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This paper investigates the performance of students enrolled in traditional versus hybrid Elementary Statistics courses at Georgia Gwinnett College (GGC). For this study, we collected and analyzed student performance data for the course goals over the spring semester of 2011. GGC is unique as it is an open access undergraduate institution, which has experienced rapid growth since its recent foundation in 2006. This presents a distinct challenge because there is a diverse student population, with various degrees of mathematical knowledge and learning capabilities. Based on the results of our findings, we have discovered that there is no significant difference between the performances of the two groups.

Keywords

Hybrid vs. traditional, Statistics, Student performance, Undergraduate education

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Abstract

This paper investigates the performance of students enrolled in traditional versus hybrid Elementary Statistics courses at Georgia Gwinnett College (GGC). For this study, we collected and analyzed student performance data for the course goals over the spring semester of 2011. GGC is unique as it is an open access undergraduate institution, which has experienced rapid growth since its recent foundation in 2006. This presents a distinct challenge because there is a diverse student population, with various degrees of mathematical knowledge and learning capabilities. Based on the results of our findings, we have discovered that there is no significant difference between the performances of the two groups.

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Introduction

Georgia Gwinnett College (GGC) is the first four-year public college to open in the 21st century. GGC opened its doors in 2006 with only two buildings, 11 full-time faculty, a handful of administrators and staff, and 100 transfer students. The institution has experienced explosive growth since that time, and now has a new library, student center, dorms and academic buildings, over 300 full-time faculty, and enrollment is expected to top 8,000 students in the Spring of 2012. In June, 2011, GGC awarded diplomas to the first class of students who had first enrolled there as freshmen.

As GGC is an "open access" undergraduate institution, any eligible student who applies will be admitted. In addition, GGC serves a diverse student population, with a wide range of cultures, languages, educational preparation and experiences. This combined with its explosive growth presents a special challenge in delivering mathematics courses at GGC.

There are no 100% online courses offered at GGC; rather traditional and hybrid models of course delivery are utilized.

Hybrid courses at GGC refer to courses where some sessions take place face-to-face while others take place online. This is an approach to learning that is designed to keep the flexibility of the online course, while retaining the interaction and spontaneity of a traditional face-to-face course. According to Rovai and Jordon (2004) "Hybrid learning is a flexible approach to course design that supports the blending of different times and places for learning, offering some of the conveniences of full online courses without the complete loss of face-to-face contact. The result is potentially a more robust educational experience than either traditional or fully online learning can offer." The Sloan Foundation, believes hybrid reflects an average of 50% online coursework (Diaz, 2011). Currently, all courses at GGC delivered in the hybrid format have a combination of reduced "face" time, and online components that may be as high as, but not exceed, 50% (Smith, 2011).

There are varying opinions at our institution concerning the effectiveness of the hybrid model. The common perception among some faculty and administration is that students do not perform as well in hybrid classes. However, the evidence to support this perception is largely anecdotal; therefore, a quantitative study is needed to determine the true situation. In this paper, we examine the effectiveness of traditional compared with hybrid instruction of statistics courses at GGC based on student performance.

Prior Literature

A review of the literature revealed that there are several empirical studies related to the comparison of online and traditional learning. A recent meta-analysis conducted by the U.S. Department of Education and Evaluation (U.S. Department of Education, 2010) identified more than one thousand empirical studies of online learning published from 1996 through July 2008. Most of these studies related to (1) web-based instruction, (2) included studies with random assignment or controlled quasi-experimental designs, and (3) studied objective measures of student performance. Web-based instruction means that the method of delivery was either entirely online or hybrid delivery.

Meta-analysis is a technique that combines the results of multiple independent studies to obtain composite results. Analysts for the U.S. Dept. of Education screened these published studies and identified 46 studies (with 51 effects) that could contribute to the meta-analysis. These studies included both online and hybrid methods of instruction. The meta-analysis determined that, on average, students in online learning conditions (this means both online and hybrid) had slightly higher performance than those students who received only traditional face-to-face instruction. Furthermore, student performance was even slightly higher for those students who received hybrid instruction. Note that the meta-analysis included those studies involving higher education, i.e. K-12 studies were excluded.

