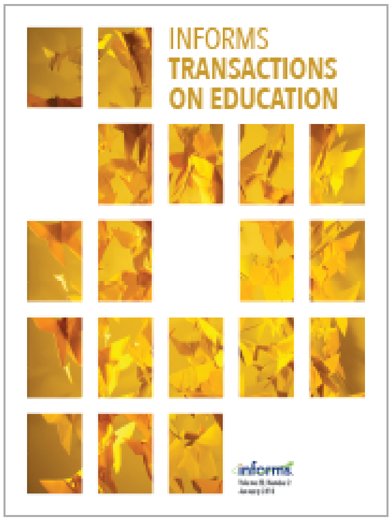


INFORMS Transactions on Education

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Using the Learning Assistant Model in an Undergraduate Business Analytics Course

Matthew D. Dean

To cite this article:
Matthew D. Dean (2020) Using the Learning Assistant Model in an Undergraduate Business Analytics Course. INFORMS Transactions on Education 20(3):125-133. https://doi.org/10.1287/ited.2019.0221

INFORMS TRANSACTIONS ON EDUCATION
Vol. 20, No. 3, May 2020, pp. 125–133
ISSN 1532-0545 (online)
http://pubsonline.informs.org/journal/ited

Using the Learning Assistant Model in an Undergraduate Business Analytics Course

Matthew D. Dean[a]

[a] Raymond A. Mason School of Business, College of William & Mary, Williamsburg, Virginia 23187
Contact: matthew.dean@mason.wm.edu, https://orcid.org/0000-0003-3456-8449 (MDD)

Received: January 4, 2018
Revised: October 1, 2018; June 21, 2019; June 24, 2019
Accepted: June 25, 2019
Published Online in Articles in Advance: March 12, 2020

https://doi.org/10.1287/ited.2019.0221

Abstract. Undergraduate business students, like many other undergraduate majors, are often apprehensive about the quantitative courses required to earn their degree. Active learning methods, including flipped classrooms, have been studied as approaches to mitigate these fears among students. With our overarching goal of helping students improve their understanding of quantitative business concepts, we implemented a novel active learning method called the Learning Assistant model. Using an experimental design holding the instructor and the student assessments constant, we report the results of the first-known implementation of this technique in a business course. As indicated by the change in the students' final numerical grades, this pedagogical technique shows promise in helping students master the material better than those who took the course in a traditional lecture-based learning environment.

Supplemental Material: The online appendix is available at https://doi.org/10.1287/ited.2019.0221.

Keywords: analytics education • Learning Assistant model • active learning • flipped classroom

1. Introduction

Business schools accredited by the Association to Advance Collegiate Schools of Business (AACSB) continually seek to enhance and improve their curriculum as part of their continuous improvement review process to maintain this premiere international accreditation. In addition to collecting, maintaining, and providing a store of effective practice resources for its members, the AACSB holds conferences and seminars focused on helping business schools redesign and improve their curriculum (AACSB International 2018). Business analytics is one of the areas business schools have embraced in their curriculum updates. This phenomenon is unsurprising given the attention business analytics and its relationship to big data has received in the popular press and across various industries (LaValle et al. 2011; Kiron et al. 2013; Richards 2017; Kent 2018a, b). Business programs often require a class covering data analytics in some form or another that focuses on quantitative analysis (Scala et al. 2018). By its very nature, a business analytics course rigorously analyzes business scenarios and applications using quantitative methods. By no means is quantitative rigor in business undergraduate programs a new concept. The concepts covered in recent business analytics textbooks match quite well with current editions of management science or quantitative methods textbooks (Anderson et al. 2016, 2019; Albright and Winston 2017; Camm et al. 2019). This observation implies that at least some quantitative-based courses are still seen as relevant to the undergraduate business curriculum. For a detailed discussion of business analytics curriculum for undergraduate majors, please see Wilder and Ozgur (2015).

Unfortunately, research suggests that business students deem quantitative courses to be the most challenging (Yousef 2011). Business majors are not alone in their struggle; other undergraduate majors also commonly experience difficulties in quantitative courses (Murtonen and Lehtinen 2003). Identifying an appropriate pedagogical technique and applying it to a quantitative-based course such as an undergraduate business analytics class could improve student academic performance and mastery of the course material. One technique that may help with the effectiveness of student learning in such courses is the Learning Assistant (LA) model, which is described in Section 2. In both the fall of 2017 and spring of 2018, we applied the LA model to a business analytics class taught in a flipped classroom and compared it to the same course taught by the same instructor who previously used a traditional, lecture-based learning format.

In the next section, we describe the LA model and provide a comprehensive literature review. Section 3 provides details surrounding our implementation of the LA model in a required undergraduate business analytics class. A description of how we analyze the effectiveness of the implementation of the LA model and the results of those analyses are described in Section 4. We conclude in Section 5 by reiterating the value of this study and highlighting future possibilities and challenges of using the LA model in undergraduate quantitative courses.

