Current Status of Research on Online Learning in Postsecondary Education

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William G. Bowen and Kelly A. Lack

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It is unfortunately the case that there have been few rigorous efforts to produce compelling evidence of the learning outcomes associated with online courses at the post-secondary level. A further criticism of the existing research literature pertaining to postsecondary education is that, with a few notable exceptions, little attention has been paid to the costs of achieving whatever outcomes have been observed—and those cost studies that do exist have severe limitations. Sad to say, this rapidly growing field has been built largely on the proverbial “wing and a prayer.” This is not to suggest that the future of online learning is bleak; on the contrary, we think online learning is highly promising. But we also believe that the research that has been published on this topic—which we have reviewed

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1 William G. Bowen has had overall responsibility for guiding the preparation of this review of the literature and has drafted parts of it. Kelly A. Lack has done by far the largest part of the “digging;” she also deserves credit for having done the analysis of recent studies and having drafted the substance of that part of the report. Kevin M. Guthrie, president of ITHAKA, has also discussed the content and reviewed the current document, as has Lawrence S. Bacow, Senior Advisor to Ithaka S+R. In light of the original submission deadline for this paper, we do not review studies published after the end of 2011.

2 The same conclusion holds, we suspect, at the K-12 level, but we have not made as comprehensive an effort at that level to chart the relevant data/studies.
in detail in preparing this report— is of limited quality and, therefore, of limited value in determining how much more of an investment, and in what form, should be made in this field. As of the moment, a priori arguments will have to continue to bear much of the weight.

We originally thought that full responsibility for this state of affairs rests with those who have conducted the studies. We have since revised that judgment. A significant share of responsibility rests with those who have created and used the online pedagogies, since the content itself often does not lend itself to rigorous analysis.

2009 SRI/DOE Meta-Analysis

Before summarizing the more recent studies, it is necessary to set a baseline by going back and reviewing briefly the widely publicized report prepared by SRI and released by the US Department of Education in 2009 (often cited as Means et al.). The first thing to be said is that this report set a fairly high bar for including studies in the meta-analysis: The studies had to compare web-based instruction (i.e. excluding video-based courses and stand-alone computer applications) to face-to-face or “offline” instruction; they had to use random-assignment or quasi-experimental research designs; and they had to focus specifically on objective measures of student learning (i.e. they could not look solely at outcomes such as student or faculty perceptions) that were measured for both the web-based and non web-based formats. The studies also needed to have been completed at the time of the meta-analysis, and had to provide sufficient information to allow effect sizes to be calculated. The authors began with an initial pool of 1,132 studies published between 1996 and 2008, and they ended up with just 46 that met the criteria above. This dramatic fall off in numbers is itself a telling reflection of the lack of sophistication of most activity in this field. Another 77 studies without face-to-face control groups were included in a “narrative synthesis.” Of the 46 studies reviewed in detail, most had sample sizes of a few dozen learners; only five included more than 400 learners. Many of the studies were in the fields of medicine or health care; very few have direct relevance to the large public universities or the broad-based community colleges that educate such a high fraction of our student population.

All that said, the findings of the DOE meta-analysis are at least mildly encouraging for the further development of online education. The authors found that students who took all or part of their class online performed modestly better, on average, than did those taking the course through traditional, face-to-face instruction. Although both purely online instruction and hybrid forms of

While not without limitations, the findings of the DOE meta-analysis are at least mildly encouraging for the further development of online education.

3 At one point, we contemplated including in this study an investigation of the marketing claims of providers of online learning, but we concluded that any thorough effort of this kind was impractical. If literature supporting the claims of providers existed, and were deemed reliable, it would most likely have been publicized, as doing so would be in the providers’ interests. At this time, we are unaware of any such research. (See, however, the “postscript” at the end of this report, and Appendix B describing case studies that purport to assess the learning outcomes achieved by McGraw-Hill’s “Connect” product.) An obstacle to third-party evaluation of marketing claims is the natural reluctance of for-profit providers to give independent “outsiders” access to sensitive materials and proprietary data.

4 Means et al., 2009, p. 17.
instruction had positive effects, the hybrid mode had a larger advantage—which is hardly surprising since hybrid forms of instruction involve the commitment of more resources. Time-on-task was found to be a significant variable, and effect sizes were larger when a new instructional approach was tried, as opposed to simply varying the medium of delivery. Significantly, the meta-analysis found that online learning can be enhanced by giving learners control of their interactions with delivery mechanisms and prompting learner reflection. “The meta-analysis findings do not support simply putting an existing course online,” the DOE report said, “but they do support redesigning instruction to incorporate additional learning opportunities online.”