Here is a partial summary of the results of the meta-analysis (pp.14-15):

- Students who took all or part of their class in online conditions performed modestly better, on average, than those learning the same material through traditional face-to-face instruction.

- Instruction combining online and face-to-face elements (i.e. hybrid instruction) had better student performance relative to purely face-to-face instruction than did purely online instruction.
- Most of the variations in the way in which different studies implemented online learning did not affect student learning outcomes significantly.
- Studies in which online learners spent more time on task than face-to-face students found a larger benefit for online learning. 13 of the 46 studies attempted to determine potential sources of variation in the effectiveness of online versus face-to-face. The only two variables found to be statistically significant were (1) the use of hybrid rather than a purely online approach to learning, and (2) increasing the time on task for online learners.
- The effectiveness of online learning approaches appears quite broad across different content and learner types.
- Effect sizes were larger for studies that varied in terms of curriculum and instructional approach, in addition to the method of instructional delivery.

The interested reader can refer to the following individual studies:

1. Keller compares student performance in accounting courses (Keller, 2009).
2. Riffell in biology (Riffell, 2005), and
3. Vernadakis in computer science courses (Vernadakis, 2011.)

Keller found that student performance was not significantly associated with the type of class delivery (traditional or hybrid.)

Riffell determined that performance on a post-course assessment test by students in the hybrid model was better or equivalent to the traditional course.

The findings of Vernadakis indicate that the hybrid approach might be a superior option for students who are learning Microsoft Office PowerPoint, which is useful to present results in a Statistics class. They conclude that the hybrid learning environment “provided opportunities for the participants to learn subjects relative to the first two cognitive processes in Bloom’s taxonomy, namely remembering and understanding factual and conceptual knowledge” (2003).

About GGC

GGC is called “the campus of tomorrow” because its mission is to be creative, experimental, and innovative. Faculty do not hold office hours; rather they are given smart phones and students call or text them at any time. Classes are limited to 26 students, and faculty is encouraged to learn their students’ names and to be involved with each student’s learning. Student engagement and the innovative use of educational technology are two of the fundamental tenants of the institution.

Unlike conventional institutions, some GGC policies challenge long-held practices in higher education. For example, GGC does not offer tenure to its faculty, which is considered to be

one of the cornerstones of higher education. The college has four schools, but no departments, which promotes faculty collaboration across disciplines. Many of its policies and practices are evolving as the institution grapples with the exponential growth.

GGC serves a five-county area in the northeast metro Atlanta area. It is located in Gwinnett County, which is now a "minority majority" county, since the sum of the minority populations now constitutes the majority. Most students are admitted as freshmen, which accounts for the largest student population (53%) followed by sophomores (20%) (Kaufman, 2011).

MATH 2000 - Statistics

The focus of this study is the course Statistics (MATH 2000), which is a sophomore elementary level statistics class offered in the School of Science and Technology and is a requirement for all science non-mathematics majors. Some class structures are traditional face-to-face, and some are hybrid courses. The traditional class meets 3 hours per week, and the hybrid meets 1.5 hours per week, with the remainder covered by asynchronous online activities.

The course contains components common to those for most beginning statistics courses. Concepts such as basic probability, hypothesis testing, data analysis, and use and interpretation of statistical technology are covered in this course (Thomas, 2011).

The course goals are as follows:

- G1) See statistics analysis as a practical and useful tool in today's society.
- G2) Understand that variability is natural, predictable, and quantifiable.
- G3) Know the parts of the process through which statistics works to answer questions.
- G4) Choose the appropriate graph and analysis technique(s) to address research questions.
- G5) Communicate the results of a statistical study in the context of the given scenario, including scope of inference and causality.
- G6) Use statistical language appropriately.
- G7) Use appropriate technology in the evaluation, analysis, and synthesis of information in problem-solving situations (Mundie, 2009).