2. The Learning Assistant Model and Literature Review

At its heart, the LA model transforms a traditional lecture-based class into an active learning environment utilizing student peers to facilitate small group discourse. The LA model was developed at the University of Colorado Boulder in 2003 and has been implemented at more than 70 institutions across the country (Van Dusen et al. 2015). The LA model's proven success in science, technology, engineering, and mathematics (STEM) classes, which generally require quantitative analysis, makes it an ideal candidate to test as a pedagogical technique in a business analytics course with the hope that it improves business students' mastery of required quantitative skills.

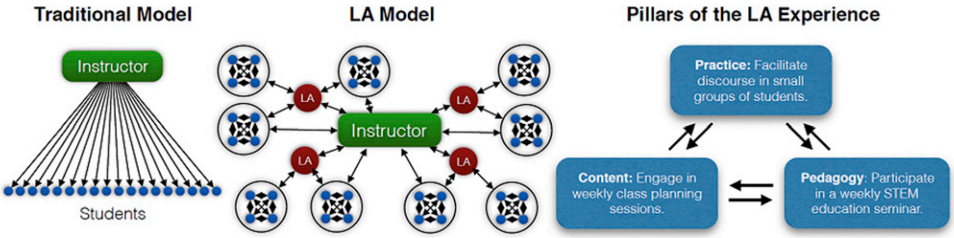
Implementing the LA model requires changing the classroom infrastructure to allow for collaborative interaction and group work among students, hiring and training learning assistants to assist in the classroom, and creating classroom exercises that promote active learning. Figure 1 displays the differences in the physical layout of a traditional model classroom and a LA model classroom.

Learning assistants (LAs) are generally undergraduate students who have previously taken the course. The pillars of the LA experience are crucial for the LAs and the students they are assisting in the course. The first pillar requires LAs to take a pedagogical course/seminar that provides instruction and training to help them be more effective during the in-class small group discourse. Typically, this seminar runs multiple weeks and teaches the LAs useful skills such as turning a closed question into an open one. Content planning is the second pillar of the LA experience. LAs are empowered to develop active learning exercises that can then be fine-tuned when they meet with the instructor for the weekly planning sessions. They have the unique experience of having been students in the course recently and understand where their peers may struggle the most or need a different approach to explaining a concept. The final pillar is practice: LAs provide assistance in the classroom, helping guide students through the active learning exercises for each class session. LAs also often serve as tutors for the course, where these sessions may be one-on-one or groups of students. In all, LAs work approximately nine hours per week and are paid a stipend for the semester.

The LA model can be implemented in multiple ways and tailored to the institutional structure and the population of the university, allowing the institution to form its own LA program. According to the Learning Assistance Alliance, "An LA program is an instantiation of the LA Model that includes all the GPEs [General Program Elements], but the usage of the GPEs may differ and an LA program may include other elements specific to the institution, the department, or even the course that LAs will be used" (Learning Assistance Alliance 2017a). All of the GPEs must be used within any LA program, but one of the key GPEs is the transformed course. A transformed course involves creating an environment where LAs promote collaborative learning and engage with the students to further their understanding of the material (Learning Assistance Alliance 2017b). The transformation can be done in a variety of classroom settings including large lecture, labs, flipped classrooms, recitations, and online (Learning Assistance Alliance 2017c).

Previous studies provide evidence that the LA model has been effective in quantitative courses within the STEM fields. Researchers at Florida International University transformed their introductory calculus- and algebra-based physics laboratory classes using the LA

Figure 1. Comparing the Traditional Teaching Model (Left) with the LA Model (Middle); Defining the Pillars of the Learning Assistant Experience in Completing an LA Program (Right)



Source: https://sites.google.com/a/colorado.edu/la-resources/home.

model developed at the University of Colorado Boulder and the open source tutorials developed at the University of Maryland, College Park. They administered the Force Concept Inventory Exam at the beginning and end of the semester to quantify whether these complementary models enhanced students understanding of the material and found that students in the transformed labs had larger increases in their scores than students in traditional labs (Goertzen et al. 2011). Researchers at the University of Colorado at Boulder found that students earning a D or F, or withdrawing (D/F/W), decreased from 34% to 27% after the implementation of the Learning Assistant model in a calculus course (Webb et al. 2014). Researchers that taught a calculus-based introductory physics class at the University of Colorado at Boulder compared the scores from the Force and Motion Conceptual Evaluation and Brief Electricity and Magnetism Assessment from a class taught with learning assistants to the national average scores for these exams taught in traditional classrooms. They determined that students in the LA-supported physics courses had a higher conceptual understanding of the material (Otero et al. 2010). Researchers from California State University, Chico, collected paired conceptual inventory scores from 17 institutions and determined that LAs are beneficial and are associated with improvements in students' conceptual understanding in introductory physics classes (White et al. 2016).

