



CAMPUS RESEARCH PROTOCOLS

INTERACTIVE LEARNING ONLINE AT PUBLIC UNIVERSITIES:

Evidence from Randomized Trials

Study Conducted in Fall 2011

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Institution A

I. Course information

- A. Course description: Institution A's statistics course (henceforth referred to as STAT 101) is offered to between 800 and 1,200 students each semester. The course is offered in a range of class sizes, including large sections of 160 to 185 students each and smaller sections of 40 to 60 students each. Regardless of class size, the sections meet either two or three times a week for a total of three hours. STAT 101 meets the general education requirement for mathematics, and is also a prerequisite for a number of majors. Most students take the course in their freshman or sophomore year. STAT 101 is not offered as an online course.
- B. Treatment group: The treatment group using the CMU statistics course consisted of two hybrid sections taught by the same instructor who taught the control group. The instructor, a full-time adjunct, had 20 years of experience and had taught introductory statistics over 60 times. The instructor had been part of the spring 2011 pilot and so was familiar with the CMU course. The two hybrid sections had 18 and 28 students in them, all of whom were study participants. Each hybrid section met for one hour each week on Friday afternoon. The instructor reported that only about 40% of the students typically attended the face-to-face session – perhaps because of the Friday afternoon timing. Most of the in-class time (90%) was spent lecturing.
- C. Control group: The traditional version of STAT 101 was offered as two large sections that met for one hour and 20 minutes twice per week. One section had 181 students and the other had 227, both with a mix of participants and non-participants. Both sections were taught by the same instructor, who also taught the treatment sections. The textbook used for the course was *Intro Stats* by DeVeaux, Velleman, and Bock (Addison Wesley). The instructor reported average class attendance of 80%, and said that about 80% of class time was spent lecturing, with the balance used for practice problems and answering questions. A variety of online materials were used to supplement the textbook, including Course Compass and MyMathLab (both Pearson products), as well as Blackboard and email.

II. Recruitment and randomization of participants

- A. Incentives: Participants assigned to the treatment group did not need to purchase a textbook and participants assigned to the control group were given a \$50 American Express gift card at the end of the semester.
- B. Recruitment and registration: On the first day of class, students in two large, traditional sections of STAT 101 (each of which had 200 to 260 students and which met either on Mondays and Wednesdays or on Tuesdays and Thursdays) were given a presentation about the study and invited to participate by signing a consent form, which they could sign immediately or drop off at the department office by the end of the following day. After participants handed in their consent forms, they were sent an email asking them to complete a baseline survey, which was administered online using a Google survey tool (not the ITHAKA-provided survey tool). The intent was that students who were

assigned to the treatment group would meet for their weekly one-hour of face-to-face time during one of the time slots of the original traditional section that they had registered for; however, this turned out not to be practical, as explained in section IV.A below, and all students assigned to the treatment group ended up meeting on Friday afternoon.

- C. Randomization: After all the consent forms had been received, a member of the project team manually randomized the participants into treatment and control groups using a random number generator. Participants were then informed by email which group they had been assigned to. The registrar's office was also informed so that the participating students could be registered in the correct section.
- D. Results: The procedure described above resulted in a total of 97 students agreeing to participate in the study, with 52 being randomly assigned to the treatment group and 45 being randomly assigned to the control group. All but two of the participants registered for the format to which they were randomly assigned.

III. Data collection

- A. Baseline survey: Conducted using a Google online survey tool after students consented to participate, as described in II.B above. Ninety participants completed the baseline survey. The students who took the survey did so between August 29th and September 6th.
- B. CAOS pre-test: Administered on the first day of class. Students were given 45 minutes to complete the exam, although most students finished in 30 minutes. Eighty-three participants completed the test; of the 14 students who were randomly assigned but who did not take the pre-test, five were reported by the Institutional Research office to have dropped or withdrawn from the course, and another student failed the course.
- C. CAOS post-test: Administered as part of the final exam. Seventy participants completed the test; of the 27 participants who did not take the post-test, 14 were reported to have dropped or withdrawn from the course, and another five students failed the course.
- D. Final exam: In addition to the 40 questions on the CAOS post-test, eight common final exam questions were administered to all participating sections of the class. However, the instructor reported that there was a "significant mismatch" between the common exam questions and the material taught in the treatment section of the class (see part IV.B below). Seventy participants (the same participants who took the CAOS post-test) completed the final exam.
- E. End-of-semester survey: Administered right after the final exam. Sixty-four participants completed the survey.