The use of technology to teach the hybrid course is pervasive. The course management system and the Center for Teaching Excellence provide support to faculty in designing and implementing creative learning activities and environment for the hybrid component of the course.

The students in the traditional class met for two and half hours per week (three times per week for 50 minute sessions) in a computer classroom. The hybrid course met one and one half hours per week (once a week for one and one half hours). The classroom time for both groups was spent on lecture of the course material, group activities (e.g., discussing

conceptual details such as the central limit theorem) and simulation activities. Because the hybrid class received an hour less each week of in class instruction time, this deficit was compensated by having the students consider preliminary concepts online using the Blackboard course management system. Activities that were used for this purpose included online quizzes and responses to discussion board posts (e.g., describe an application of probability within your career field). There were several online components to which both groups had access. For example, the instructor posted Echo 360 videos that were available to both groups as well as the instructor's notes. Echo 360 is a screen and voice capture tool. In addition, both groups completed homework assignments within MyStatLab, which includes online tutorials and other online interactive study aides.

The Study

Justification for Study

While there have been other studies regarding the effectiveness of the hybrid model (U.S. Department of Education, 2008), they may not apply to our institution due to the "open access" admission policy, the diversity of the student body, and the tremendous growth of the institution.

Based on verbal feedback, there are concerns among instructors and some administrators regarding student performance in the hybrid model (Napier, 2011). Clearly, there have been copious observations and assumptions linking the impact of hybrid teaching models on the effectiveness of the multi-disciplinary freshman and sophomore level students, but research following a quantitative method (statistical analyses) approach is needed as evidence to the validity of such assumptions in our particular environment.

Two common complaints among students and instructors revolve around the uncertainties surrounding the outcome of the hybrid model, and the lack of student participation during the "hybrid session". The assumption commonly made by those instructors is that the hybrid model can play an equally effective role in maximizing the learning value, but the specific configuration of the hybrid model role remains questionable. Such conjectures can be misleading, and they may potentially cloud these issues.

Research Questions and Hypothesis

The question at hand deals with the extent to which teaching the hybrid model of MATH 2000 is as effective as the traditional model, based on student performance. The research hypothesis for this study is: "The performance of students in the MATH 2000 hybrid model is not equivalent to the performance of students in the traditional model."

The null hypothesis is then: "The performance of students in the MATH 2000 hybrid model is equivalent to the performance of students in the traditional model."

Methodology

The study encompasses 92 students (51 traditional and 41 hybrid) across 4 sections of MATH 2000 Statistics during the spring of 2011. A single instructor taught all four sections in the study, thus inherent instructor differences did not inflate the results. The students self-selected the traditional versus hybrid format. However, all sections of Statistics were full or nearly full so many students merely signed up for classes based on availability. There did not appear to be a notable population shift between the hybrid and traditional

courses as, hybrid courses are relatively new at GGC and many students were not aware of any differences between hybrid and traditional format until the first day of class.

Data was obtained from a common assessment exam, given to 92 students (51 traditional and 41 hybrid). The exam directly measures student performance in each of the 7 course goals listed in Section 3. The 7 goals deal with statistical concepts associated with each of the course goals and are addressed by common questions administered on the assessment exam. Results of the assessment process are itemized in the student performance result table (see Figure 1).