As hinted earlier, there are multiple ways to apply the LA model. In our business analytics class, we utilized a flipped classroom environment. A flipped classroom environment provides lectures online, allowing classroom time to be used for discussion and collaborative group learning activities (Swart and Wuensch 2016). The extant literature has no reported usage of the LA model in any business classes. However, there are institutions that have applied other active learning methods to quantitative business courses, such as the flipped classroom. Providing an active learning environment where students can work collaboratively while engaging with the professor, has proven to benefit students academically in quantitative classes (Webb et al. 2014). These studies and the ones discussed below demonstrate that there is interest and value in discovering and implementing pedagogical methods that can improve student learning in business education. We hypothesize that applying the LA model to an undergraduate business analytics class can improve student academic performance through better mastery of the course material.

From 2013 to 2014, William Swart and Karl L. Wuensch, researchers at East Carolina University, flipped a required quantitative business class titled Business Decision Modelling. They used Zhang's modified version (Zhang 2003) of Moore's seminal theory of transactional distance (Moore 1993) to measure whether the flipped quantitative business class decreased transactional distance and increased student comprehension. Moore defined transactional distance as a "psychological and communications space to be crossed, a space of potential misunderstanding between the inputs of instructor and those of the learner" (Moore 1993, p. 23). The larger the transactional distance, the more that learning is constrained. In other words, learning is inhibited with larger transactional distance. The researchers found that the transactional distance improved (i.e., decreased) between the students, between the students and the teachers, between the students and the technological interface, and between the students and the content in the flipped classroom with an improvement in the student outcomes of satisfaction, learning, and progress (Swart and Wuensch 2016).

Their study is applicable for multiple reasons. The flipped classroom studied by the researchers at East Carolina University taught decision theory, simulation, multiple regression, forecasting, and optimization, which are similar concepts taught in our business analytics class. Our results complement the research done by Swart and Wuensch (2016) and give further insight into the impact of pedagogical techniques that advance student learning. Whereas their study did not look at student grades, our study examines students' final course grades in a designed experiment, allowing us to compare outcomes from the LA model to a traditional classroom setting. Our flipped classroom structure is very similar to the environment described in Swart and Wuensch's article, where students watch an online lecture video outside of class and collaboratively work with their peers in class on a group project related to the lecture content. In both studies, the professor walked around the class answering questions and engaging in group discussions with the students. Our research expands their study by adding LAs to the classroom and comparing assessment results from previous sections of the course taught in a traditional learning setting.

Ardavan Asef-Vaziri, a professor at California State University, Northridge, flipped an operations management class and compared students' perceptions of the components of the flipped classroom and students' midterm exam grades to operations management courses taught in a traditional manner. This quantitative-based course teaches students how to apply analytical skills to data-driven operations management problems. The online portion of this course comprised detailed PowerPoint slides, recorded lectures, quizzes based on the lectures, and step-by-step animated assignments. Class time was used for discussion about the online component and interactive group work, including simulation games and case studies. Asef-Vaziri taught this course in a traditional manner in the spring of 2011 and the fall of 2011 and taught it in a flipped classroom format in the fall of 2012 and the fall of 2013. The midterm exam grades were higher for the sample of students in the flipped classrooms (Asef-Vaziri 2015). Our research expands this study by examining student performance for the entire course/semester, as measured by final numerical grades, and adding LAs into the classroom setting.

In our study, the LAs add a vital component to the flipped classroom. In addition to having "extra hands" in the classroom to help field student questions, the LAs are able to provide a unique perspective to the material. Their pedagogy seminar coupled with proper mentoring from the instructor allows these former students who are now LAs to effectively connect with the current students by relating their own recent personal experience of learning the material for the first time. The truly effective LAs can utilize their own experience to help other students see the "how" and "why" of a concept in a language that is often different from the instructor's. We also expand on previous studies by comparing final numerical grades of sections of a business analytics course taught using the LA model to sections of the same course taught by the same instructor in previous semesters that used a more traditional learning environment. (For more details on the course using the LA model, see Section 3.)

Noting the similarities and differences between the past studies on flipped classrooms and our current study using the LA model distinguishes the contribution of our research and demonstrates the importance of active learning research. We implement the LA model utilizing a flipped classroom environment where students use in-class time to participate in group-based exercises and problems. Utilizing an experimental design, we investigate student outcomes by explicitly comparing final grades between the two groups of students: those who took the class in a traditional setting and those who took it using the LA model. This is significant for multiple reasons. First, our study provides the higher education pedagogical community with insight into the effect of the LA model on students' grasp of quantitative concepts in a business classroom as measured by formal assessments from the course. Second, our study is the first to analyze the implications of implementing the LA model in a business course.