IV. Implementation issues

- A. Scheduling of treatment group face-to-face session. The original intention was for students to be recruited from two large sections of STAT 101. Participants who were randomized into the treatment group were to be assigned to a treatment section, which would be taught by a different instructor, and which would meet each week during the same three-hour time slot as the (traditional) section for which they originally registered,

except that the treatment section would meet for only one hour rather than for the entire three hours. This set-up would ensure that the weekly one hour face-to-face session would fit into the students' schedules. However, all of the treatment and control sections ended up being taught by the same instructor. This meant that the treatment group had to find a different time to meet for their weekly face-to-face session, since the instructor could not be in two places at the same time. The only time that would work for everyone was Friday afternoon; one of the two treatment sections met for one hour on Fridays starting at 2:45 p.m., and the other met on Fridays for one hour starting at 3:50 p.m. The choice of this time slot may have negatively affected student attendance, which was only about 40% on average. The instructor noted that the students taking the course in the hybrid format "seemed to be particularly disengaged. They treated the weekly meetings more as an inconvenience than an opportunity and generally took little advantage of office hours."

- B. Mismatch of course content and final exam questions. According to the instructor, the curriculum used in the CMU course was not well aligned with the material taught in the traditional sections: "The traditional stats course emphasizes problem solving and inference. Inference in the [CMU] course is handled very superficially." For similar reasons, the instructor also reported that there was a "significant mismatch" between the common exam questions and the material taught in the treatment section.

Institution B

I. Course information

- A. Course description: Institution B's statistics course (henceforth referred to as STAT 101) is offered to between 900 and 1,000 students every semester. It is a prerequisite for the institution's business major. Most students who take it are sophomores. The course is taught in sections that are generally capped at 40 or 80 students each, although there is some variation. Each semester, 12 to 15 sections are offered. STAT 101 is not generally offered in an online or hybrid format.
- B. Treatment group: The treatment group using the CMU statistics course consisted of three sections taught by two different instructors, with class sizes ranging from 19 to 48. All students in these sections were study participants. Both instructors were familiar with the CMU course. One had 20 years of teaching experience, while the other (the one who taught two treatment sections) had just three years of experience and was teaching introductory statistics for only the second time. The course was advertised as a hybrid course that included one face-to-face class per week (one hour or one hour and 15 minutes, depending on the section). According to the instructor, most students attended the face-to-face sessions (70% to 100%). Both instructors used the face-to-face time in a similar fashion: lecturing (50%), going over practice problems (40%), and the balance of time in class discussion and answering questions. Both instructors made use of Blackboard.
- C. Control group: The traditional version of STAT 101 was offered as three sections taught by three different instructors, with section sizes ranging from 30 to 49 students. One class met for three hours on Friday mornings; one for three hours on Saturday mornings, and the third class met twice a week for one hour and 15 minutes each time. One of the instructors also taught a treatment section in the study. All students in the control sections were study participants. The instructors were all experienced teachers, with 9 to 25 years of teaching experience. The textbook used for the course was *Business Statistics: A First Course* (Pearson). Class attendance was 95% or higher. One instructor used most of his class time (80%) for lecturing, and the balance mainly for practice problems. The other two reported only using 50% for lecturing, and a larger share of time (20% to 30%) for practice problems. All instructors used Blackboard, as well as online tools provided by the textbook publisher for homework and practice problems (Pearson MyLab and Course Compass).

II. Recruitment and randomization of participants

- A. Incentives: All participating students were provided with a free textbook or course materials: students in the treatment group had free access to the CMU online materials, and students in the control group were given a free e-textbook worth approximately \$90.
- B. Recruitment and registration: Starting with the weeks prior to advance registration, the study was actively promoted through information sessions, information tables, an informational website, flyers, and ads in the student newspaper. Interested students were instructed to register for one of three study sections. Students who registered for

one of the study sections received an email with a link to the online consent form. The email also informed them that these sections were restricted to study participants, and that if they did not complete the consent form within seven days they would be automatically dropped from the section so that they would have the opportunity to register for a different section of their choice before the classes were all filled. This approach ensured that all students who registered for the study sections had also consented to participate in the study.

- C. Randomization: After completing the online consent form, the system prompted students to complete the baseline survey, after which they received an email confirming their successful registration and participation in the study. Approximately one week before the beginning of class, all participants were randomly assigned into the treatment and control groups using a random number generator. They were then sent an email informing them of the section to which they had been assigned. The reason for informing the students about their section assignments close to the beginning of the semester was to reduce the likelihood they would change their minds based on the outcome of the random assignment and try to switch sections.
- D. Results: The procedure described above resulted in a total of 229 students agreeing to participate in the study and being randomly assigned, with 117 randomly assigned to the treatment group and 112 randomly assigned to the control group. However, of the students who agreed to participate in the study, nine of the 117 students in the treatment group, and eight of the 112 students in the control group, were not enrolled in STAT 101 at the start of fall 2011 semester. In addition, one student in the control group switched into a traditional section that was not affiliated with the study. Thus, 108 participants who were randomly assigned to the treatment group, and 103 participants who were randomly to the control group, were enrolled in study-affiliated sections at the start of the semester.

