Student Choices of Reduced Seat Time in a Blended Introductory Statistics Course

By

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Student Choices of Reduced Seat Time in a Blended Introductory Statistics Course

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Abstract

Two instructional features are available to students in blended courses that are not present in traditional courses. First, online content is available with the intent that it substitute for a portion of face-to-face lectures or other in-class types of material delivery. Second, in-class seat time in a blended course is reduced as compared to the traditional version of the course. In this paper, we explore student choices of reduced seat time in a style of blended course that does not have a punitive attendance policy, uses online lectures rather than in-class lectures, and conducts alternative, but optional, in-class activities. After accounting for the natural tendency of students to skip classes in a traditional course, we find an interval estimate of 49 to 62 percent for the mean reduction in seat time chosen by students. Also, using an empirical model of attendance, we find that student use of online materials contributes in a positive way to class attendance.

JEL Classification: A10, A23, C00
Key Words: Blended Courses, Business Statistics, Student Choice, Undergraduate, Education
The blended format has become a popular mode of course delivery in higher education. Parsad, Lewis, and Tice (2008), in a report from the National Center for Education Statistics, define blended courses as combining online and in-class instruction with reduced in-class seat time. The concept of blending instructional materials with online delivery modes to replace a portion of in-class seat time has proven to be an attractive alternative to traditional courses that are characterized by face-to-face (instructor-to-student) lectures and full use (sometimes mandatory for students) of the classroom time allotted to the course. A substantial number of studies have promoted the blended trend and have evaluated its progress and evolution in a favorable light. For example, Garrison and Kanuka (2004) and Klein, Noe, and Wang (2006) consider blended learning to possess transformative potential by promoting new and higher levels of student responsibility, control, and independence, and by raising levels of critical thinking. Arbaugh et al. (2009) provides an extensive survey of studies of blended learning with emphasis upon the business disciplines.

But “how blended” is a course that is described or promoted as being blended? At one end of the blended spectrum is the traditional face-to-face course with no online content while at the other end is the purely online course. We propose that students, when given the opportunity, will determine for themselves “how blended” a blended course will be by selecting their own levels of reduced seat time. The blended course in this study is a collegiate introductory course in business and economic statistics where lectures are only available online while the traditional class period is used for complementary learning activities. No formal lectures are given in class and the course does not have an attendance policy. Students are free to create an approximation to a traditional course by regularly attending class periods. At the other extreme, if students
choose not to attend class periods they effectively create an online course and do so without fear of incurring an attendance penalty.

We present evidence on several aspects of the reduced seat time feature in a blended course. First, what reduction in seat time do students prefer when given the choice? Attendance records are used to establish the preferred reduction in seat time. Second, how does the reduction compare with the natural tendency to skip class in a traditional course? We use a traditional section of the same course, delivered with classic face-to-face lecture methods, as a comparison group to measure the natural tendency to skip. Interval estimates of the percent of reduced seat time, after taking into account the natural tendency to skip, are prepared. Third, what factors contribute to (or detract from) class attendance in a blended course? An empirical model of attendance is constructed and estimated in three different formats to address the question. Among several interesting results from the model, we find evidence of a mid-course correction by students having grades below the class median that prompts an increase in attendance (decrease in reduced seat time). Fourth, is attendance in a blended course reduced by the use of online materials? Two measures of online materials usage are considered, the volume of accesses to online materials and the consistency with which the materials are accessed during the course. Estimates of the net effect upon attendance from the two measures are developed.

Our blended course combines characteristics of flipped courses and flexible courses and could be referred to a “flip-flex” course. First comes the “flip” characteristic in the form of not providing in-class lectures and urging students to listen to online lectures and read material prior to the optional class meeting in which the material forms the basis for questions, clarifications, discussions, and demonstrations. Second comes the “flex” characteristic that is present by virtue of the class meetings being optional with no penalty for not attending. Students may totally opt
out of attending class other than for the exams that are administered in the classroom. However, such behavior is unlikely to occur. Owston, York, and Murtha (2013) summarize several attractions to students stemming from the availability of face-to-face sessions within blended courses: students can communicate directly with the instructor; students can interact with one another, make acquaintances, and carry the learning process outside of the classroom; students may develop a greater sense of satisfaction with the course experience. More details of our course structure are given in a later section.

In the flip-flex environment, the role of the instructor as a dependable provider of in-person “first encounters” with course material can no longer be counted on by students. Yet, according to survey results shown in Farley, Jain, and Thomson (2011), the feature of “introduce new concepts” (i.e. first encounters) is the primary activity expected by students in a face-to-face lecture. The spectrum of detail and instructional approach that instructors can take during optional class periods of a flexible blended course is very broad and, if so desired, can be made to approximate a first encounter. For example, an instructor can limit activities and interchanges in optional class periods to be narrowly focused. An example from an introductory statistics course is as follows. A student has just asked the instructor, “I’m confused about the calculation of the expected value of the discrete random variable in exercise 25 from the text. Could you please explain how they got the answer?” This question can be answered in a direct, terse manner or very generally by allowing the particular exercise to serve as a springboard for a much more general discussion and presentation. A direct, terse answer could entail showing the solution from the text’s solution manual on the classroom projection system and quickly noting that the multiplication of the values of the variable by the respective probabilities need to be summed and the arithmetic carefully checked. Or, the student’s question can easily be turned
into a 10 minute (or longer) “flash lecture” about discrete random variables in general. If the
day’s classroom activities include several of these episodes, then for all practical purposes the
students have just received a reasonable facsimile of a traditional lecture. Thus, the lines
between a flip-flex course and a web-enhanced traditional course can be made very sharp or
blurred depending upon instructor styles.