3. The Business Analytics Course and Implementation of the Learning Assistant Model

Business Analytics is a required course for all students at the institution of this study pursuing a bachelor of science in business administration (BSBA). The course can be considered a "survey course" in the sense that it covers the three commonly agreed-upon areas of business analytics: descriptive, predictive, and prescriptive. The course emphasizes the importance of the ability to draw conclusions from data using quantitative analysis techniques. The primary analysis tool used in the course is Microsoft Excel™, using built-in functions and the Data Analysis ToolPak and Solver add-ins. The course prerequisites include college algebra, business statistics, and an Excel course. Additionally, this course is a prerequisite to the required operations management course for all students pursuing a BSBA. This 300-level course is typically taught either in a face-to-face classroom setting or online. Students are typically juniors and must earn at least a letter grade of a "C" for graduation requirements. The university is a regional comprehensive institution and is widely considered a "commuter school" where students juggle a full course load, a part- or full-time job, and often complicated familial obligations.

The business analytics course was first introduced into the curriculum in the fall semester of 2016 when it was taught in two sections of 40 students each in a traditional, lecture-based format. Only one professor taught the course. In the spring semester of 2017, the same professor taught the only two offered sections of the course again, with one section being traditional face-to-face and other section online. The three face-to-face sections comprise the group of students who took the course in the traditional lecture-based format and totaled 120 students. Students in these traditional classes met twice a week for 75 minutes each time. Class time primarily revolved around lecture and demonstration by the instructor. Assessment of student mastery of material included quizzes, homework assignments, and exams. Quizzes and homework assignments could be completed twice, with the highest grade counting toward the student's overall course grade. Open-computer, open-book, and open-notes exams were administered online and timed during a specified time window. Exams presented students with a random data file and asked them to conduct specific analyses and interpret their work.

The second group of students took the same course from the same instructor but utilized the transformed LA model format. Specifically, we integrated the LA model into a face-to-face section of the business analytics class during the fall semester of 2017 and utilized the LA model in another face-to-face section in the spring 2018 semester. A total of 79 students took the LA model course. As mentioned earlier, the LA model can be integrated into different classroom settings. We chose to implement the model by transforming the traditional lecture-based course into a flipped classroom environment. Consistent with the university's three-credit courses, our class still met for 75 minutes twice a week. However, students were instructed to read the textbook and watch online videos before coming to class. This allowed classroom time normally reserved for lecture to be replaced by collaborative activities designed by the instructor to reinforce the concepts presented in the video lectures and textbook. Additionally, formative "pop quizzes" were used in some class meetings to help students discover where they needed to focus their study. Immediate review of these quizzes allowed the instructor to emphasize important concepts with short bursts of "microlectures"—three to four minutes of reviewing the importance of the topic. Students in the LA model sections were assessed using the same quizzes, homework assignments, and exams.

The LA model class convened in a new active learning classroom (ALC) that the university had created over the summer months of 2017. Its setup was typical of many ALCs where there is no "front of room" and student seating is clustered in small groups with supporting technology. In particular, each of the eight "pods" had its own large screen monitor, allowing students to connect a laptop for their group to clearly see and work with a single Excel document. Optionally, individuals within their group could use their own laptops following the "driver" of the group Excel document on their monitor. The classroom was arranged similarly to the LA model classroom depicted in Figure 1, making it conducive for active group learning. The Business Analytics course has a capacity set at 40 students, allowing the group size of each pod to be five students.

The collaborative activities and exercises were presented to the entire class, allowing students to ask general questions about the "problem." The students were then instructed to work in their groups on the exercise. The online appendix provides two examples of exercises used during the class. As the groups worked, the professor and the two LAs moved around the classroom to assist students and answer questions. After most of the groups completed the exercise, the entire class would reconvene. The instructor would display a group's work to all of the pods' monitors and have the group explain to the entire class how they tackled the problem and demonstrate the steps they followed. Discussion among the entire class ensued as the instructor prodded the presenting group with more in-depth questions and other groups chimed in with their approach.

The combination of the interaction and collaboration between the groups, the instructor, and the LAs and the debrief sessions with the entire class is perhaps the most interesting aspect to this class using the LA model. The LAs were actively involved in each class meeting, engaging students and answering questions. Students seemed to connect with the LAs and felt comfortable asking them questions that they were hesitant to ask to the instructor in a large class setting. Members of groups collaborated every class to work through the active learning exercises and problems. The collaboration of students within a group is one of the primary benefits of the LA model. Students are forced to not only work through problems but also explain their logic and reasoning to the other members of the group. Then groups are required to explain their analysis to the entire class. In effect, students are forced to explain or teach the concepts to their peers, invoking notions of the Latin proverb *docendo discimus* ("by teaching, we learn").

The LAs are an obvious vital part of this pedagogical approach. In our case, the LAs were undergraduates who completed the course during one of its traditional learning environment offerings. They were both exemplary students and earned high marks for the course and eagerly transitioned into the LA role. They met with the professor for one hour before each class meeting to discuss the current topics that were going to be covered, review the exercises that were going to be used for the class period, plan relevant future classroom activities, and provide their perception and feedback regarding student progress. The LAs were empowered by the instructor to fully engage with the students during the collaborative group work. The same two LAs were used for both semesters comprising the LA model group of students described in this study.