It would be wrong, however, to suggest that conclusive evidence concerning the cost-effectiveness of online instruction exists. It did not at the time of the DOE study and it does not today (as we will document in a later section of this report). In an NBER working paper titled “Is it Live or is it Internet? Experimental Estimates of the Effects of Online Instruction on Student Learning,” David N. Figlio of Northwestern University and his co-authors criticize the methodology of the DOE analysis and argue that much more work—and, in particular, much more careful experimental work—needs to be done before sweeping conclusions can be reached. To demonstrate the kind of research they think is needed, Figlio et al. conducted a randomized study of students in a microeconomics course and compared the learning outcomes for students who attended the live lectures and students who watched videos of the lectures online. They found no significant differences in outcomes.

Another review of the DOE analysis—by Columbia University’s Community College Research Center (CCRC)—also concludes that the DOE analysis contains little data relevant to the question of the effectiveness of fully online courses in typical college and university settings. Many of the studies in the DOE analysis were of hybrid modes of teaching that continued to provide lots of face-to-face teaching, and many were studies of short educational programs among student populations very different from those who attend community colleges. In fact, the CCRC report says that only seven studies in the DOE analysis involved undergraduate or graduate students enrolled in semester-long online courses, and these seven studies found no significant advantages or disadvantages of online courses. The CCRC report also expresses concern that online courses may work less well for low-income students with low-speed Internet access at home.

Our conclusions are that: (1) Figlio et al. are too harsh in their condemnation of the DOE study; (2) the Figlio comparison of a traditional course with a particular online mode of presentation (video presentation of lectures) is narrow and of limited relevance, in that it is not applicable to many varieties of online

5 Ibid. p. 51.


courses—still, it is of interest in light of the proliferation and increasing popularity of video-driven courses; (3) the CCRC report is correct in pointing out the limited relevance of the DOE study for typical college/university settings; and (4) both Figlio and the CCRC are right in calling for much more extensive and much more careful experimental research into the effectiveness of sophisticated modes of online teaching in college and university settings.

The NCAT Studies

There is another large set of data on online learning initiatives that deserves careful attention, even though it too has defects. Carol Twigg and her colleagues at the National Center for Academic Transformation (NCAT) have worked with well over 70 campuses to introduce course redesigns that involve a variety of models of online instruction. The NCAT reports on these initiatives describe each one in considerable detail and (unlike most other studies) document cost savings in essentially every case; they also generally report some improved student learning outcomes.8 However, these case studies have two serious limitations from a research standpoint. First, they are all “before-and-after” studies, which compare the results achieved by a redesigned course in year t with the results for the traditional variant of the same course in year t – 1. Controls are lacking, and one of NCAT’s quarterly newsletters is frank in acknowledging that in some cases situations have changed noticeably between the “before” and “after” years in question.9 These are not the kind of rigorous, randomized studies that can produce robust results. The “evidence of success” is based on case studies and examples. Also, the results are all self-reported; careful third-party evaluation would be preferred.

Still, the consistency of the reported outcomes certainly suggests strongly that redesigning courses along the lines suggested by the various NCAT models produces positive results. In our view, Twigg deserves great credit for: (1) having seen the potential of online courses early on; (2) having had the courage to emphasize the importance of achieving cost savings; and (3) having worked hard (albeit, one would have to say, without marked success) to encourage both replication and sustainability.10

8 An Education Sector Report (Ben Miller, “The Course of Innovation: Using Technology to Transform Higher Education,” May 2010) provides a very useful summary of NCAT’s work and references to all of the underlying NCAT Reports conducted up to the time of its preparation.


10 Both Miller’s report and a subsequent column by Kevin Carey (“The Better Mousetrap Problem,” Chronicle of Higher Education, May 27, 2010) point out that, in Carey’s words, “In many ways the most interesting part of the NCAT story isn’t the colleges that have adopted these proven methods. It’s the colleges that haven’t—i.e., most colleges” (out of a universe of many thousands nationwide). Both Miller and Carey discuss the reasons for this pattern in detail.