REDUCED SEAT TIME AND OTHER BLENDED FEATURES

In this section, we review a variety of studies that have offered specifics about the
structures of their blended courses and have carefully described the reductions in seat time versus
traditional versions of the course. We hope to convey a general sense of the frameworks,
protocols, and activities used by instructors of blended courses once the decision has been made
to reduce the seat time versus that in the traditional version of the course. Since our course is
introductory statistics, we begin with studies involving courses from that subject area.

Utts et al. (2003) describe a blended course in elementary statistics that featured a 60
percent reduction in seat time versus the traditional version of the course. The blended course
had one class meeting of 80 minutes per week. Attendance at the 80 minute class was mandatory
for the students as they needed to complete a weekly quiz in class. The quiz covered materials
that had been previously assigned for the week and it was administered during the first 20 to 30
minutes of class. The other 50 to 60 minutes were used by the instructor to do an overview of
materials for the following week as well as to go over some of the interactive online materials.
Additionally, students had to complete weekly homework, a midterm exam, and a
comprehensive final exam.
Elementary statistics was also the subject in Ward’s (2004) blended course. The reduction in seat time was 50 percent with one class session of 75 minutes being held per week. During the session, the instructor did not present new material, using the time instead to answer questions related to problems and practice worksheets, and to administer quizzes and tests. Emphasis was placed on the importance of learning the materials outside of class. Each online module included links to learning activities, such as interactive worksheets, applet demonstrations, practice exams and answers, computer lab tasks, and reviews of the materials presented in the textbook. The attendance policy for the weekly class session was not discernible from the course description so it is not clear whether students could choose to attend or not.

The blended course in Cybinski and Selvanathan (2005) is the third, and final, course from the introductory statistics area that we summarize. After attending a two-hour plenary session in the first week of class, students had the option of attending three hours of class time every week consisting of a two-hour workshop and a one-hour laboratory session. The traditional version of the course held four hours of class time every week. Based on a student that chose to attend all available class meetings in the blended course, the reduction in seat time would be 25 percent, a relatively minor reduction. However, because attendance was optional, a student could effectively create a purely online course with a reduction in seat time of 100 percent. The blended course used the same text, and students were provided with the same lecture notes, as in the traditional version of the course. Students were expected to use an online learning tool containing modules of content keyed to the major topics in the course. Within that tool, students participated in online practice sessions and quizzes on a weekly basis.

Riffell and Sibley (2005) describe a blended version of their environmental biology course that enforced a substantial reduction of 67 percent in seat time versus the traditional
version. The traditional version had three 50-minute lecture classes per week while the blended version had one. The other two lecture classes were replaced by online homework assignments, one due prior to the remaining lecture and the second due at the end of the week. The single lecture class in the blended version, as well as one of the three in the traditional version, was termed an “active” lecture environment. A short lecture of 5 to 15 minutes led off the class meeting followed by giving students a problem to complete that would be graded. Students could collaborate with others and ask questions of the instructor while completing the task. After the work session was completed, the instructor gave a short wrap-up lecture about the completed problem. One or two of these lecture-problem-lecture sequences were done in the week’s single 50-minute class.

Attendance was taken in the blended class in a manner that would mimic attendance records in the traditional class, that is, participation in one or more of the three “classes” per week. A student was considered to have attended an online homework “class” if at least one half of the online homework problems were attempted. Attendance was also collected during the single active lectures of the weeks. A student was counted as present if they turned in the in-class exercise(s) completed during the active lecture. The weight attached to the attendance record in the final course grade was 15 percent.

Keller et al. (2009) created a blended version of a managerial accounting course by eliminating one of the two weekly class meetings in their traditional offering for a reduction in seat time of 50 percent. The blended version was offered concurrently with the traditional version. A standard lecture format was used in the weekly class meeting. Students in the blended version were assigned to teams and worked together on problem sets that were submitted online to the instructor. Solutions to the problem sets were subsequently posted.
Online practice quizzes were also featured in the blended course but no other customized materials such as online lectures are mentioned by the authors.

Ashby, Sadera, and McNary (2011) used materials from a purely online version of their intermediate algebra course as the foundation for a blended version. The course was organized into units with each containing online materials that included lectures in the form of slides with audio, transcripts of the lectures, practice problems with answers, and a quiz for self-assessment of progress. The blended course was listed in the course schedule as meeting twice a week but students were informed on the first day of class that only one class meeting per week would be held and that the second meeting would be replaced by an optional lab. Thus, students had a choice to reduce seat time up to 50 percent. Lectures and other class activities common to a traditional version of the course were conducted during the single class meeting of the week. Fewer examples were provided at the single class meetings versus what could be provided if there had been a second lecture class for the week. At the optional labs, the instructor was present to answer questions and provide assistance with the online content noted above. The authors noted that the attendance rate at the optional labs was low.

A moderate reduction in seat time was made by McKenzie et al. (2013) in their development of a blended version of an introductory psychology course. The traditional version of the course had carried three weekly lectures of one hour each. Seat time was reduced to a single weekly lecture of two hours and an online personalized learning system from a commercial vendor was integrated into the course. Modules aligned with lecture topics were created in the learning system. In each module, students took a pre-test and the system generated a personalized study plan according to the outcome. After working through a set of online materials organized under the study plan, a post-test was available to measure progress. Lecture
slides were available prior to the in-class lectures and audio recordings of them were available afterwards. The generous level of access to the lecture content before and after the fact may partially explain the declining attendance rate at the lectures as the term progressed, from 82 percent at the outset to 36 percent at the end.