III. Data collection

- A. Baseline survey: Conducted online at the time students consented to participate, as described in II.C above. All participating students completed the baseline survey.
- B. CAOS pre-test: Administered on the first day of class. Students were generally given as much time as they needed to complete the test (none took more than 45 minutes). There was some variation in the amount of time reported in each section, with one hybrid-format instructor reporting only 25 minutes. However, most students completed the test in 30 to 35 minutes. Two hundred and nine participants completed the test (99% of the 211 participants who were enrolled in study-affiliated sections at the start of the semester).
- C. CAOS post-test: Administered in class on either the last day of class or the second-to-last day. The same protocol was used as for the pre-test, with students permitted to take as much time as needed. One hundred and eighty-nine participants completed the test (99% of the 191 participants who completed the course in study-affiliated sections).
- D. Final Exam: The three pairs of treatment/control sections meeting in each time slot were treated as matched pairs, with the instructors in each pair agreeing on a set of common questions for the final exam. Both groups were administered a set of common questions

on the final exam – in two cases, 20 questions, and in one case, 15 questions (ranging from 20% to 57% of the final exam grade). The procedure was implemented successfully for one pair, but not for the other two – see section IV below for a full explanation. As a result, only 63 participants completed the common final exam questions as originally planned. All participating instructors confirmed that the common questions adequately or mostly reflected the material taught in class.

- E. End-of-semester survey: Administered at the same time as the post-CAOS test. One hundred and eighty-eight participants completed the survey (98% of the 191 participants who completed the course in study-affiliated sections).

IV. Implementation issues

Common final exam questions not administered in all sections: As noted in section III.D above, the common final exam questions were not administered as planned for two of the three matched pairs of treatment/control sections. One of the instructors was teaching both a treatment and control section. In a last minute mix-up, the common questions for those two sections were inadvertently swapped. As a result, two treatment sections shared a set of common questions, and two control sections shared a (different) set of common questions, rather than the questions being shared across matched treatment/control pairs as intended. (The third pair, which administered the common set of questions on the final exam as originally planned, was not affected.)

In order to at least partially compensate for this situation, the instructors for the six study-affiliated sections agreed on a new set of 20 final exam questions which were then entered into an online survey tool. Students were sent an email (and two reminders) after the fall 2011 semester finished asking them to answer the questions as part of the study (with no effect on their course grade). As an incentive, they were told that their names would be entered into a raffle for two iPads if they answered all the questions. Between February 14th and February 29th, 105 answered at least one question on this assessment (55% of the 191 students who completed the course in study-affiliated sections). Of these 105 students, the amount of time that elapsed between when the student started the assessment and when the student ended the assessment ranged from one minute to more than six days, with the middle 50% taking between 4 and 19 minutes.

Institution C

I. Course information

- A. Course description: Institution C's statistics course (henceforth referred to as STAT 101) is offered in the institution's psychology department to between 200 and 250 students every semester. It is a required course for students majoring in psychology and is usually taken in students' sophomore or junior year, and primarily, though not exclusively, by psychology majors. The course is taught in 10 to 12 sections of 20 to 30 students each. Typically one fully online section of statistics is offered each semester, though in the fall 2011 semester there were no fully online sections offered; the only sections that were offered in a format that was at least partly online were the hybrid sections affiliated with the study.
- B. Treatment group: The treatment group using the CMU statistics course consisted of four hybrid sections taught by four different instructors, with class sizes ranging from 16 to 23. Each section included a mix of participants and non-participants (between 33 and 57 percent were participants). None of the instructors had participated in the spring 2011 pilot study and so all were using the CMU course for the first time. A supervisor who had used the CMU course previously met with the hybrid-format instructors weekly. Two were adjuncts and two were graduate assistants, and all four were relatively new teachers – three with less than two years experience, all teaching introductory statistics for the first time. One instructor taught at least two semesters of undergraduate-level statistics and one graduate-level statistics class before, and one had five years of experience. The course was advertised as a hybrid course that included one 50 minute face-to-face class per week. Three instructors reported 80% to 95% attendance at the face-to-face sessions, but one reported typical attendance of only 50%. All four instructors used most of their weekly class time to answer questions and go over practice problems; time spent lecturing ranged from 10% to 40%. In addition to Blackboard and email, at least three instructors made use of Aplia, online software published by Cengage that offers additional automatically graded practice problems and assignments.
- C. Control group: The traditional-format study participants were divided among six sections of STAT 101 that were taught by five different instructors, with section sizes ranging from 19 to 26 students. Five of the six traditional sections met twice a week for two hours and 5 minutes each time; the sixth traditional section met once a week for four hours and 10 minutes. The sections included a mix of participants and non-participants; within each section, 12% to 42% of the students were participants. Of the three instructors who returned their questionnaires, all were adjuncts, with one to two years of teaching experience; one was teaching introductory statistics for the first time. The textbook used for the course was Gravetter and Wallnau's *Statistics for the Behavioral Sciences* (9th edition), published by Cengage. Class attendance ranged from 80% to close to 100%. The three instructors used a little over half of their class time (50% to 60%) for lecturing, and the balance for practice problems and answering questions. All three used

Blackboard and Aplia, the same publisher website used in the treatment sections as a source of additional practice problems.