4. Analysis and Results

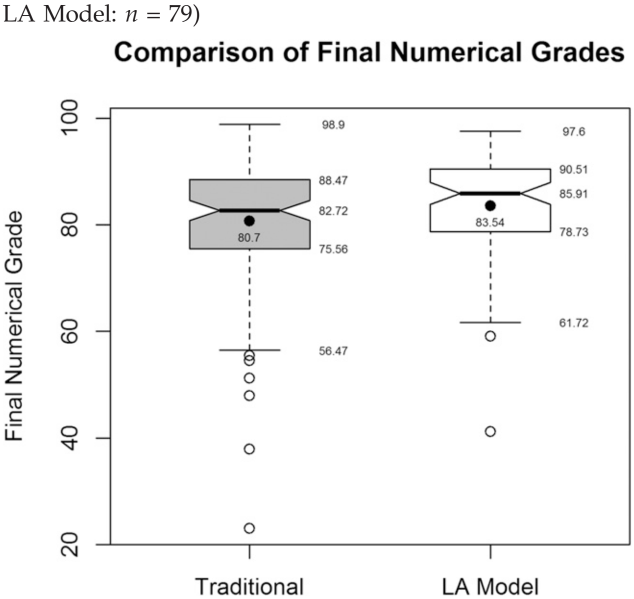
The primary reason we transformed the Business Analytics course from a traditional learning environment into a course that incorporated the LA model was the desire to help students succeed. We hoped and hypothesized that all students taking the course utilizing the LA model format would gain a better mastery of the material and thus earn better grades for the course. In other words, can we improve the entire distribution of grades, not just the lower tail, by utilizing the LA model?

Recall that the "traditional" group of students were students who attended a face-to-face class twice a week for 75 minutes each time. The class time was primarily dedicated to lecture and demonstration by the instructor. There were 120 total students in this group. The "LA model" group of students watched lectures and demonstrations online outside of class time and then spent the class time of 75 minutes twice a week working in groups on active learning exercises. During class, they were assisted by the instructor and two LAs. Students were required to explain their analysis of the exercises to the entire class, allowing for more in-depth discussion and microlectures by the instructor. The LA model group contained 79 students. All students were taught by the same instructor utilizing very similar formal assessments. We compare these two groups of students to determine whether there are differences.

Our comparison of the two groups employed a variety of methods that examined final numerical grades. There were a total of five students in the traditional group who withdrew from the course and received a letter grade of a "W." No students from the LA model group earned a W. For all of our analyses, we do not consider the students who had a letter grade of a W. There are two primary reasons for removing these students from the analysis. First, because they did not complete the entire course, their final numerical grade would be much lower than the students who stayed in the course and attempted the assessments. Second, a student may have to withdraw from a course for numerous reasons, many of which may not be related to the student having difficulty with the course material. Including the W students would bias our results in favor of the LA model, so removing these students makes the analysis more conservative. The final sample size for the traditional group was 115 students; the sample size for the LA model group remained at 79 students.

Initially, we created a notched box plot of the students' final numerical grades as shown in Figure 2. This graphic helps to visually compare the two groups. We notice that the students in the LA model group show a higher mean and median and less variance than the traditional group. Both groups are

Figure 2. Comparing the Final Numerical Grades of Students Taking the Course with a Traditional Teaching Model with the Students Who Took the Course Incorporating the LA Model (Traditional: n = 115; LA Model: n = 79)



left-skewed. The notched box plot can help informally inspect whether a difference in the two medians exists. If the two notches do not overlap, it indicates strong evidence that the two medians differ (Chambers et al. 1983, p. 62). In this case, the two notches look to be slightly overlapping, giving us motivation to more rigorously explore whether and how the central locations of the two groups differ.

Additionally, we can visually inspect the probability density functions of the two groups to help identify possible differences. Figure 3 shows promise that the LA model may be helping reach our goals of assisting students to be more successful in the business analytics course—in particular, the "middle" students.

Both of these figures suggest that the distributions of the two groups are different. The middle portion of the distribution can be thought of as the "average" or "typical" student. Figure 3 indicates that the concentration of grades for those typical students has shifted to the right toward higher numerical grades with a higher peak for the LA model. This observation is encouraging. It leads us to statistically test whether the LA model is effective and produces higher student grades than does the traditional model.

First, we compare the means between the two groups using parametric approaches. We start by conducting a one-tailed Welch two-sample t-test, allowing us to compare the means between the two independent groups without assuming equal population variances. To see whether the LA model students are earning higher final numerical grades, we form the following hypothesis test.