The studies reviewed above were selected to provide specific examples of reduced seat times and accompanying characteristics in blended courses. In addition to the above studies, Table 1 contains summary information from several other studies concerning seat times in traditional and blended versions of courses from a variety of disciplines. The array of studies in the table shows a wide range of reduced seat times (percent of traditional). Most of the reduced seat times in the list are the amounts enforced by the course structure rather than chosen by students. The wide range of times stirs a sense of curiosity. If students are presented with a blended course structure containing a comprehensive portfolio of online materials and no attendance policy for the complementary class meetings, what will their preferences for reduced seat time be?

**STRUCTURE OF THE BLENDED COURSE**

Our course is an introductory course in business and economic statistics. Many business schools and economics departments offer such a course, with some designating it as a degree requirement. The data for this study come from one blended section and one traditional section of the course, both sections having been taught by the same instructor at a public university. The two sections were a part of the instructor’s regular teaching load. The course has prerequisites of 27 credit hours or above (roughly sophomore standing), business calculus, and successful completion of a computer proficiency course. It is a required course for all business and economics majors.
### Table 1: Seat Time in Traditional and Blended Courses

<table>
<thead>
<tr>
<th>Study</th>
<th>Course Subject</th>
<th>Traditional Seat Time</th>
<th>Blended Seat Time</th>
<th>Percent of Traditional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashby et al. (2011)</td>
<td>Mathematics</td>
<td>3 hours/week</td>
<td>1.5 hours/week</td>
<td>50%</td>
</tr>
<tr>
<td>Bergstrom (2011)</td>
<td>Cell Biology</td>
<td>5 hours/week</td>
<td>2.5 hours/week</td>
<td>50%</td>
</tr>
<tr>
<td>Cybinski et al. (2005)</td>
<td>Statistics</td>
<td>4 hours/week</td>
<td>3 hours/week</td>
<td>75%</td>
</tr>
<tr>
<td>Dowling et al. (2003)</td>
<td>Accounting</td>
<td>3 hours/week</td>
<td>1.5 hours/week</td>
<td>50%</td>
</tr>
<tr>
<td>Keller et al. (2009)</td>
<td>Accounting</td>
<td>2 meetings/week</td>
<td>1 meeting/week</td>
<td>50%</td>
</tr>
<tr>
<td>Klein et al. (2006)</td>
<td>Business</td>
<td>2 meetings/week</td>
<td>1 meeting/week</td>
<td>50%</td>
</tr>
<tr>
<td>Larson et al. (2009)</td>
<td>MIS@</td>
<td>13 meetings/semester</td>
<td>8 meetings/semester</td>
<td>62%</td>
</tr>
<tr>
<td>Laumakis et al. (2009)</td>
<td>Psychology</td>
<td>N.A.*</td>
<td>N.A.*</td>
<td>55%</td>
</tr>
<tr>
<td>Lin (2008)</td>
<td>Technology</td>
<td>3 meetings/week</td>
<td>2 meetings/week</td>
<td>67%</td>
</tr>
<tr>
<td>McFarlin (2008)</td>
<td>Physiology</td>
<td>3 hours/week</td>
<td>1.5 hours/week</td>
<td>50%</td>
</tr>
<tr>
<td>McKenzie et al. (2013)</td>
<td>Psychology</td>
<td>3 hours/week</td>
<td>2 hours/week</td>
<td>67%</td>
</tr>
<tr>
<td>Melton et al. (2009)</td>
<td>Health</td>
<td>2 meetings/week</td>
<td>1 meeting/week</td>
<td>50%</td>
</tr>
<tr>
<td>Moore et al. (2010)</td>
<td>Geography</td>
<td>2 hours/week</td>
<td>1 hour/week</td>
<td>50%</td>
</tr>
<tr>
<td>Napier et al. (2011)</td>
<td>Computing</td>
<td>3 meetings/week</td>
<td>2 meetings/week</td>
<td>67%</td>
</tr>
<tr>
<td>Pereira et al. (2007)</td>
<td>Anatomy</td>
<td>45 hours/semester</td>
<td>33 hours/semester</td>
<td>78%</td>
</tr>
<tr>
<td>Riffell et al. (2005)</td>
<td>Biology</td>
<td>2.5 hours/week</td>
<td>50 minutes/week</td>
<td>33%</td>
</tr>
<tr>
<td>Scida et al. (2006)</td>
<td>Spanish</td>
<td>5 hours/week</td>
<td>3 hours/week</td>
<td>60%</td>
</tr>
<tr>
<td>Senn et al. (2008)</td>
<td>Technology</td>
<td>15 meetings/semester</td>
<td>5 meetings/semester</td>
<td>33%</td>
</tr>
<tr>
<td>Utts et al. (2003)</td>
<td>Statistics</td>
<td>200 minutes/week</td>
<td>80 minutes/week</td>
<td>40%</td>
</tr>
<tr>
<td>Ward (2004)</td>
<td>Statistics</td>
<td>2.5 hours/week</td>
<td>1.25 hours/week</td>
<td>50%</td>
</tr>
</tbody>
</table>

* N.A. - Not available. @MIS – Management information systems.

The blended course had the characteristics listed below.

1. Lectures were only available online and were in the form of slides with audio narrations by the instructor. Lectures were organized according to section numbers of chapters in the course text, thereby segmenting the material in a manner similar to what the students experienced when reading and working with the text. Students could select specific topics within chapter sections and drill down to specific slides and narrations dealing with the topic of interest.
2. Semi-weekly classes were 75 minutes in length and conducted as question-answer, exercise-solving, and general practice sessions by the instructor. Teaching assistants were not used in any of the class periods. A progress schedule was provided at the beginning of the course showing the recommended pace to be followed for the semester. The progress schedule specified the online lectures that should be listened to prior to each class period and also gave lists of suggested exercises in the text to be attempted (but not submitted for grading). Practice activities and questions aligning with the most current material were given priority during the class periods. When priority practice activities and consideration of priority questions were concluded, the floor was opened for questions from earlier material and for reviews of practice activities that had been held for earlier topics. Student absences were not penalized.

