirement, the math standard for the current university being studied, as defined by its math department in Table 3, *does not* match figures of the ACT standardized testing agency (see Table 4). At least one reputable source (Collegenews.com) notes that ACT scores have remained

Table 2
Mathematics Prerequisite Course Coding Sheet

	MS108 starting grade: A=8, B=6, C=4, D=2				
	ADJUSTMENTS				
	Math before COM415?*	Taken twice?	LS098/MS100 remedial course?	*MS204/ MS302 Superior Statistics prep*?	
[MS108 starting grade]	+1	-1	-1	+2(204) +3(302)	[enter coded 108]

*Note that students were allowed to enrolled in COM 415 Mass Communication Research with MS108 as a prerequisite or co-requisite, although students were advised/encouraged to take the math class first.
This instrument was used to numerically calculate student performance in previous math classes; the range of coded108 variable was 2 to 12 amongst participants.

Table 3
Entry-Level Mathematics Placement (mathematics component score)

* ACT	SAT before 2010	* current SAT	Math placement
16 or less	390 or less	410 or less	Basic Algebra Skills (LS098)
17 - 19	400 - 470	420 - 480	Intermediate Algebra (MS100)
20 - 21	480 - 490	490 - 510	Exploring Math (MS108)
22 - 23	500 - 510	520 - 550	Pre-calculus Algebra

* Scores for math placement must be less than three years old at the beginning of the term for which the student was registered.

relatively stable when compared against SAT scores (SAT Scores Continue Their Downward Spiral, 2013), prompting the researchers to rely more heavily on ACT data while converting SAT scores into ACT using the equivalents found in Table 4, which also shows data for all 159 students who took COM415 that were in the initial study group.

Sample

Because MS108 grade data was only available for those taking the course in the four most recent sections, the current study analysis relies on the 94 students in the far right column of Table 3. Note that those missing a math placement score (14.9%) were transfer students from the community college system, which did not provide their placement scores upon transfer. The numbers also reveal that (at least) 43 students did not have the prerequisite ACT score to avoid taking a remedial math class, while transfer transcripts revealed that 3 of the 14 missing ACT/SAT scores did in fact transfer in credit for MS100. Moreover, one student with an ACT score of 20 voluntarily took MS 100 as further preparation. This means that 47 of the 94 study participants (50%) took a remedial math course prior to a second math course, usually the general education math class that also served as a prerequisite/co-requisite for the research course.

The final examination that contained numerical and statistical concepts was administered, and a post hoc analysis was performed after retrieving the ACT/SAT scores of each student, as well as how well each student had performed in the prerequisite math course. As previously specified, no math assessment score was available for the 14 transfer students, and no math grade was available for 26 students, most of whom were the same transfer students.

Table 4

Mathematics Component Score by Standardized Test

Math placement	ACT[a]	SAT	All students	Study students
[b]Basic Algebra Skills	14 or less	350 or less	3 (1.9)	1 (1.1)
Basic Algebra Skills	15	360-380	17 (10.7)	12 (12.8)
Basic Algebra Skills	16	385-405	17 (10.7)	13 (13.8)
[c]Intermediate Algebra	17	410-425	19 (11.9)	15 (16.0)
Intermediate Algebra	18	430-445	10 (6.3)	6 (6.4)
Intermediate Algebra	19	450-465	8 (5.0)	6 (6.4)
[d]Exploring Math	20	470-485	8 (5.0)	4 (4.3)
or Finite Mathematics	21	490-500	5 (3.1)	4 (4.3)
or Pre-calculus Algebra	22	510-520	4 (2.5)	3 (3.2)
	23	525-540	6 (3.8)	3 (3.2)
[e]Basic Statistics (MS204)	24	545-560	6 (3.8)	5 (5.3)
	25	565-580	5 (3.1)	2 (2.1)
	26	585-600	5 (3.1)	4 (4.3)
	27	605-620	5 (3.1)	2 (2.1)
	28	625-640	---	---
		Missing	41 (25.8)	14 (14.9)
		Total	159 (100)	94 (100)

[a] comparison scores between ACT and SAT were taken from (ACT-SAT Concordance, 2013) data.

[b] remedial course, LS098, no credit towards degree; being phased out as newer admissions standards no longer allow provisional admission for ACT scores 16 or below on math.

[c] essentially a remedial math course, in that it does not satisfy the math degree requirement for any major; units count towards degree.

[d] satisfies math degree requirement for COM major; Finite Mathematics or Pre-calculus Algebra satisfy most other majors.