II. Recruitment and randomization of participants

- A. Incentives: All participating students (treatment and control) received a \$50 Amazon gift card at the end of the semester. In addition, they were given priority registration for the spring 2012 semester. Unlike at most other campuses participating in this study, all students were expected to purchase a textbook (even the students taking STAT 101 in a hybrid format), since the textbook is considered an important reference text for subsequent psychology classes.
- B. Recruitment and registration: The research protocol called for active recruitment of participants through information sessions and a website – however, as explained in section IV.A below, the recruitment and registration did not take place quite as planned. As originally planned, there were four pairs of sections of STAT 101 designated as study sections; within each pair, one traditional-format (control) and one hybrid-format (treatment) section met at the same time. During the registration period for fall 2011 classes – which took place during the spring 2011 semester – when students went online to register for one of these six sections, a message on the registration website informed them that they were required to register in person during specified hours at a designated computer lab. The department chair also sent an email to all students intending to register for STAT 101, informing them about the study. At the social science lab, department staff knowledgeable about the project entered their email addresses into an ITHAKA-provided online website, which immediately sent them an email invitation to participate in the study. Students then immediately sat down at a computer and clicked on a link in the email to take them to the online consent form. Students who chose not to participate were allowed to register in one of the traditional sections.
- C. Randomization: After completing the online consent form, the website prompted participants to complete the baseline survey, after which they were randomized by the tool into either the treatment or control group. However, whereas the original intention was for students to first choose a time slot, after which they would be randomized into the traditional or hybrid section that met during that time slot, what actually occurred was a bit different: students were allowed to sign up for any section within the format to which they were randomly assigned; they were not restricted to a particular hybrid or traditional section that met within a pre-specified time slot.
- D. Results: The procedure described above resulted in a total of 92 students who agreed to participate and were randomly assigned, with 47 randomly assigned to the treatment group and 45 to the control group. Of these 92 students, only 80 actually enrolled in the course, and 74 of those 80 enrolled in the format to which they were randomly assigned. Of the six students who enrolled in a format other than the one to which they were randomly assigned, four students randomly assigned to the hybrid format enrolled in a traditional section, and two students randomly assigned to the traditional format enrolled in a hybrid section.

III. Data collection

- A. Baseline survey: Conducted online at the time students consented to participate, as described in II.C above. All participating students completed the baseline survey.
- B. CAOS pre-test: Rather than taking the pre-test in class, during the first two weeks of the fall 2011 semester (August 30th -September 13th) students were instructed to go to a designated room during specified hours. After signing in with a proctor, students were allowed to take as much time as they needed to complete the test (they had been told it would take 30 to 45 minutes). Sixty-nine participants completed the test (86% of the 80 students who were randomly assigned and enrolled in the course).
- C. CAOS post-test: The same procedure was used as for the CAOS pre-test: at the end of semester (between December 8th and December 22nd) students were instructed to go to a designated room during specified hours, where they were allowed to take as much time as they needed to complete the test under the supervision of a proctor. Forty-nine participants completed the test (68% of the 72 participants who completed the course).
- D. Final Exam: All treatment sections administered a common set of 69 questions on the final exam. However, only three of the six control sections administered the common final exam questions. Three of the participating instructors (two control and one treatment) said that the common questions “adequately reflected” the material taught in their sections; two treatment instructors said the questions “mostly reflected” the material they taught. Fifty-two participants completed the final exam; these 52 participants constitute 90% of the 58 participants who completed the course and who were enrolled in sections in which the instructors included a set of common questions on the final, but only 72% of the 72 participants who completed the course.
- E. End-of-semester survey: Administered at the same time as the post-CAOS test. Forty-nine participants completed the survey (68% of the 72 participants who completed the course).

IV. Implementation issues

- A. Students not recruited as planned. As noted in section III.B above, the publicity and recruitment for the study did not take place as planned. Due to the sudden departure of a key staff person in the registrar’s office, no one at Institution C was told when registration for fall 2011 classes would start until three days before. As a result, there was no time to hold information sessions to recruit students. In addition, even though there was a note on the registrar’s web site telling students to come to register for STAT 101 in person, at first the system did not block them from registering online, so some students went ahead and did so. When a new staff person was appointed, those students who had already signed up for STAT 101 were told they would be de-registered and needed to sign up again in person, which annoyed some students who thought they had already secured a spot by signing up online.
- B. Non-participants included in treatment sections. According the research protocol, students who needed to take the course during one of the time slots allocated to the study, but did not want to participate in the study, were allowed to register in the control section offered during that time slot. Because participation rates were lower than hoped for (perhaps because of the situation described in IV.A), the control sections filled

up sooner than expected with a combination of participants and non-participants. In effect, this capped the number of participants and left the treatment sections with empty seats. To fill those seats, non-participants were allowed to register for the hybrid (treatment) sections. Although this may have resulted in a smaller number of participants, it did not otherwise impact the study.