3. The course was organized into four modules. An exam worth 40 points was given during the concluding 75-minute class period of each module. There was no comprehensive final exam. A series of computer homework assignments using spreadsheets was required. The assessments had the following weights in the final course grade: exams - 90 percent; computer homework - 10 percent. Although students received randomized data sets for the computer homework, collaboration was encouraged. Accordingly, the 10 percent weight in the final course grade was not earned in a controlled environment and is disregarded in this study. The sum of the scores on the four exams will be referred to as “course points” in later work.

4. The instructional formats to be used in the sections were not indicated in any advance registration materials. Students did not have any information as to the formats prior to the start of the course.
5. A short math quiz of 16 questions was administered in the classroom at the beginning of the course for the purpose of assessing students’ backgrounds in basic mathematics. The quiz was based on that used by Johnson and Kuennen (2006) in their study of math skills and performance in an introductory business statistics course.

The traditional section had semi-weekly class meetings of 75 minutes each and the meetings were used for face-to-face lectures. The same text, lists of suggested exercises, and assessment system were used in the traditional and blended sections. Exams and the math quiz were similar in format and coverage, the same computer homework tasks were assigned (with randomized data sets), and the same points system for exams and homework was used. Our blended format gives students a wide range of choice in customizing the course, anywhere from an online course (with the exception of the exams not being online) to an approximation of a traditional face-to-face course by regularly attending all class periods.

THE CHOICE OF REDUCED SEAT TIME

Students have a natural tendency, of varying degree, to skip class. For example, Romer (1993) documented a very high skip rate of 40 percent in an introductory economics course. In contrast, Rochelle and Dotterweich (2007) experienced a much lower skip rate of 13.8 percent (an average of 3.87 skips out of 28 class meetings) in an introductory business statistics course. The natural tendency to skip creates two versions of reduced seat time that are of interest when attempting to measure student preferences in a blended course. First is the reduction in seat time with respect to an assumed attendance rate standard of 100 percent. Second is the reduction in seat time that takes into account the natural tendency to skip if the student were attending the traditional version of the course. For example, a blended course may show an average attendance percent of 30 percent but it may not be accurate to say that students have reduced
their seat time by 70 percent due to the blended nature of the course. Suppose that their skip rate in the traditional version of the course would have been 20 percent. In effect, the chosen reduction in seat time due to the blended nature of the course has been 50 percentage points downward from the traditional section’s 80 percent attendance rate, for a chosen reduction factor of $100(1 - (50/80)) = 62.5$ percent in seat time rather than 70 percent. The tendency to skip will vary by course subject, instructor, time of day, and student characteristics. We control for the first three of those four influences by focusing on sections of the same course taught by the same instructor at the same time of day and on the same days of the week (but in different semesters). For the fourth influence, student characteristics, we establish the skip rate in a traditional section attended by students whose characteristics are similar to those of the students in the blended section.

Means for the student characteristics in the blended and traditional sections are given in Table 2. Also shown in the table is the t statistic for testing the equality of means in the two sections. There were 87 students in the blended section and 92 students in the traditional section. Student age is effective at the beginning of the course and was recorded in whole years. Many students take the course in their sophomore or junior years. Accordingly, the means of age in the sections are close to 20 years. Based on the t test reported in the last column of the table, the difference in mean age between the blended and traditional sections is not significant. Mean credit hours previously earned by students are close to the breakpoint between sophomore and junior standing. Semester credit hours have means in the sections that are between 13 and 14. The means of transfer hours are in the vicinity of 15, roughly equivalent to transferring a total of one semester’s work from one or more previously attended institutions. None of the means of
the credit-hour based characteristics are significantly different across the blended and traditional sections.

Table 2: Student Characteristics, Means

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Blended</th>
<th>Traditional</th>
<th>Difference</th>
<th>t test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>20.21</td>
<td>20.24</td>
<td>-.03</td>
<td>-.11</td>
</tr>
<tr>
<td>Total credit hours</td>
<td>53.58</td>
<td>54.60</td>
<td>-1.02</td>
<td>-.30</td>
</tr>
<tr>
<td>Semester credit hours</td>
<td>13.41</td>
<td>13.68</td>
<td>-.27</td>
<td>-.92</td>
</tr>
<tr>
<td>Transfer hours</td>
<td>14.89</td>
<td>15.43</td>
<td>-.54</td>
<td>-.18</td>
</tr>
<tr>
<td>GPA</td>
<td>3.22</td>
<td>3.19</td>
<td>.03</td>
<td>.47</td>
</tr>
<tr>
<td>Math quiz (of 16)</td>
<td>11.24</td>
<td>11.52</td>
<td>-.28</td>
<td>-.65</td>
</tr>
<tr>
<td>Calculus grade&lt;sup&gt;@&lt;/sup&gt;</td>
<td>9.13</td>
<td>8.49</td>
<td>.64</td>
<td>1.75**</td>
</tr>
<tr>
<td>ACT math</td>
<td>24.99</td>
<td>24.61</td>
<td>.37</td>
<td>.59</td>
</tr>
<tr>
<td>ACT composite</td>
<td>25.10</td>
<td>24.28</td>
<td>.83</td>
<td>1.40</td>
</tr>
<tr>
<td>Course points (of 160)</td>
<td>117.09</td>
<td>115.48</td>
<td>1.61</td>
<td>.56</td>
</tr>
<tr>
<td>Attendance (percent)</td>
<td>38.2</td>
<td>86.0</td>
<td>-47.8</td>
<td>-13.99*</td>
</tr>
</tbody>
</table>

* significance levels: * - .01, ** - .10.  <sup>@</sup> To calculate the mean and standard deviation, letter grades were converted to numeric values:  F  = 0; D- = 1;D = 2; D+ = 3;…; A+ = 13.