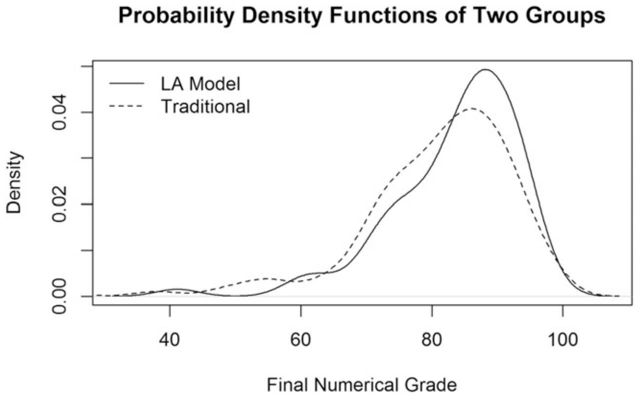
Hypothesis 1. *The mean final numerical grades for students from traditional classes are greater than or equal to the mean final numerical grades for students from the LA model classes*:

$$\mathrm{H1}_0: \mu_{\mathrm{trad}} \geq \mu_{\mathrm{LAM}},$$
$$\mathrm{H1}_A: \mu_{\mathrm{trad}} < \mu_{\mathrm{LAM}}.$$

Using a Welch two-sample t-test, we find that students from LA model classes earn higher numerical grades (M = 83.54322, SD = 9.79263) than students who took the course in a traditional setting (M = 80.69805, SD = 12.13998); $t(187.01) = -1.8011$, p = 0.03665. Thus, Hypothesis 1 is rejected at the 5% significance level.

It is important to note that the box plot in Figure 2 showed outliers. The total proportion of outliers across both groups is approximately 4%, with a higher proportion of 5.2% belonging to the traditional group. One approach to dealing with outliers while comparing central locations is to use trimmed means instead. Yuen (1974) derived a method for comparing trimmed means of two samples. Whereas Wilcox (2012, p. 329)

Figure 3. Visually Inspecting the Density Plots for the Final Numerical Grades of Students Taking the Course with a Traditional Teaching Model and the Students Who Took the Course Incorporating the LA Model (Traditional n: = 115; LA Model: n = 79)



suggests that 20% trimming is a good choice for general use, we performed Yuen's test for trimmed means iteratively using a trimming parameter ranging from 2% to 25%. The corresponding formal hypothesis is as follows.

Hypothesis 2. *The trimmed mean final numerical grades for students from traditional classes are greater than or equal to the trimmed mean final numerical grades for students from the LA model classes*:

$$\mathrm{H2}_0: \mu_{\mathrm{trad}}^{\mathrm{trimmed}} \geq \mu_{\mathrm{LAM}}^{\mathrm{trimmed}},$$
$$\mathrm{H2}_A: \mu_{\mathrm{trad}}^{\mathrm{trimmed}} < \mu_{\mathrm{LAM}}^{\mathrm{trimmed}}.$$

The resulting p-values ranged from 0.03032 (24% trimming) to 0.04554 (5% trimming). (For the full trimming results that was tested, please see the p-values found in Table 2 in the online appendix). We see that these results are consistent with the one-tailed, two-sample t-test from before. All of these p-values support rejecting the Hypothesis 2 at the 5% significance level and indicate that the students in the LA model group exhibited higher trimmed mean final numeric grades than the students from the traditional group.

It is also useful to conduct nonparametric tests to provide a different perspective. In particular, many nonparametric methods attempt to circumvent issues with outliers. The Mann–Whitney U test (also commonly referred to as the Wilcoxon-Mann-Whitney test) is a classic nonparametric technique for testing whether two independent samples were selected from populations having the same distribution. We test the following hypothesis.

Hypothesis 3. *The true location shift of final numerical grades when moving from the traditional group to the LA model group is less than or equal to* 0.

A Wilcoxon-Mann-Whitney test indicated that the true location shift was greater than 0; W = 5,216, p = 0.03992. We conclude that at the 5% significance level, the two groups have different distributions and that the location shift is in the direction of higher grades for the LA model group compared with traditional group. The presence of tied values may cause difficulty for this test. One suggested alternative is the method developed by Cliff (1996) because it appears to perform relatively well for tied values. When we conduct this robust test, the resulting p-value is 0.045, coinciding with the conclusion from the Wilcoxon-Mann-Whitney test.

The various statistical tests indicate that, overall, there is a difference in the central tendency between the two groups, with the LA model students having higher final numerical grades. From Figures 2 and 3, we are also interested in comparing these two groups by inspecting multiple quantiles at the same time. A method that performs well when comparing quantiles, even in the presence of tied values, was given by Wilcox et al. (2014). We use this bootstrap method and examine all the quantiles from 0.05 to 0.95 in steps of 0.05. As indicated by the results in Table 1, the five quantiles between 40% and 60% (inclusively) all show statistical significance that the students from the LA model group have higher final numerical grades than the students from the traditional group. That is, the middle/typical students are performing better when the LA model is used instead of the traditional model. This result coincides with our previous tests on the central location of the two groups and is encouraging in the sense that the LA model appears to be helping the "average" student.