- C. Students allowed to sign up for any study section. As explained in Section II.C, although the research plan had called for students to be randomly assigned to matched pairs of treatment/control sections meeting in the same time slot, in fact, after they were randomized, participants were permitted to sign up for a section in their assigned format during any time slot.
- D. No common final exam questions in three control sections. As noted in Section III.D, one of the instructors, teaching a control section, did not administer the common final exam questions. For the other two control sections, the instructor did not give a final examination.
- E. Missing instructor questionnaires. Two of the five instructors teaching control sections did not return their instructor questionnaires.

Institution D

I. Course information

- A. Course description: Institution D's statistics course (henceforth referred to as STAT 101) is usually offered to between 100 and 200 students each semester (although in fall 2011, only 88 students in total enrolled in the course). The course is offered in sections with class sizes normally between 20 and 40, but in some cases as large as about 55. It is a four-credit course that generally meets twice a week for two hours each time. STAT 101 meets the general education requirement for math, and is also a prerequisite for a number of majors. At least one section of STAT 101 is offered as an online course each semester. Most students take the course in their sophomore or junior year.
- B. Treatment group: The treatment group using the CMU statistics course consisted of two hybrid sections taught by the same instructor. The instructor, who was a full-time associate professor with tenure (and also the campus principal investigator for the project), had 18 years of experience and had taught introductory statistics over 60 times. The instructor had been part of the spring 2011 pilot, and had also used the CMU course in the fall 2010, and so was familiar with the CMU course. He also had experience teaching other online courses. There were three students in one section and five in the other. All students in the hybrid sections were study participants. The instructor reported that about 60% of the students typically attended the face-to-face sessions. Less than half of the in-class time (40%) was spent lecturing, another 40% was spent working on practice problems, and the balance was used to answer student questions.
- C. Control group: The traditional version of STAT 101 was offered as two sections that met for one hour and 50 minutes twice per week. One section had 29 students and the other had 37. There were a mix of study participants and non-participants in the traditional-format sections (in one section, two of the 29 students were study participants, and in the other section, six of the 37 students were study participants). The sections were taught by different instructors, one with four years of experience and one with eight. Both were adjuncts. The textbook used for the course was *Understandable Statistics*, 10th ed. (Brooks Cole, 2011). The two instructors reported quite different uses of their class time. In one, 65% of class time was spent lecturing, with the balance for practice problems and answering questions. In the other, only 20% was used for lecturing, 50% was used for practice problems and answering questions, and the remaining 30% for class discussion. Other than email and PowerPoint, no educational technology was used by either instructor.

II. Recruitment and randomization of participants

- A. Incentives: Participants assigned to the treatment group did not need to purchase a textbook and participants assigned to the control group were given a \$50 gift card at the end of the semester for the college book store.
- B. Recruitment and registration: STAT 101 was listed in the registration system as having two large sections capped at 80 students each (a separate online section, not part of the study, was also available). On the first day of class, students in both sections were given

a presentation about the study and invited to participate by signing a consent form, which they could sign immediately or drop off at the department office by the end of the following day. Students who agreed to participate also completed a paper version of the baseline survey at the same time. After randomization of participants had occurred, each large section was divided into two sections, one treatment and one control (the control sections thus included both participants and non-participants), with the treatment section meeting for one hour during one of the originally scheduled time slots for that section.

- C. Randomization: After all the consent forms had been received, the campus principal investigator (PI) randomized the participants into treatment and control groups using a random number generator. Participants were then informed by email the format to which they had been assigned. The registrar's office was also informed so that the participating students could be registered in the correct section.
- D. Results: The procedure described above resulted in a total of 16 participating students, with nine in the treatment group and seven in the control group, although one student who had been randomly assigned to the treatment group switched into a control section near the beginning of the semester.

III. Data collection

- A. Baseline survey: Conducted on the first day of class at the time students consented to participate, as described in II.B above. Of the 16 students who consented to participate in the study, 15 completed the baseline survey (94%).
- B. CAOS pre-test: Administered on the first day of class. Students were given about 35 minutes to complete the text. Fifteen participants completed the test (94%).
- C. CAOS post-test: Administered immediately prior to the final exam. Students were given the same amount of time as for the pre-test (about 35 minutes). Thirteen participants completed the test (81% of the students who originally consented to be in the study). (Of the three who did not take the post-test, two failed the course and the third received a grade of Incomplete.)
- D. Final Exam: Common final exam questions, which the instructors reported adequately reflected the material taught in the class, were administered to all participating sections of STAT 101. Twelve participants completed the final exam (75% of the students who initially agreed to be in the study). (Of the four who did not take the post-test, two failed the course and the other two received a grade of Incomplete.)
- E. End-of-semester survey: Administered at the same time as the final exam. Thirteen participants completed the survey (81% of the students who originally agreed to be in the study). (The three students who did not take the survey either failed the course or received a grade of Incomplete.)