The next group of five student characteristics in Table 2 reflect prior academic performance, aptitude, and potential, particularly in relation to an introductory statistics course. GPA is the overall grade point average effective as of the beginning of the course. The math quiz, patterned after the quiz from Johnson and Kuennen (2006), is an indicator of the student’s general level of preparation in basic math skills of the type likely to be encountered in an introductory statistics course. The grade in the prerequisite calculus class and the score on the math portion of the ACT also serve as signals of student abilities in quantitative subject material. Calculus letter grades were converted to a numeric scale (shown at the bottom of the table) for purposes of calculating means and the associated test statistic. An indicator of general aptitude is provided by the ACT composite score and is used by the institution in its admission requirements. Within the group of five characteristics, only the mean calculus grade exhibits a significant difference, although just at the 10 percent level, between sections with the blended class having the slightly higher mean. Based upon the numeric scale used to convert letter
grades, the difference of .64 amounts to approximately one-half of the gap between the grade levels. In our data, the difference resides in the upper portion of the gap between the letter grades of B and B-. We do not have an explanation for the difference, only speculation. Many of the students in the introductory statistics class have taken courses in their freshman and sophomore years in a standard sequence due to the need to satisfy prerequisites for higher level courses. Calculus is one of the prerequisites for the introductory statistics class. Our blended section and traditional section were not taught in the same semester. It may have been the case that a nontrivial proportion of students in the blended section, as they were fulfilling the calculus prerequisite, just happened to encounter an instructor (or instructors) that was more lenient in grading than was the case for the students that ended up in the traditional section.

The lack of significant differences between means in Table 1, with the minor exception of the calculus grade, is evidence that the students from both sections constitute one relatively homogeneous group. This remains true at the end of the course as evidenced by the means of course points. There is no significant difference in student performance between the blended and traditional sections. Overall, we conclude that we can proceed under the assumption that we have a legitimate treatment group (blended section) and control group (traditional section) for developing an estimate of the reduction in seat time chosen by students in a blended versus traditional course. Thus, we can proceed to the estimates of reductions in seat time. The point estimate for the mean reduction in seat time chosen by students is 61.8 percent and the 95 percent interval estimate of the mean reduction is 58.3 to 65.3. After taking into account the natural tendency to skip in the traditional version of the course, the point estimate of the mean reduction in seat time chosen by students is $100(1 - (38.2/86.0)) = 55.6$ percent. An interval estimate can be prepared based upon the delta method for determining the standard error of the
ratio of two means. The 95 percent interval estimate is 48.7 percent to 62.5 percent. Fieller’s (1954) method was also used to create the interval and it yielded an almost identical result.

**ONLINE MATERIALS AND REDUCED SEAT TIME**

In this section we describe an empirical model of attendance and show how various student characteristics and usage of online materials affect the choice to attend class meetings in the blended course. By describing the determinants of attendance, we are indirectly describing the determinants of choosing levels of reduced seat time. For example, if the level of a student characteristic positively affects the choice to attend class, it is negatively affecting the choice to reduce seat time (not attend class). In effect, reduced seat time is merely the inverse of class attendance.

Two measures of student usage of the online materials will be used. The first measure is total accesses of the four modules of online materials. The second measure is the consistency measure developed by Baugher, Varanelli, and Weisbord (2003). It is based upon whether or not a student accesses online materials between adjacent class periods. A value of one is recorded when the student accesses at least one piece of material between a pair of adjacent class periods. It does not matter whether the material being accessed is current or tardy in terms of course flow, only that at least one access to some piece of material occurred. The consistency measure is the count of the number of those interclass time spans in which students made accesses to materials. There were 26 pairs of adjacent class periods between which students could have made accesses to materials. An addition of one to the consistency measure signals that the student has used online materials during the time span between a pair of class periods and therefore serves as an indicator of the student’s continuity of engagement with the course.
Table 3 contains descriptive statistics for the usage measures. For both measures, the minimum value observed in the sample was two. From the mean of the consistency measure, students accessed one or more materials between adjacent class periods 15 times out of the 26 pairs of adjacent class periods.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total accesses</td>
<td>2</td>
<td>155</td>
<td>60.6</td>
<td>31.4</td>
</tr>
<tr>
<td>Consistency (out of 26)</td>
<td>2</td>
<td>26</td>
<td>14.9</td>
<td>6.0</td>
</tr>
</tbody>
</table>

The availability and usage of online materials may have significant, but unpredictable, effects upon class attendance. Do students view usage of the online materials as complementary to class attendance or as a substitute for class attendance? The first measure, total accesses, represents the general level of reliance upon the online materials. The expected direction of the effect upon class attendance is ambiguous. The effect might be complementary. Higher numbers of accesses might indicate higher interest levels in the subject, leading to higher class attendance. Or, it could be that total accesses act as a substitute for class attendance. The more accesses by the student, the less perceived is the need to go to class. The second measure, consistency, could also be either complementary to attendance or serve as a detractor from attendance. Higher consistency scores reflect higher levels of student engagement and we would expect class attendance to be higher as a result. However, the consistency measure could merely be mirroring patterns in total accesses, creating the possibility that higher consistency scores lend a negative effect upon attendance if total accesses do. A mixed outcome may prevail. It may turn out that accesses to the online materials serve as a substitute for class attendance while consistency of accessing materials serves as a complement to class attendance. In that case, the net effect could be positive, zero, or negative and will need to be determined.
There is a strand of literature dealing with attendance decisions and the availability of online materials within traditional face-to-face courses (they would be classified accordingly as “web-enhanced”) and blended courses that have face-to-face lectures as a component of the course portfolio. Representative studies in the strand include Kinlaw, Dunlap, and D’Angelo (2012); Traphagan, Kucsera, and Kishi (2010); and Grabe, Christopherson, and Douglas (2005). Examples of online materials include webcasts of face-to-face lecture captures, lecture outlines, lecture transcripts, lecture slides, and course readings. A recurrent finding in the literature is that the availability of online materials of the types in the preceding list creates negative incentives to attend face-to-face lectures. However, there are exceptions. For example, survey results reported in Yudko, Hirokawa, and Chi (2008) do not point to a negative effect upon attendance from the availability of online materials. Because our blended course does not have a face-to-face lecture component, we cannot translate any of the above themes into expectations of how online materials will affect the choice of reduced seat time.