5. Conclusion

As students often deem quantitative courses to be the most difficult, our goal was to identify and implement a pedagogical technique that might improve students' performance. We measured the effectiveness of the LA model applied to a quantitative business class by comparing the students' final numerical grades who participated in the LA model classroom to those students who took the same course taught in a traditional manner by the same instructor. Summarizing our results from the previous section, we showed that the central location for the final numerical grades of the two groups was different; students from the LA model group earned statistically higher/better final numerical grades when conducting one-tailed hypothesis tests at the 5% significance level for both the mean and trimmed mean. We also found some evidence that the LA model is useful at increasing the final numerical grades for "the middle students" when we compared quantiles of the two groups. Overall, there is modest improvement with the implemented

Table 1. The 40th–60th Percentiles Show Statistically Significant Higher Final Numerical Grades for the LA Model Compared with the Traditional Model at the 5% Level

Quantile	Traditional	LA model	Traditional – LA model	Estimated *p*-value
0.40	80.25572	83.54830	−3.29258	0.0340
0.45	81.68550	84.77170	−3.08621	0.0385
0.50	82.96522	85.88825	−2.92303	0.0350
0.55	84.23363	86.83062	−2.59699	0.0385
0.60	85.37172	87.61692	−2.24521	0.0480

Note. LA, learning assistant.

LA model, indicating that it can be successful at "bending the curve" in the proper direction by shifting the distribution of success to the right.

Although the results of this study are encouraging, there are some challenges that should be considered. This course was transformed into a flipped classroom and utilized an ALC. Not every university has access to or can easily convert classroom space into an ALC. There are potentially other ways to implement the LA model without an ALC, but we did not explore those options for this study. Additionally, the setup used required students to bring their own laptops. However, there is no laptop requirement at this institution. Although the overall impact was minimal, some students commented that having a "standard computer" at each pod would be beneficial. Additionally, when students did not bring a laptop, they may have been at a disadvantage because the course was structured around collaborative group work exercises that required Microsoft Excel. Although these students could follow along on the group's shared screen, they could not complete the actual steps to the exercise individually.

The transformed course utilized a flipped classroom environment, which places a preparatory burden on students by requesting that they watch the online videos and read the textbook before coming to class. We found that, via surveys, at the beginning of the semester students intended to watch the videos before coming to class but by the end of the semester admittedly fell short of their initial intentions. If the group work and curriculum is designed around the assumption that the students have watched the online lectures prior to attending class, instructors might wish to combat any potential issues by, for example, formally quizzing students directly on the assigned videos for the class to help with student accountability.

Another potential hurdle is the unfamiliarity of the structure and expectations of a transformed LA model class. Students generally do not understand the expectations of this type of class, as it differs from traditional courses. One way to help with this issue is for the instructor to emphasize the expectations of students and how they differ from a traditional lecture-based course *multiple times throughout the semester*. This reiteration should also be accompanied by "*the why*" the course is being taught using this model. These reminders may help students be better prepared to engage in the active learning exercises during the class meetings.

The instructor also observed that students often chose to sit in the same groups and the same seats. Although classmate familiarity is aided by this occurrence and may enhance a student's experience, instructors may have pedagogical reasons to encourage students to rotate tables on a weekly basis. Implementation largely depends on learning goals for the course.

Although the LA model provides LAs with a pedagogical course, instructors implementing the LA model should carefully select the LAs for their classrooms. Learning assistants should have a strong grasp of the material and robust communication and social skills, as their interaction with the students will have a strong impact on the success of the implementation. The university must also allocate the funds to pay the LAs and resources to correctly implement this model in classrooms. For example, when first attempting to implement the LA model, the instructor may need some monetary incentive to transform the course, as it can be a large and involved endeavor.

As instructors consider whether to attempt transforming their own quantitative courses using the LA model, they should carefully weigh the anticipated benefits and costs. Although the necessary course transformation is time consuming and requires careful thought, our initial successes are encouraging. We suggest that instructors get buy-in from colleagues and administrators to help increase the chances of successful implementation. Helping students master the quantitative material is a worthy goal for instructors; providing students an active learning setting that allows them to "learn by doing" is an earnest goal. We suggest that the LA model allows educators to attain such goals.

References

AACSB International (2018) AACSB conferences and seminars for business schools: AACSB events. Accessed September 6, 2018, https://www.aacsb.edu/events.

Albright SC, Winston WL (2017) *Business Analytics: Data Analysis and Decision Making*, 6th ed. (Cengage, Boston).

Anderson DR, Sweeney DJ, Williams TA, Camm JD, Cochran JJ, Fry MJ, Ohlmann JW (2016) *Quantitative Methods for Business*, 13th ed. (Cengage, Boston).

Anderson DR, Sweeney DJ, Williams TA, Camm JD, Cochran JJ, Fry MJ, Ohlmann JW (2019) *An Introduction to Management Science: Quantitative Approaches to Decision Making*, 15th ed. (Cengage, Boston).

Asef-Vaziri A (2015) The flipped classroom of operations management: A not-for-cost-reduction platform. *Decision Sci. J. Innovative Ed.* 13(1):71–89.

Camm JD, Cochran JJ, Fry MJ, Ohlmann JW, Anderson DR, Sweeney DJ, Williams TA (2019) *Business Analytics*, 3rd ed. (Cengage, Boston).