[e] more advanced statistics class that COM majors have been allowed to substitute for general education requirement.

Results

RQ1: Is there a relationship between a students' grade in the mathematics course that satisfies their major requirements and how well the student performed on course-embedded assessments that address statistical proficiency?

As described in the methodology section, we felt that certain adjustments to the data had to be made prior to the making of regressive comparisons. Better-prepared students, especially those who had taken advanced statistics courses, could not fairly be compared to students who had only taken the minimum prerequisite course to be admitted to COM 415, the research course. Following such adjustments, we created a compensatory coding scheme to account for student math course taken and math instruction/performance prior to COM 415 [see Table 2]. Further, we were unable to obtain all of the data that we had requested. To deal with missing data, we used series mean inputation.

We ran regressions that would locate predictions, if any, of the level of math preparation through prerequisites and student performance on the statistics test that formed a large part of the students' COM Research grade. Again, as with the response to RQ1, we found a weak prediction for the effect of math preparatory courses (MS 108 and various statistics courses) on performance using this analysis method (R^2 = .134; ß = .366, p < .001).

RQ2: Is there a relationship between a students' ACT/SAT scores and their performance in their college mathematics course?

To answer this question, we converted the cases of subjects we had followed from the taking of their ACT (or SAT). However, because SAT scores were so infrequently chosen, we converted both SAT scores and ACT scores to their relative percentiles. We then used a common online common reference tool (ACT-SAT Concordance, 2013) to estimate the ACT scores of students who had only taken the SAT. If a student had taken both the SAT and the ACT, we accepted the ACT score noted earlier as the more stable assessment (Collegenews.com).

While the studied university uses only an A-B-C-D-F grade rubric, the instructor grading for the course utilized a point-scale system that was first normalized for differences between fall and spring semesters and then converted to a 1-100 grading scale for comparison with ACT percentiles. When we ran the regression analysis, we found that the ACT adjusted percentile tended to predict students' final COM 415 (Communication Research) score (R^2 = .195; ß = .442; p < .001), albeit somewhat weakly.

RQ3: Is there a significant difference in test scores/grades earned by students based on gender?

This research question followed up on studies in both statistics education and communication in the literature that tended to indicate that female students, generally speaking, out-perform their male counterparts; attitude and desire have been mentioned as possible explanations for the difference. Our findings using a one-way ANOVA did determine a differences in success correlated to gender, with females receiving the higher scores on average (F = 2.28, p = .01) with a mean score of 68.39 versus 66.89 for males. The difference, while not large, was statistically significant.

RQ4: Is there a significant difference in test scores/grades earned by students based on area of emphasis within communication?

This research question followed up on Dunwoody and Griffin (2013), assuming that their findings with respect to differences in SAT College Board scores between students in their various areas of emphasis was a plausible predictor of possible success in a statistics-based course. The findings exactly matched theirs, in that the journalism majors scored highest, with a mean score of 75.23 (p = .01), followed by the public relations students, with a mean score of 67.53 (p = .01) and with the broadcasting students earning the lowest scores on average at 61.77 (p = .01).

H1: Students with higher math ACT/SAT scores received higher scores on the statistical component within the final exam.

The results indicate a moderate correlation between performance on the ACT and students' statistics exam scores (R^2 = .470, p < .001). When we converted this to a regression, due to the always-prior nature of the taking of the ACT to the senior-level COM research course, we found once again significant but weak explanation of the variance in the dependent variable of the scores on the test. We investigated this further through curve estimation and other non-linear schemes of best fit, but found that the weakly linear regression prediction fit the data points best (R^2 = .221; ß = .470, p < .001).

H2: Students who earned higher grades in their math prerequisite received higher scores on the statistical component within the final exam.

When we ran a regression, the results indicate that better and more extensive preparation in math tends to be weakly but significantly predictive of success in the statistics component of the communication research course. As throughout this study, our parsing of the predictive variables has not yielded anything with more than a weak predictive power, evidenced here again (R^2 = .074; ß = .273, p = .01).

H3: Females received higher scores on the statistical component within the final exam, compared to their male counterparts.

The results indicate a small but persistent difference in significant means for the two gendered groups. Female students had an arithmetic mean of 66.14 for their test, versus M = 64.88 for the male students. This is not a large difference, but in the confidence interval of the spread of differences the women ranged from M = 63.90 to 68.39, while the men ranged from M = 62.87 to 66.89 with a p = .01.