IV. Implementation issues

Small sample size. In the spring 2011 pilot phase of the study, when the same recruitment and randomization process were used, 35 students agreed to participate out of a pool of about 140 (25%). Although the pool of potential participants was smaller in

the fall semester (86), it was thus surprising that only 16 students agreed to participate (19%). When asked his opinion about what might explain this differential result, the campus PI suggested several possibilities.

- Students might sign up for a specific section in large part because they want a particular instructor, and for that reason might be reluctant to participate if there was a risk of ending up with a different instructor. In the spring, students had to join the study if they wanted a chance of keeping their preferred instructor; in the fall, the opposite was true; i.e. the only way they could be certain of keeping their preferred instructor was to opt out of the study.
- Students in the fall might have heard negative comments about the online course from students who participated in the spring.

Still, in order to better understand why students chose not to participate, the campus PI administered a brief survey to all non-participants. Of the 54 respondents, by far the most common reason given for choosing not to participate was a dislike of online courses, and/or a preference for face-to-face interaction with an instructor (76% stated this reason). Another 14% felt the risk of taking an online course was too great, either because they had failed the course once before, or because they had had prior negative experiences with online courses. Interestingly, although the majority (65%) indicated that the incentive was “sufficient,” it did not appear to be a significant factor in their decision-making process, implying that there was *no* reasonable incentive that would have persuaded them to take an online course.

Institution E

I. Course information

- A. Course description: The study was conducted with two separate courses in two departments; neither department normally offers an online or hybrid version of the course.
1. In Department 1, the statistics course (henceforth referred to as STAT-A 101) is offered to about 250 to 300 students every semester, typically as 10 to 12 sections with 20 to 30 students per section, with sections meeting about four hours per week. All sections meet in a computer lab for one of the four hours. STAT-A 101 fulfills core requirements for many other majors. It generally attracts sophomores and juniors and also fulfills the mathematics general education requirement.
 2. In Department 2, the statistics course (henceforth referred to as STAT-B 101) is a core required course for all department majors. Each semester there are 250 to 300 students in 12 to 16 sections of about 25 students each. STAT-B 101 generally meets for about four hours per week. Students often take this class in their sophomore or junior year.
- B. Treatment groups: STAT-A 101 had one instructor teaching a hybrid section; STAT-B 101 had two instructors teaching one hybrid section each (for a total of three hybrid sections). The hybrid sections all met for one hour face-to-face rather than the normal four hours per week.
1. In the STAT-A 101 treatment section, all students were participants. The instructor was an associate professor with 15 years teaching experience, had taught introductory statistics over 45 times, and had participated in the spring 2011 pilot study. According to the instructors, about 75% of students attended the face-to-face sessions.
 2. In each of the two STAT-B 101 treatment sections, all students were participants (with the exception of one student). Both instructors were assistant professors with three to four years of teaching experience. For one instructor, this was his first time teaching introductory statistics; the other had taught the class three other times. Neither had any prior experience teaching online or using the CMU course. There were some differences in the way the two instructors reported used the weekly face-to-face hour. One used the time primarily for lecturing (75%), with the remainder spent answering questions and doing practice problems; the other spent less than half the time lecturing (40%), and divided the rest of the time among questions (25%), practice problems (25%), and discussion (10%). Both instructors reported that about three-fourths of the students generally came to the face-to-face sessions, and both made use of Blackboard and email to communicate with their students.
- C. Control groups: The traditional control sections in the two departments were taught differently:
1. In Department 1, there were three traditional STAT-A 101 control sections, ranging in size from 14 to 30 students each. Each control section met at the same time, so each section had a different instructor. Each control section met four hours per week, with

one hour in a computer lab, and each consisted of a mixture of study participants and non-participants. The instructors were all experienced teachers; one was an associate professor with over 45 years of experience while the other two were adjuncts, one with 30 years of experience and one with ten. The textbook used for the course was *Statistical Techniques in Business and Economics*, 15th ed. (McGraw Hill, 2011). Class time was mostly spent lecturing (70% to 75%), although one alternated lecture presentations with class time spent working through practice worksheets. Most students attended class (85% to 94%). Two of the instructors used Blackboard, supplemented with McGraw-Hill's online Connect for graded assignments and practice tests. The third instructor only used email.

2. For STAT-B 101, in Department 2, there were two traditional classes. One section was a double section that combined two smaller sections and had a total of 73 students; the other traditional section had 24 students. Both traditional sections met two times per week for one hour and 45 minutes each time. The classes contained a mix of participants and non-participants. Each traditional study-affiliated section met at the same time as a hybrid section. While one traditional section instructor was a full professor and the other was an adjunct, both were highly experienced teachers, with 37 and 44 years of experience, respectively. The full professor had previously taught introductory statistics over 200 times, and the adjunct had taught it over 60 times. Both used most of their class time for lecturing (60% to 75%). The textbook used in one traditional class was *Understanding Statistics in the Behavioral Sciences*, 9th ed. (Cengage Learning, 2008); the other traditional section used *Fundamental Statistics for the Behavioral Sciences*, 7th ed. (Cengage Learning, 2011). Both instructors reported that 95% of their students typically came to class.