Crede, Rock, and Kieszcynka (2010) conducted a meta analysis of studies that have examined relationships between class attendance and a variety of student characteristics. Of the student characteristics represented in the range of studies, two stand out. The strongest bivariate relationship with class attendance is provided by grade point average with a weighted mean observed correlation of .37, followed by “conscientiousness” with a weighted mean observed correlation of .22. Accordingly, we adopt grade point average as the cornerstone of our model of attendance. Our version of “conscientiousness” is the consistency measure of online materials use. Recall that the consistency measure is the count of the number of interclass time spans in which the student accessed online materials. The higher the score on the consistency measure, the more conscientious students are being with regard to levels of engagement in the course.
The introductory business and economics course is quantitative in nature and so will likely be more appealing to students that have academic strengths along quantitative lines. Accordingly, the level of a student’s strength in quantitative areas may contribute to the student’s record of class attendance. There are at least three candidate measures available to us that could serve to represent aptitude and preparation in quantitative areas: the calculus grade, the score in the math portion of the ACT college entrance exam, and the score on the math quiz given at the beginning of the course. Johnson and Kuennen (2006) showed that their math quiz (our quiz is patterned after it) is a significant predictor of student performance but that the calculus grade and math ACT score are not. Accordingly, we place our focus upon the math quiz.

The number of credit hours being taken by the student concurrently with our blended course may have an effect upon class attendance. Higher course loads create increasing demands upon the student’s time and also offer them opportunities to find courses that they may enjoy more than our blended course. The number of hours transferred from institutions attended previously may also affect decisions to attend class. From the descriptive statistics reported in Table 2, the mean credit hours that were transferred by transfer students in the blended class was approximately 13, or roughly one semester of coursework. If a transfer student is coming from a community college, they are likely facing a higher tuition cost per credit hour for our course than experienced previously. Having to pay a higher price may prompt the transfer student to consume more of the available product, instruction in this case, than a non-transfer student. All students have equal access to online materials so transfer students may use class attendance as their route for consuming more instruction. We might well observe a positive effect upon attendance from transfer hours.
Class attendance is a dynamic process that plays out over the entire duration of a course. For example, Jones (1984) found that low grades earned early in a course were negatively, albeit moderately, correlated with attendance in a psychology course that had four exams. That is, initial low grades tended to be associated with more frequent absences from class, a sort of downward spiraling effect. Only the correlations pertaining to the first two of the exams were significant, indicating that the signal strength from grades wanes once the midpoint of the course has been passed.

We want our empirical model to include an allowance for students to reconsider their attendance behavior in light of their grades and make behavioral adjustments. Being optimistic, we would hope that any mid-course adjustment by students would have a positive effect upon attendance in contrast to the findings of Jones (1984). Wake-up calls to students concerning class standing and projected course grades occur mainly at the exam milestones, of which there are three prior to the last exam in our course when, for all intents and purposes, it is too late to make meaningful adjustments or changes in behavior. But when is it too late to attempt mid-course corrections, some of which might take the form of increasing class attendance? Like Jones (1984), we focus upon the first and second exam milestones that occur roughly one quarter of the way and halfway through the semester’s calendar, respectively. In the discussion of our estimation results to come later, we establish that the milestone of the second of the course’s four exams, given at the midpoint of the course, provides the wake-up call to students. The variable, referred to as the mid-term grade signal in the model below, is a dummy variable that takes on the value of one for students whose cumulative exam percent through the second exam is less than or equal to 72.5, approximately the median of the class grades.
We adopt the following model, expressed for student $i$:

$$A_i = \beta_1 + \beta_2 \text{GPA}_i + \beta_3 \text{MQ}_i + \beta_4 \text{SCH}_i + \beta_5 \text{TH}_i + \beta_6 \text{MS}_i + \beta_7 \text{TA}_i + \beta_8 \text{CON}_i + \varepsilon_i$$

(1)

where the variables are $A$ - attendance as the percent of classes attended; $\text{GPA}$ - grade point average at the beginning of the course; $\text{MQ}$ - math quiz score; $\text{SCH}$ - semester credit hours; $\text{TH}$ - transfer credit hours; $\text{MS}$ - midterm grade signal; $\text{TA}$ - total accesses of online materials; $\text{CON}$ - consistency of accessing online materials; $\varepsilon$ - error term. The model in (1) was estimated as: (i) a linear model while measuring $A_i$ as a percent; and (ii) a linear probability model while measuring $A_i$ as a proportion rather than a percent. The standard errors of estimated coefficients in the linear model were estimated using a heteroskedasticity-consistent covariance matrix estimator. Generalized least squares is used for estimation of the linear probability model and is sometimes referred to as the minimum chi-square estimator in this environment. The error covariance matrix is diagonal with the elements being the variances of the attendance proportions, $(1/n)(p_i)(1 - p_i)$. As noted by Greene (2000), a feasible generalized least squares estimator that employs an error covariance matrix based upon proportions may generate very low standard errors (very high $t$ ratio statistics) for the estimated coefficients. Every diagonal element of the error covariance matrix contains $n$ as a divisor and the product of the last two terms in the variances is capped at .25 regardless of the scaling of the variables in the model.