Figure 1. Results of Comparison of Student Performance on Course Goals

Course Goal	Total Points Earned in Traditional Sections	Total Points Earned in Hybrid Sections	Total Points Possible	Percentage Correct for Traditional Sections	Percentage Correct in Hybrid Sections
Goal 1	41	17	255	16.0	8.3
Goal 2	206	167	255	80.8	81.5
Goal 3	235	173	255	92.2	84.4
Goal 4	241	189	255	94.5	92.2
Goal 5	488	398	765	63.8	64.7
Goal 6	393	273	765	51.4	44.4
Goal 7	193	160	510	37.8	39.0

Analysis of the study

A MANOVA (Multivariate Analysis of Variance) experiment in SPSS (Statistical Package for the Social Sciences) was utilized comparing the population of hybrid instructed students versus traditionally instructed students. MANOVA is needed to determine if the populations are from the same distribution or if they emerge from differing distributions. The seven assessment question scores are viewed as a vector with seven components and real number entries:

$$\langle Q_1, Q_2, Q_3, Q_4, Q_5, Q_6, Q_7 \rangle$$

The null hypothesis is that the populations come from the same distribution and the alternative hypothesis is that the populations emerge from differing distributions. In other words, we will check to see if the mean on the composite variable is the same across the two groups in the following manner:

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

Population 1 denotes the traditional style "face to face" instruction while population 2 refers to the hybrid style instruction with sizes 51 and 41 respectively.

The MANOVA experiment suggests that the performance was statistically independent of the method of instructional delivery. This means that while there were differences in student performance between the traditional and hybrid sections, the differences were not statistically significant. The MANOVA output table reports the exact statistics associated with the experiment, including reported degrees of freedom and F-statistics (see Figure 2).

Figure 2. MANOVA Output on the Common Assessment Questions

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
format	Q1	3.444	1	3.444	1.914	.170
	Q2	.026	1	.026	.009	.924
	Q3	3.427	1	3.427	2.040	.157
	dim1 Q4	.304	1	.304	.228	.634
	Q5	.437	1	.437	.025	.874
	Q6	24.931	1	24.931	.697	.406
	Q7	.317	1	.317	.025	.875

Figure 3 summarizes the results related to the p-values and R squared quantities associated with each assessment question. One can observe that all of the p-values greatly exceed the value of our standard alpha value of $\alpha = 0.05$. Hence, it must be concluded that the null hypothesis cannot be rejected. Thus, the variances of performance between students in the traditional and hybrid courses are not significant across all of the course goals. Only a small percentage of variance between the groups (approximately between 0% and 2%) can be explained by inherent differences between traditional teaching methods and hybrid teaching methods (see Figure 3).

Figure 3. Summary of MANOVA Hypothesis Test Results

Assessment Component	Associated P-value	Reported R Squared	Reject H_0 ? Reject H_0 if $p < 0.05$
Goal 1	0.170	0.021	No
Goal 2	0.924	0.000	No
Goal 3	0.157	0.022	No
Goal 4	0.634	0.003	No

Goal 5	0.874	0.000	No
Goal 6	0.406	0.008	No
Goal 7	0.875	0.000	No

Based on this sample, the mean of the means of student performance is slightly higher for traditional sections (62.4%) in comparison with the hybrid sections (59.2%). Thus, the overall average student performance is approximately 3.2 percentage points higher in the traditional sections than in the hybrid sections. However, the increase is not statistically significant according to our detailed analysis of the original hypothesis. Therefore, it could be determined that the apprehension felt by some students and faculty members regarding the performance of students in hybrid courses is unwarranted.

Conclusions

The purpose of this study was to discover if students enrolled in the hybrid sections of MATH 2000 were performing as well as students enrolled in the traditional (face-to-face) sections at our institution. To assess this question, we collected and analyzed student performance data for the seven course goals during the spring semester of 2011.

Based on the results of our findings, we have discovered that there is no significant difference between the performances of the two groups, with a 95% level of confidence. The data shows that students in the traditional sections perform slightly better than their counterparts in the hybrid sections, but the differences are not statistically significant.

Additional studies are needed to ensure accuracy of findings, as student performance on final exams may not encompass the assessment of mastery of material in a Statistics course. An opportunity for future work would include a more specific analysis of the hybrid learning activities associated with statistics to determine which of these are most effective. In particular, an investigation of how the hybrid components affect the student learning of the use of statistical software such as SPSS and Excel would be an asset to the existing literature.

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