In addition to the lack of evidence that the courses redesigned at one institution have been adopted elsewhere—the math “emporium” work done at Virginia Tech being one exception—we do not know how many of the redesigned courses have been sustained at their home campuses. Some case studies done by our Ithaka S+R colleague, Matthew P. Long, suggest that it has been difficult in some settings to upgrade technology and to sustain the original efforts.
More Recent Studies

Since the publication of the 2009 DOE meta-analysis, as well as in the years following the cut-off date for inclusion in the DOE paper, several other studies have been published on the comparative effectiveness of web-based instruction and traditional, face-to-face learning in higher education. Some of these could not have been included in the DOE meta-analysis because they were published after its cut-off date; others may have been available to the authors at the time the meta-analysis was written but were not included for some other reason (for example, perhaps they did not fulfill the authors’ inclusion criteria or were simply overlooked). Nonetheless, as the popularity of web-based learning continues to escalate—as a result of a combination of factors including, but not limited to, increasing familiarity with forms of technology among college-age students and budgetary pressures to teach more students with fewer resources—taking another look at what others have learned about the effectiveness of web-based courses is warranted, even if great caution is warranted in interpreting these findings. This section of our report considers those studies that satisfy a set of basic criteria. To be included in this follow-on literature review, a study must fulfill all of these requirements:

1. Compare face-to-face learning to blended or online learning.
2. Examine learning outcomes or performance specifically (as opposed to self-reported outcomes such as student ratings of, or satisfaction with, the course).
3. Involve one or more undergraduate, for-credit college course(s) that are offered outside of a continuing education program.
4. Take place in the United States or in a location with a comparable higher education system.
5. Be authored by someone who is not a current student (for instance, a paper submitted in partial fulfillment of dissertation or bachelor’s degree requirements would be excluded from the review).

Approximately 15 studies have been identified that fulfill these criteria. (Please see the Table at the end of this paper, which contains detailed information on each study, as well as Appendix A, where each study is described in even more detail.) The subject matter of the courses involved ranges from marketing and accounting to psychology and biology, from statistics and probability to electrical engineering. Some studies were conducted at community and technical colleges; others took place at private and public four-year colleges and universities in various regions of the country.
Cautions

A few words of caution are necessary. Very few of the studies examined involved a rigorous design in which students were randomly assigned to the face-to-face format or the online/hybrid format; rather, students were generally allowed to self-select into a certain course format. Furthermore, of the observational studies, some did not make any attempt to control for differences in the students taking the online or hybrid version course and the students taking the face-to-face version. This limitation is particularly problematic because, in a number of studies, the differences in background characteristics between the two groups were not trivial. Moreover, of those studies that did include a rigorous design, most did not have a large sample size; of the two studies that employed randomization (the “gold standard,” so to speak, in evaluation research) the larger sample size consisted of only 36 students across the two formats.

Also complicating the picture was a lack in the consistency in the definitions used. In addition to the variety in subject matter, the studies differed in whether they involved comparisons of a purely online course—with no face-to-face meetings—or of a hybrid course—with one or more face-to-face meetings each week—to a face-to-face course. Furthermore, what was meant by an “online” or “hybrid” course in one study was not necessarily the same as what was meant by a “web-based” or “blended” course in another. Some of the online courses in the studies provided students with instant feedback and hints as they worked through activities or simulations, supplemented by discussion boards and chat rooms with other students and the instructors. Other courses seemed far less sophisticated and appeared to consist of little more than video recordings of lectures posted on the Internet. The variety of courses available that can be described as “online” or “blended” is noteworthy because the differences in their features can play a significant role in how much students learn from those courses. The same group of students might do much better than the comparison group when the online students are using a highly sophisticated online course, but much worse than the comparison group when the online students are using a relatively rudimentary online course. While some studies gave an in-depth description of what the “online” course being evaluated entailed (in some cases, by even providing screen shots or sample exercises), others did little to elaborate on what was meant by “online” or “blended.”

Some studies also involved a comparison of multiple face-to-face courses with the online or hybrid versions of those same courses, using final course grade and/or completion rate as the only performance-related outcomes. In such studies it is not always clear how much the “online” courses differ from each other. If the

11 As noted in the following paragraph, some studies in the literature review compared the face-to-face format of one or more courses to a purely online format; others compared the face-to-face format to the hybrid (partly online, partly face-to-face) format; and still others compared the face-to-face format to both the hybrid format and to the completely online format, or did not specify the degree of face-to-face contact students in the web-based format had with their instructor.