We also use a logit version of (1) and model the probability of attending class as

$$P_i = \Lambda(x_i'\beta) = \frac{e^{x_i'\beta}}{1 + e^{x_i'\beta}},$$

where
\[ x'\beta = \beta_1 + \beta_2 \text{GPA}_i + \beta_3 \text{MQ}_i + \beta_4 \text{SCH}_i + \beta_5 \text{TH}_i + \beta_6 \text{MS}_i + \beta_7 \text{TA}_i + \beta_8 \text{CON}_i . \]

(2)

The log-odds version of the model is

\[ \ln \frac{p_i}{1-p_i} = \beta_1 + \beta_2 \text{GPA}_i + \beta_3 \text{MQ}_i + \beta_4 \text{SCH}_i + \beta_5 \text{TH}_i + \beta_6 \text{MS}_i + \beta_7 \text{TA}_i + \beta_8 \text{CON}_i + \epsilon_i^* , \]

(3)

where \( p_i \) is the sample proportion of attendances by student \( i \). The log-odds version is estimated by generalized least squares. The error covariance matrix is diagonal with elements \( [(n)(p_i)(1-p_i)]^{-1} \).

Results from estimating the three models are shown in Table 4. Taking the linear model first, grade point average has a positive and significant influence upon attendance. The math quiz score has the expected positive sign but does not appear to contribute significantly to the decision to attend class. Semester credit hours are not significant either. Transfer hours are a significant determinant of attendance, consistent with our suspicion that transfer students will want to consume more instruction having generally paid a higher tuition cost for the course than was their prior experience. The midterm signal concerning exam performances is significant and provides a positive influence upon attendance. So there is evidence of a wake-up call and the reaction is to increase class attendance. The marginal impact is 9.5 percentage points which translates into roughly two classes.

Total accesses to online materials provides a negative influence upon attendance and it is significant. Based on total accesses alone, it would appear that accessing online materials substitutes for class attendance. However, the sheer volume of accesses is not the only manner in which the availability of online materials can affect decisions to attend class. Note that the consistency measure is positively related to attendance and the effect is significant. In fact,
consistency has the highest t statistic (so therefore the highest partial correlation with attendance at .45) of any of the variables in the model. Thus, we have the mixed effect from online materials that was noted earlier as being possible.

Table 4: Estimates of the Model for Attendance in the Blended Course

<table>
<thead>
<tr>
<th>Variables</th>
<th>(i) Linear Model of Attendance Percent</th>
<th>(ii) Linear Probability Model</th>
<th>(iii) Logit (log odds) Model$@$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade point average</td>
<td>18.675 (2.84)*</td>
<td>13.423 (4.76)*</td>
<td>22.210 (7.74)*</td>
</tr>
<tr>
<td>Math quiz</td>
<td>.743 (1.06)</td>
<td>1.410 (-1.05)</td>
<td>.574 (-.87)</td>
</tr>
<tr>
<td>Semester credit hours</td>
<td>.004 (.01)</td>
<td>-.403 (-.87)</td>
<td>-.463 (-.71)</td>
</tr>
<tr>
<td>Transfer hours</td>
<td>.396 (2.70)*</td>
<td>.446 (8.01)*</td>
<td>.418 (7.85)*</td>
</tr>
<tr>
<td>Midterm signal</td>
<td>9.534 (1.92)**</td>
<td>5.616 (2.66)*</td>
<td>13.009 (5.70)*</td>
</tr>
<tr>
<td>Total accesses</td>
<td>-.237 (-2.14)*</td>
<td>-.153 (-3.14)*</td>
<td>-.270 (-3.14)*</td>
</tr>
<tr>
<td>Consistency</td>
<td>2.747 (4.54)*</td>
<td>1.886 (7.76)*</td>
<td>- (12.96)*</td>
</tr>
<tr>
<td></td>
<td>-66.475 (-3.27)*</td>
<td>-40.704 (-4.61)*</td>
<td>-.250 (-1.00)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.484</td>
<td>.459</td>
<td>.496</td>
</tr>
</tbody>
</table>

Notes: $@$ average marginal effects; * significance levels: * - .05, ** - .10. t-statistics are in parentheses and are based upon standard errors from: (i) heteroskedasticity-consistent covariance matrix estimates for the linear model, (ii) generalized least squares for the linear probability model, and (iii) the delta method for the average marginal effects from the logit model. Coefficients and standard errors of the linear probability model and the average marginal effects from the logit have been rescaled for interpretation as effects upon attendance percent.

Results from estimating (1) as a linear probability model are similar in general tone to those from the linear model of attendance percent. The coefficients in the linear probability model have been rescaled to be the effects upon attendance percent rather than upon attendance proportion. This makes comparison of coefficients across models more convenient. Standard errors of the coefficients were rescaled in the same manner so the t statistics apply to the rescaled
coefficients. The t statistics are higher in absolute value than in the linear model but the
tendency for high t statistics in the linear probability model, as described by Greene (2000), has
already been noted. Grade point average, transfer hours, the midterm grade signal, and
consistency in accessing online materials all provide positive and significant effects upon
attendance just as in the results from the linear model. As concerns positive influences, the math
quiz is a significant contributor to attendance in the linear probability model whereas it was
insignificant in the linear model. Total accesses carries a negative and significant coefficient,
once again showing that the countervailing forces of total accesses and consistency of accesses
will need to be reconciled.