Chambers JM, Cleveland WS, Kleiner B, Tukey PA (1983) *Graphical Methods for Data Analysis* (CRC Press, Boca Raton, FL).

Cliff N (1996) *Ordinal Methods for Behavioral Data Analysis* (Lawrence Erlbaum Associates, Mahwah, NJ).

Goertzen RM, Brewe E, Kramer LH, Wells L, Jones D (2011) Moving toward change: Institutionalizing reform through implementation of the Learning Assistant Model and Open Source Tutorials. *Phys. Rev. Special Topics Phys. Ed. Res.* 7(2):020105-1–020105-9.

Kent J (2018a) NJ Hospital Association launches big data analytics center. *Analytics in Action* (blog), September 6, https://healthitanalytics.com/news/nj-hospital-association-launches-big-data-analytics-center.

Kent J (2018b) Using big data, machine learning to reduce chronic disease spending. *Analytics in Action* (blog), September 6, https://healthitanalytics.com/news/using-big-data-machine-learning-to-reduce-chronic-disease-spending.

Kiron D, Ferguson RB, Prentice PK (2013) From value to vision: Reimagining the possible with data analytics. *MIT Sloan Management Rev.* (March 5), https://sloanreview.mit.edu/projects/from-value-to-vision-reimagining-the-possible-with-data-analytics/.

LaValle S, Lesser E, Shockley R, Hopkins MS, Kruschwitz N (2011) Big data, analytics and the path from insights to value. *MIT Sloan Management Rev*. 52(2):21–32.

Learning Assistance Alliance (2017a) What is the LA Model and how does it differ from an LA Program? Accessed December 11, 2017, https://sites.google.com/a/colorado.edu/la-resources/gpes/la-model.

Learning Assistance Alliance (2017b) What are transformed courses? Accessed December 11, 2017, https://sites.google.com/a/colorado.edu/la-resources/gpes/transformed-courses.

Learning Assistance Alliance (2017c) Learning Assistant Program implementation guide, revised October 2017. Report, Learning Assistance Alliance, University of Colorado Boulder, Boulder. https://drive.google.com/file/d/0BwM_fXj_NzPmNTNEYmNnb1VOaVE/view.

Moore MG (1993) Theory of transactional distance. Keegan D, ed. *Theoretical Principles of Distance Education*, 1st ed. (Routledge, London), 22–38.

Murtonen M, Lehtinen E (2003) Difficulties experienced by education and sociology students in quantitative methods courses. *Stud. Higher Ed.* 28(2):171–185.

Otero V, Pollock S, Finkelstein N (2010) A physics department's role in preparing physics teachers: The Colorado learning assistant model. *Amer. J. Phys.* 78(11):1218–1224.

Richards G (2017) Extracting value from business analytics: Consider your decision environment. *Ottawa Bus. J.* (December 6), http://www.obj.ca/article/extracting-value-business-analytics-consider-your-decision-environment.

Scala N, Tomasi S, Goncher A, Bursic K (2018) Motivation and analytics: Comparing business and engineering students. *INFORMS Trans. Ed.* 19(1):1–11.

Swart W, Wuensch KL (2016) Flipping quantitative classes: A triple win. *Decision Sci. J. Innovative Ed.* 14(1):67–89.

Van Dusen B, Langdon L, Otero VK (2015) Learning Assistant Supported Student Outcomes (LASSO) study initial findings. Churukian AD, Jones DL, Ding L, eds. *2015 Phys. Ed. Res. Conf. Proc.* (American Association of Physics Teachers, College Park, MD), 343–346.

Webb DC, Stade E, Grover R (2014) Rousing students' minds in postsecondary mathematics: The undergraduate learning assistant model. *J. Math. Ed. Teachers College* 5(2):39–47.

White J-SS, Van Dusen B, Roualdes EA (2016) The impacts of learning assistants on student learning of physics. Jones DL, Ding L, Traxler A, eds. *Proc. 2016 Phys. Ed. Res. Center, Sacramento, CA*, 384–387.

Wilcox RR (2012) *Modern Statistics for the Social and Behavioral Sciences: A Practical Approach* (CRC Press, Boca Raton, FL).

Wilcox RR, Erceg-Hurn DM, Clark F, Carlson M (2014) Comparing two independent groups via the lower and upper quantiles. *J. Statist. Comput. Simulation* 84(7):1543–1551.

Wilder CR, Ozgur CO (2015) Business analytics curriculum for undergraduate majors. *INFORMS Trans. Ed.* 15(2):180–187.

Yousef DA (2011) Academic performance of business students in quantitative courses: A study in the faculty of business and economics at the UAE University. *Decision Sci. J. Innovative Ed.* 9(2):255–267.

Yuen KK (1974) The two-sample trimmed *t* for unequal population variances. *Biometrika* 61(1):165–170.

Zhang AM (2003) Transactional distance in web-based college learning environments: Toward measurement and theory construction. Unpublished doctoral dissertation, Virginia Commonwealth University, Richmond.