12 The two randomized studies to which we refer are those conducted by Poirier and Feldman (2004) and Mentzer, Cryan, and Teclehaimanot (2007). While a third study, by Christou, Dinov, and Sanchez (2007), is described in its abstract as a “randomized controlled study,” there is no mention of randomly assigning students in the text of the article in the section where the authors describe the study’s design, rendering it unclear whether random assignment of students actually took place.
online courses in the study are relatively similar to each other—for example, if the same learning management systems were used, the same types of homework assignments were given, and the same types of automatic feedback were provided to students by the machine—the results might indicate how effective that particular type or model of online learning is, relative to the face-to-face format. On the other hand, there may be much more heterogeneity in the types of online or hybrid courses being studied: for example, the online version of introductory statistics may be much different from the online version of introductory economics (in other ways than just subject matter). If there is substantial heterogeneity, the studies may not be measuring the effectiveness of a particular kind of online learning so much as evaluating the effectiveness of the “average” (so to speak) online course included in the sample. Knowing how much and what kind of variation exists among the different “treatments” is useful, but unfortunately this information is not always provided.

Similarly, many studies did not specify what kind of instruction students in the “face-to-face” or “on-campus” sections received and how much variability there was across those face-to-face sections. The so-called traditional or face-to-face section(s) for one online-versus-traditional-course comparison (for example, a comparison of an online accounting course to a face-to-face version of the same course) might be substantially different from the face-to-face section(s) of another course (for example, environmental biology). Large (or small) variations across face-to-face sections may exist in terms of the amount of weekly face-to-face interaction with instructors students received, class size, experience or skill level of the instructor, how the face-to-face time was used, and so on. Nonetheless, information about what constituted traditional, face-to-face instruction in the relevant sections, and how much variability there was across face-to-face sections, was not provided in some studies (much less incorporated into the authors’ analyses).

Each study included in this literature review also has more specific limitations, suggesting that, when considered alone, that particular study cannot provide conclusive evidence about the effectiveness (or ineffectiveness) of online (or blended) learning. The limitations described here are the common and general patterns that need to be kept in mind when interpreting the results of the literature about “online learning” as a whole.

Findings

Despite the caveats described above, a holistic look at the literature assembled provides little, if any, evidence to suggest that online or hybrid learning, on average, is more or less effective than face-to-face learning. Not only do the types of online or hybrid learning involved in the studies vary considerably, but so do the outcomes measured, which range from homework assignment scores and project grades, to exam scores, to final course grades, to completion and withdrawal rates. In fact, most studies employ multiple measures of students’ performance. How valid these measures are is an open question (and one that is beyond the scope of this paper). However, assuming that the measures employed are useful indicators of the student learning that takes place in the respective course(s), the

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13 See Appendix A for a more detailed description of each study, including the limitations.
By and large, the studies reviewed offer little evidence to support conclusively the claim that online or hybrid learning is significantly more effective or significantly less effective than face-to-face instruction.

Literature does not show a pattern of online students consistently outperforming their face-to-face format peers, or vice versa. Even within a single study, there are few cases where one group outperformed the other group on all performance measures evaluated (Xu and Jaggars’ longitudinal study being one of the few exceptions). Rather, most of the studies have mixed results: on some of the measures, students in the online or blended format did better, but on others they did worse, relative to students in the face-to-face format—or else on some measures the online – or blended-format students did significantly better or worse than the students in the face-to-face format, but on other measures there was no significant difference between the two groups. As an illustration:

- Of the two studies in which the researchers reported randomly assigning students to a face-to-face or online/hybrid format, one study showed no significant differences in exam performance between online and face-to-face students, but showed that online students were less likely to submit assignments and consequently earned significantly lower course grades (Mentzer, Cryan & Tcelehaimanot, 2007). The other study showed that online students performed significantly better on exams, but about the same on papers (Poirier & Feldman, 2004). However, while these two studies had the most rigorous designs, they unfortunately also had very low sample sizes.

- Of the (observational) studies that included more than 1,000 participants taking a variety of courses that were offered both in online/hybrid (the study did not distinguish between the two) and face-to-face formats, one study (Xu & Jaggars, 2011) showed that students taking online courses had a higher probability of withdrawing and received lower course grades than students in face-to-face courses. By contrast, Carpinelli et al. (2006) found that “distance learning” students earned significantly higher course grades.