Discussion

The literature indicates that statistics instruction is something that should be of concern to all educators, regardless of discipline. It is particularly relevant to journalism and mass communication programs, an assertion supported by its inclusion as one of the skills in the newer ACEJMC Standard Two. Smaller programs such as the one in the current study need to decide whether to include statistics within their own courses, rely on external courses to teach statistics, or a combination of both. The study program falls under the last category, after revising its math requirement to a course that includes some statistics, while then infusing statistical concepts into a capstone research course.

Essentially most, if not all, of the relationships between variables uncovered in the literature as to the disposition of scores following the mitigation of mathematics preparation for statistics, especially for communication students, were confirmed in their statistical validity. However, a point of concern is the strength of the relationships, wherein no one factor was predominantly responsible for the observed learning outcome, as perceived by weaker or stronger scores. It is well known, for example, that male ACT and SAT test takers tend to do slightly better on mathematics than females. However, our study (along with others) shows that women get better grades than men in college, including in courses such as math and statistics. Perhaps other factors, such as persistence, organization and personality positively affect performance even in highly quantitative kinds of courses. The results, and in particular the analysis involving the coded108 variable [see Table 2], lends support to the assertion that the teaching of statistics in several courses might facilitate more statistical learning. This can be construed from the fact receiving a higher math course grade, having taken a math course with stronger emphasis on statistics, and not having to take any remedial math were all positive numerical influences on a student's coded108 score, which was then comparatively analyzed against statistical proficiency scores collected as assessment data for this study. The inclusion of statistical analysis as a teaching strategy in the research course, a quantitative methodology for the final project (survey research), arguably strengthened a student's ability to apply numerical and statistical concepts to real life situations.

Possible Area of Weakness

One of the justifications for undertaking the study was to explore how well the math course chosen by the communications program as a prerequisite prepared them for the statistical analysis that all students were required to do as part of their survey research project. This assumes that most students gained knowledge that was useful in completing their coursework and performed better on the statistics portion of the final examination. Conversations with the research instructor revealed that knowledge of statistics could be perceived as useful to as much as 50% of the graded content within the course, through the final exam and the survey project. The other 50% may be due to such variables as writing prowess, organization of ideas and class contribution. Statistics knowledge was also not a singular influencing factor, as research skill(s) and critical thinking ability(s) could also be identified as positive influencers of student learning (and their observed performance on this study's assessment tools accordingly).

Moreover, professors frequently report that students retain little from their initial statistics course. A study by Sierpinska, Bobos, and Knipping (2008) identified students' frustrations with "prerequisite" mathematics courses, those that students might be required to be in compliance with before they take the course that satisfies the mathematics requirement for their particular major. The "fast pace" of the course(s) was identified by students as the most frustrating, which the researchers reasoned was possibly linked to their expectation(s) from past courses in secondary school that were taught at a slower pace. Moreover, students often have a "difficult rapport with truth and reasoning in mathematics"(Sierpinska et al., 2008, p. 289); one explanation for this in relation to the current study is that those who opt to major in mass communications might be characterized as being more "creative minded" as opposed to "rational minded."

As a justification for challenging communication students who might not be inclined to understand statistics, the learning of statistical analysis techniques has been identified as important to public relations majors in particular, in whose jobs quantitative survey methods are often employed. Fullerton and Kendrick (2013) asserted that while the advertising industry requires basic analytical ability, their students suffered from varying degrees of "quantiphobia" (p. 135). The exploratory math course that incudes statistics was chosen as a prerequisite so that a student has a fair chance of succeeding in a senior-level research course that is highly dependent upon prior math preparation, a fact that many communication students seem never to consider.

Limitations of the Study

The current study was not without its limitations, and the researchers took every effort to obtain as much data as possible concerning every study participant. The assistance of the registrar's office and university records available in the student information system were able to provide enough information to make for some interesting statistical analysis, but one of the weaknesses was lack of information for many of the transfer students. The math assessment scores for this cohort rarely transferred to our registration system and it was difficult to determine which (if any) had possibly taken a higher math course not searchable for, using the current system. Wherever we could, pains were taken to carefully curate the data, to account for missing data in the most conservative way possible, and to uncover the most fruitful method of preparing communication students for that rigorous and often difficult course, mass communication research. This course, which a growing number of researchers has regarded as absolutely essential to the success of investigative reporters, broadcast business researchers, and public opinion practitioners, is nonetheless not always the "most eagerly looked forward to" course for undergraduate communication students. Discovering the predictive math preparation that may best help them, along with identifying which teaching strategies are conducive to statistical learning, is worth further and continuing research.

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