Estimates based on the log-odds form of the logit model from (3) are given in the final
column of Table 4. The values shown in the column are not the coefficients from the logit
model. Rather, they are the average marginal effects upon the probability of attending and have
been rescaled for reporting purposes as the effects upon attendance percent. The average
marginal effect from a variable in a logit model is the average across observations of
\[
\frac{\partial P}{\partial x_{ij}} = \Lambda(x'_i \beta)[1 - \Lambda(x'_i \beta)]\beta_j .
\]

Standard deviations of average marginal effects are calculated via the delta method described in
Greene (2012). No marginal effect is associated with the constant term since a change to the
constant term is not a meaningful consideration.

The average marginal effects from the logit model are similar to the coefficients from the
linear probability model in terms of sign and patterns of statistical significance, with the
exception of the math quiz. It is not a significant determinant of attendance, a result that also
occurred when using the linear model. Otherwise, grade point average, transfer hours, the
midterm grade signal, total accesses, and consistency in accesses continue to show significant effects upon attendance.

Within the context of the above estimates, what can be determined about the net effect upon attendance from the availability of online materials in the blended course? The coefficients of total accesses and the consistency measure (or their average marginal effects from the logit model) cannot merely be added to develop an estimate of the net effect. The differing magnitudes of the variables must be taken into account. We will use the net contribution to the attendance percent from the variables at their respective means. The estimates are reported in Table 5 along with t statistics for testing the hypothesis that the net effect is zero. The net effect is positive and significantly different from zero within all three models. So the availability of online materials contributes positively to attendance. Consistent use of online materials contributes to student engagement in the course, thereby promoting attendance to a greater degree than accesses to the online materials detract from attendance.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Linear Model of Attendance Percent</th>
<th>Linear Probability Model</th>
<th>Logit Model (log odds) Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total accesses</td>
<td>-14.4</td>
<td>-9.3</td>
<td>-16.4</td>
</tr>
<tr>
<td>Consistency</td>
<td>40.9</td>
<td>28.1</td>
<td>46.5</td>
</tr>
<tr>
<td>Net</td>
<td>26.5</td>
<td>18.8</td>
<td>30.1</td>
</tr>
</tbody>
</table>

Notes: t statistics are in parentheses. * significance level - .05.

The results of this study can be used as input into the process of designing blended courses. Those who may be attracted to the flip-flex structure now have information on student preferences for reduced seat time and can tailor in-class complementary activities to the expected
size of the group that will attend class meetings. Our results are also useful to those who are designing new blended courses or are contemplating a restructuring of their existing blended courses but do not want to adopt all of the features of the flip-flex structure. For example, suppose an instructor wants to enforce reduced seat time for all students in the form of cutting down the number of class meetings, as was done in many of the courses represented by the studies in Table 1. What should the reduced seat time be? Although they may not provide the last word, what do students want in terms of reduced seat time? Our interval estimates can be of help. Recall that the interval estimate without taking into account the natural tendency to skip is 58.3 to 65.3 percent. Taking into account the natural tendency to skip lowered the interval estimate to 48.7 percent to 62.5 percent. If the instructor feels that the natural tendency to skip will be accommodated by the enforced reduction in seat time, then the latter interval should be consulted. The interval contains 50 percent, a percent that aligns well with courses that traditionally have two class meetings of equal duration per week. Our results suggest that, on average, reducing those weekly class meetings from two to one would match up well with student preferences. But what about courses where three class meetings of equal duration per week has been the tradition? The top end of our interval is close to two-thirds but reducing seat time from three meetings to one meeting per week cannot be recommended based on our results. However, over a two-week period, seat time could be reduced by three class meetings.

SUMMARY

Our flip-flex version of a blended course allows for, but does not enforce, reduced in-class seat time. Students are allowed to choose the reduction in seat time that they prefer. A comprehensive set of online lectures is available as a replacement for traditional in-class lectures. The same number of class meetings are held as in the traditional version of the course but all,
except for exams, are optional. Topic demonstrations, question-answer exchanges, discussions, “flash lectures”, and other learning activities take place during the meetings. The format gives the student a wide range of choice as to how they will compose their course characteristics. At one extreme, the student could choose to create an online class and at the other could closely approximate a traditional course experience by attending all, or a substantial proportion, of the semi-weekly class meetings.

The goals of this study have been to describe student choices of reduced seat time, to determine how the use of online materials affects class attendance, and to explore how student characteristics contribute to, or detract from, class attendance in the flip-flex environment. Data was gathered in one blended section and one traditional section of an introductory statistics course, both taught by the same instructor. Point and interval estimates of the mean reduction in seat time chosen by students were developed, with and without taking into account the natural tendency of students to skip. When taking into account the natural tendency to skip, the interval estimate of mean reduced seat time is consistent with a blended course design that imposes a reduction of one of the weekly class meetings in a traditional course that would normally meet twice a week.

Two student characteristics stand out as providing positive and significant effects upon class attendance (or the reverse of reduced seat time): grade point average and hours transferred from previous institutions. The signal from math aptitude, while positive in direction, is not as definitive as either of the above two student characteristics and the significance of the signal varied according to the estimation method applied to the empirical model of attendance. Moving on to other influences, our study has revealed that there is more than one dimension involved in the interplay between availability of online materials (ours fully replace in-class lectures) and
class attendance. The volume of accesses does negatively impact attendance, a substitution tendency by students that might be expected. However, the extent to which students consistently access online materials through the flow of the course provides a positive impact upon attendance. On balance, the net effect from these countervailing forces is positive. The student’s sense of engagement with the class, as evidenced by the consistency of accesses, prevails as the dominant force.

REFERENCES