- Of the studies that did not involve randomization (and so were subject to self-selection effects), but whose analysis included controls for a number of background characteristics and/or other predictor variables, Riffell and Sibley’s (2005) research showed that hybrid-format students did better than face-to-face students on post-course assessments, but that the difference was only significant for upperclassmen. Weber and Lennon (2007), however, found that online students were significantly more likely to withdraw from the course and earned significantly lower final exam, final project, and final course grades—but, after running regressions that controlled for background characteristics, “course format had an insignificant contribution to learning achievements.”

Christou, Dinov, and Sanchez (2007) found that the overall performance of online/hybrid students was significantly better than the overall performance of face-to-face students.

The description above is intended to provide an (incomplete) overview of the studies reviewed; please see the Table and Appendix A for more details. By and large, these studies offer little evidence to support conclusively the claim that online or hybrid learning is significantly more effective or significantly less effective than face-to-face instruction. As is so often true, the “devil is in the details”—but, as the architect Robert Venturi is fond of reminding people, “Don’t let ‘de-tails’ wag the dog.” It is a tough balance to strike.

Conclusions and Other Observations

Prompted by the *New York Times* dissection of the Carnegie Learning K-12 math course, we were asked by several parties to comment on the danger that providers of online courses in the postsecondary world have inflated their claims of success. This danger always exists, perhaps especially where for-profit providers are (understandably) seeking revenues and returns on their investments. We should be skeptical of any analysis of learning outcomes that has been done by self-interested advocates of online learning. It is asking a great deal of those who are basing their careers or businesses on successful adoption of online education to be objective in evaluating the success of their own work; it is relevant to note that drug companies contract out clinical trials. There is no escaping the responsibility of institutional users to conduct their own rigorous assessments, or (better yet) to require real third-party evidence of good learning outcomes. Too often users simply accept what sounds exciting and promising as “proven.”

In partial defense of what may seem like (and often are) cavalier efforts at assessment, it is also important to understand how difficult it is to do rigorous research on educational outcomes, especially where human subjects and Institutional Review Board requirements are involved. Barriers to randomization, including resistance from faculty, students, and administrators, can be difficult to overcome, and implementing proper research protocols is challenging. Still, there is no substitute for rigorous research, and Ithaka S+R is now engaged in an effort to fill at least a small part of this void. Absent such research, there is no way to answer the question about the prevalence of “inflated report cards” in a definitive way.

There is one important difference between the K-12 and postsecondary worlds to bear in mind in the context of efforts to assess “learning effectiveness.” This difference concerns responsibility for the control of costs and the attitude toward costs. Although costs are a big issue at both levels, exploring in detail the many differences in how they should be thought about is beyond the scope of this short report. Suffice it to say that school districts at the K-12 level are naturally focused on how to improve simple measures of outcomes, such as test scores, without increasing outlays or making drastic changes in staffing. And it is the lack of clear evidence of improvements in outcomes that presumably stimulated the New York Times piece on the Carnegie Learning math course. At the postsecondary level, individual institutions have (or should have) both a strong interest in measuring costs and a strong incentive to control or reduce costs, especially as enrollment of more students is considered. Thus, in assessing learning effectiveness at the postsecondary level, close attention should be paid to outcomes in relation to cost—achieving the same outcomes at half the cost per student should be seen as a big victory. Twigg has understood this, but many creators and users of online courses have not. A huge complication is that it is by no means easy to study costs, because there are potentially large differences between the start-up

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or one-time costs of sophisticated online instruction and costs in some kind of equilibrium state a few years down the road. As part of the companion study referenced earlier, Ithaka S+R has explored a cost simulation approach to analyzing potential cost savings, but much more work need to be done in this area.\(^\text{17}\)

To return more directly to the question of how to respond to arguments over “inflation of report cards,” one clear recommendation is to avoid claiming too much, unless or until the evidence is clear. Not getting out on the proverbial limb is the best way to reduce the risk that one will fall when the limb is cut off. The ambiguity of evidence about learning outcomes should not really surprise us, given how little is known, more generally, about how college students learn.

We wish to reiterate our conviction that the lack to date of powerful quantitative evidence of learning effectiveness (with proper controls in place) does not imply that the rapidly increasing number of efforts to employ online learning is a mistake—not at all. We remain persuaded—on the basis of a priori reasoning, anecdotal commentaries, and the consistency of findings in even imperfect studies of learning outcomes—that determined efforts should be made to improve online learning, taking full advantage of features that are specific to an online environment, such as automatic and interactive feedback loops. Well-designed online instruction has great promise.\(^\text{18}\) At the same time, rigorous efforts should be made to assess readily measurable outcomes such as completion rates and time-to-degree, paying attention to differences in outcomes among different student populations and different sets of institutional users.