II. Recruitment and randomization of participants

- A. Incentives: Both departments adopted the same incentives: control participants received \$50 as a credit to their university account upon completion of the study. In addition, students assigned to the treatment section were not required to purchase a textbook. Seven students in the treatment groups who had Macintosh computers were also provided with free copies of software that was needed to allow them to use Minitab, one of the statistical packages used in conjunction with the CMU course.
- B. Recruitment and registration: The recruitment and registration process was similar for both departments. On the first day of class, students who had registered for concurrent sections¹ of the class were given a presentation about the study and invited to participate by signing a consent form and completing a baseline survey, which they could either do during that class, or else they could turn in the documents to the department office by 4 p.m. the next day. (Students registered in those concurrent sections had also been sent an email about the study over the summer to make sure they did not purchase a textbook they would not be able to return if they decided to participate.) There were a total of eight sections involved in the study (four in each department): three treatment sections (one in Department 1 and two in Department 2)

¹ There was one difference between the two departments. In Department 1, there were four concurrent sections (three control sections and one treatment section) that met during one time slot, and in Department 2 there were two time slots, with two concurrent sections (one control and one treatment) meeting during each time slot.

and five sections containing control students (three in Department 1 and two in Department 2).

- C. Randomization: After all the consent forms had been received (at 4 p.m. on the day after the first day of class), the project principal investigators (PIs) manually randomized the participants into treatment and control groups using a random number table. Participants were then informed by email the group to which they had been assigned. Behind the scenes, the registrar's office made sure each student was registered in the correct section.
- D. Results: The procedure described above resulted in a total of 81 students agreeing to participate in the study, with 41 students randomly assigned to the treatment group (15 in STAT-A 101 in Department 1, and 26 in STAT-B 101 in Department 2) and 40 to the control group (16 in STAT-A 101 and 24 in STAT-B101). However, three students in STAT-B 101 who were randomly assigned to the hybrid format later switched to a traditional section; two of the three students switched into a study-affiliated control section, while the third student switched into a traditional section that was not affiliated with the study. No STAT-A 101 study participants switched sections. Of the 160 students in STAT-B 101 who were informed about the study, 110 chose not to participate, and one of these students refused to have his or her background data used by researchers. In STAT-A 101, of the 132 students who were informed about the study, 101 chose not to participate, and 38 of these students refused to have their background data used by researchers.

III. Data collection

- A. Baseline survey: Administered on the first day of class at the time students were invited to participate in the study, as described in II.B above. All participating students in STAT-A 101 completed the baseline survey; 49 of the 50 participating students in STAT-B 101 completed the survey.
- B. CAOS pre- test: The CAOS pre-test was administered on the first day of class for all sections in both departments. Students were given approximately 30 minutes to complete the test. In both departments, all participants (31 in Department 1 and 50 in Department 2) completed the test.
- C. CAOS post-test: For STAT-A 101, in Department 1, students were given 30 minutes to complete the test immediately after their final exam; 22 students completed the post-test (100% of the participants who completed STAT-A 101). For STAT-B 101, in Department 2, the post-test was administered in a review class near the end of the semester; students were also given 30 minutes. 44 participants completed the test (92% of the 48 students who completed STAT-B 101).
- D. Final Exam: Both groups were administered a set of common questions on the final exam. There were 20 common questions given to participants in Department 2, and a different set of 20 common questions, several with multiple subparts, given to participants in Department 1. In Department 1, 23 participants completed the course (STAT-A 101) and took the final exam. (The 23 students who completed the final exam and the course amount to 100% of the participants who completed the course.) In Department 2, 45 of the 47 participants who completed the course (STAT-B 101) in a

study-affiliated section took the common questions on the final exam (two participants did not complete the course and a third completed the course in a non-study-affiliated section). (The 45 participants who took the final exam represent 96% of the students who completed STAT-B 101 in a study-affiliated section.) All participating instructors confirmed that the common questions adequately or mostly reflected the material taught in class.

- E. End-of-semester survey: For STAT-A 101, the end-of-semester survey was administered during the final exam, and was completed by 22 participants (100% of the participants who completed the course). For STAT-B 101, the survey was administered in class at the same time as the post-CAOS test, and 45 participants completed the survey (representing 96% of the students who completed the course in a study-affiliated section).

IV. Implementation issues

The study was implemented as described above without any major problems or concerns.