We also believe that much more careful attention should be paid to analyzing costs (in some long-term equilibrium state). Potential cost savings are far from inconsequential, especially in sectors of post-secondary education where there is great (unrelenting) pressure to “do more with less.”

\(^\text{17}\)See “Interactive Learning Online at Public Universities: Evidence from Randomized Trials” by Bowen et al.

\(^\text{18}\)VanLehn’s meta-analysis of randomized studies pertaining to the effectiveness of synchronous, computer-based tutoring may also be of interest to the reader in this regard. While not directly within the scope of this literature review, VanLehn’s analysis suggests that, in science, technology, engineering, and math fields, the instructional approaches used by some “intelligent tutoring systems” can be as effective in some settings as one-on-one tutoring by a human. See Kurt VanLehn, “The Relative Effectiveness of Human Tutoring, Intelligent Tutoring Systems, and Other Tutoring Systems,” Educational Psychologist, 46.4 (2011): 197-221, http://dx.doi.org/10.1080/00461520.2011.611369.
A postscript on commercially-provided online learning platforms is in order. After we finished a draft of this report, we learned about a series of case studies of McGraw-Hill’s “Connect” product cited by McGraw-Hill. We have examined these case studies in some detail and Kelly A. Lack has prepared Appendix B, which describes and evaluates them. In brief, the studies report some improvements in learning outcomes using Connect. But the studies themselves are not rigorous and suffer from a wide variety of methodological shortcomings (including lack of controls for potential “selection effects”) which make it next-to-impossible to assess their reliability. It is also important to bear in mind what is said above about the need for third-party assessments of claims for their products made by providers. A final point is that in these case studies there is (unsurprisingly) no effort to assess whether the reported results justify the costs involved in using “Connect.”
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<th>Study</th>
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<td>Carpinelli et al. (2006)</td>
<td>3,491 students across both formats; 10 online students, 25 online students</td>
<td>New Jersey Institute of Technology</td>
<td>150 courses</td>
<td>Observational</td>
<td>Final course grade</td>
<td>Students in distance learning courses earned significantly higher grades than students in face-to-face courses.</td>
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<td>Christou, Dinov &amp; Sanchez (2007)</td>
<td>Stats 13 study: ≈160 students across two formats Stats 100A study: 20 synchronous audiographics students, 39 hybrid students, 34 face-to-face students</td>
<td>University of California-Los Angeles</td>
<td>Introductory probability (Stats 100A) and introductory statistics (Stats 13)</td>
<td>Experimental (according to abstract) with standardization in instruction*</td>
<td>Scores on exams and overall performance</td>
<td>Stats 13 study: Overall performance was significantly greater for the hybrid group. The hybrid group did significantly better on 2 of 5 tests and significantly worse on 1 of the 5. Stats 100A study: Hybrid students scored significantly higher on 3 exams and had better overall performance.</td>
</tr>
<tr>
<td>Dell, Low &amp; Wilker (2010)</td>
<td>13 online students, 46 face-to-face students</td>
<td>Unspecified</td>
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<td>Observational with standardization in instruction</td>
<td>Performance on 2-3 page report on experiment; analysis of learning episode; essay-format question on final exam</td>
<td>The online students did significantly better on the report; there was no significant difference between the two formats in the scores on the analysis of learning episode or on the essay-format question.</td>
</tr>
<tr>
<td>Dinov &amp; Sanchez (2006)</td>
<td>20 hybrid students, 39 face-to-face students</td>
<td>University of California-Los Angeles</td>
<td>Introductory probability</td>
<td>Observational with standardization in instruction</td>
<td>Homework; midterm; final exam; course grade</td>
<td>The undergraduates in the hybrid group did slightly better on all measures than the undergraduates in the face-to-face group, but the results were reversed when graduate students were included in analysis.</td>
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<td>Enriquez (2010)</td>
<td>25 online students, 30 face-to-face students</td>
<td>Cañada College (member of California Community College system)</td>
<td>Circuits analysis</td>
<td>Observational with standardization in instruction</td>
<td>Scores on 15 homework sets, 4 tests, and final exam; retention rate; proportion of students earning A, B, or C in course</td>
<td>The retention rate and the percentage of students who received an A, B, or C were the same across two groups. Online students did slightly better with respect to homework assignments, final exam, and course grade, and slightly worse on tests, but the differences were not significant.</td>
</tr>
<tr>
<td>Heldhusen (2009)</td>
<td>10 online students, 20 synchronous audiographics students, 23 hybrid students, 14 face-to-face students</td>
<td>Unspecified, though author is affiliated with University of Wisconsin</td>
<td>Engineering graphics</td>
<td>Observational with standardization in instruction</td>
<td>Scores on post-test and on very similar lab exercises</td>
<td>The synchronous audiographics section scored the highest overall on post-test; the online section scored the lowest. The only significantly difference on overall post-test scores between 2 formats was between the hybrid and audiographics formats (the latter did better). There was no significant difference on overall lab scores, though there were a few significant differences between formats for particular test and lab topics.</td>
</tr>
<tr>
<td>Mentzer, Cryan &amp; Teclehaimanot (2007)</td>
<td>18 online students, 18 face-to-face students</td>
<td>Medium-sized campus, with at least 20,000 students</td>
<td>Early childhood education survey course</td>
<td>Experimental with standardization in instruction</td>
<td>Scores on midterm and final exams and final course grade</td>
<td>The two formats had equivalent performance on the midterm and final exams, but final grades were significantly lower for online students, who were more likely to not complete other assignments that counted toward their final grades.</td>
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<tr>
<td>Parsons-Pollard, Lacks &amp; Grant (2008)</td>
<td>425 online students, 305 face-to-face students</td>
<td>Large, urban public university in southeast with total enrollment of 30,000</td>
<td>Introductory criminal justice</td>
<td>Observational with standardization in instruction</td>
<td>Scores on 3 exams; final course grade</td>
<td>Only performance on the third exam and the final course grade were significantly correlated with delivery format. The online group did better on the exam, but the face-to-face group had significantly higher final course grades.</td>
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<tr>
<td>Plumb &amp; LaMeres (2011)</td>
<td>30–40 students in each delivery format</td>
<td>Montana State University</td>
<td>Introduction to Logic Circuits</td>
<td>Observational with standardization in instruction</td>
<td>Scores on assignments for 8 modules; final exam grade; course grade</td>
<td>There were no significant differences in course or final exam grades, but there were significant differences on scores for 2 modules. On one module, the online group did better; on the other, the face-to-face group did better.</td>
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## STUDIES INCLUDED IN THE LITERATURE REVIEW