Institution F

I. Course information

- A. Course description: Institution F's statistics course (henceforth referred to as STAT 101) is offered to about 200 students every semester through the mathematics department. A hybrid version of the course has been offered for the past four years, developed and taught by an experienced adjunct who also participated as an instructor in the spring 2011 pilot. STAT 101 attracts mainly freshman and sophomores who are not math or statistics majors and fulfills the math general education requirement.
- B. Treatment group: The CMU course was offered as a single section in place of the existing hybrid course that had been developed in-house, taught by the same experienced adjunct who regularly teaches the hybrid course, and who has taught introductory statistics for over ten years. The same instructor participated in the spring 2011 pilot study. It was advertised as a hybrid course that included a 50-minute face-to-face section. The hybrid section was capped at 130 students; actual enrollment for fall 2011 was 99 (not all students were participants). According to the instructor, about 85% of students attended the face-to-face sessions. The face-to-face time was used as follows: lecturing (35%), answering questions (20%), going over practice problems (20%), and doing other activities (25%). The instructor made use of Blackboard, email, G-chat, and text messaging to communicate with students.
- C. Control group: The traditional version of STAT 101 was taught as a large lecture course meeting twice a week for one hour and 15 minutes with about 90 students (a mixture of participants and non-participants). Discussion sections of 25 to 35 students each met once a week for an additional 50 minutes. The instructor was an adjunct with 30 years of experience, and had taught introductory statistics about 10 times. The textbook used for the course was *Statistics: Concepts & Controversies*, 7th ed. (Freeman, W. H. & Company, 2008). Class time was spent as follows: lecturing (75%), answering questions (10%), class discussion (10%), and going over practice problems (5%). About 85% of students typically attended class. The instructor also made use of Blackboard.

II. Recruitment and randomization of participants

- A. Incentives: All participating students received a \$25 in the form of a check at the completion of the study. In addition, students assigned to the treatment section were not required to purchase a textbook. Students assigned to the control group were given \$101.50 to purchase a textbook.
- B. Recruitment and registration: A math department staff person attended freshman orientation and handed out flyers in order to recruit students and explain the study. Students who registered in advance were also recruited. To register for STAT 101, all students were required to go in-person to the math department office (i.e. the course registration system would not allow them to register online without assistance). At the department office, students were informed about the details of the study by designated staff members. Students were encouraged to read the online consent form on computers

that had been set-up in the department for that purpose, although they were not required to do so. After reading the online consent form, students who wanted to participate could click “I agree,” at which point they were immediately prompted to complete the baseline survey online. Students who chose not to participate were permitted to register online for the section of their choice, including the hybrid section (as non-participants).

- C. Randomization: After completing the baseline survey, the computer randomly assigned the participants to either the treatment or control group and informed the students with an on-screen message. With the help of the department staff, the students then immediately registered online for the appropriate section to which they had been assigned. Students in the control group were assigned to a discussion section that met during the same time slot as the face-to-face component of the treatment group.
- D. Results: The procedure described above resulted in a total of 90 students agreeing to participate in the study, with 47 assigned to the treatment group and 43 assigned to the control group. However, 12 students who agreed to participate in the study switched into a format other than the one to which they were randomly assigned; three of these participants were assigned to the hybrid group but switched into the traditional group, and the remaining nine were assigned to the traditional group but switched into the hybrid group. In addition, another 12 participants were randomly assigned but either never enrolled in the course, or else dropped the course altogether before the start of the fall semester. Seven of the 12 students who did not end up taking the course were assigned to the traditional format; one of the seven had a time conflict and another had already taken the course in summer 2011. The remaining five students who were randomly assigned but did not end up enrolling in the course at the beginning of the fall semester were randomly assigned to the hybrid format; one of the five did not have the necessary prerequisites for STAT 101.

III. Data collection

- A. Baseline survey: Conducted online at the time students consented to participate, as described in II.B above. All participating students completed the baseline survey.
- B. CAOS pre-test: Administered in class during the first week of the semester (on September 12th). Students in both groups were given approximately 30 minutes to complete the test, with a few students taking at most 40 minutes. Seventy-four participants completed the pre-test (82% of the students who agreed to be in the study). Eight of the 16 students who consented but did not take the pre-test dropped the course after they were randomly assigned but before the start of the fall 2011 semester; the 74 students who took the pre-test thus represent 90% of the students who both consented to participate in the study and who actually enrolled in the course at the beginning of the semester.
- C. CAOS post-test: Administered in class near the end of the semester (on December 5th). Students in both groups were given approximately 30 minutes to complete the test, with a few students taking at most 40 minutes. Seventy participants completed the test (90% of the 78 participants who completed the course).

- D. Final Exam: Both groups were administered a common final exam. Seventy-eight participants completed the course; of those 78, 76 took the final exam (representing 97% of the participants who completed the course).
- E. End-of-semester survey: Administered at the same time as the post-CAOS test. Sixty participants completed the survey (77% of the participants who completed the course).

IV. Implementation issues

The study was implemented as described above without any major problems or concerns, with the exception of the 24 students who switched sections or dropped the course entirely after learning their random assignments.