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<th>Study</th>
<th>Sample Size</th>
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<td>Poirier &amp; Feldman (2004)</td>
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<td>Rich &amp; Dereshiwsky (2011)</td>
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<td>Riffell &amp; Sibley (2005)</td>
<td>55 hybrid students, 74 face-to-face students</td>
<td>Michigan State University</td>
<td>Introductory environmental biology</td>
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<td>Scores on active-learning activity and on post-test</td>
<td>The hybrid group did better on the post-test; the difference was significant for upperclassmen but not for freshmen. The active-learning exercises were more effective when coupled with online activities (rather than with passive lectures); the hybrid students did better than the face-to-face students on the post-test questions on topics covered by the active-learning exercises. No covariate-delivery format interactions were significant.</td>
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<tr>
<td>Wagner, Garippo, &amp; Lovaas (2011)</td>
<td>171 online students, 435 face-to-face students</td>
<td>Unspecified, though all authors are affiliated with Niagara University</td>
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</tr>
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*While the abstract describes the study as a “randomized controlled study,” there is no mention of randomly assigning students to one format or the other in the text of the article.*
Carpinelli, et al. (2006)

Carpinelli and his colleagues looked at a sample of 3,491 students taking 150 courses at the New Jersey Institute of Technology over the course of two semesters. Of the 3,491 students and 7,701 course enrollments in the sample, 1,156 students and 1,683 enrollments constituted the “distance learning” (defined only as “eLearning”) group; the other students and enrollments in face-to-face courses constituted a control group for the researchers. The types of files used by the instructors in the distance learning courses varied—some included multimedia files, some included text files, some included both types of files—as did the rank of the instructor and the software platform used (which was generally either WebCT or WebBoard). (The WebCT and WebBoard platforms both allow for online chatting, discussion forums, the sharing and storage of documents, the posting of assignments and quizzes, and the tracking of grades.) The researchers compared the final course grades of the students in the two groups, and collected background data on students’ ethnicity, gender, and SAT scores; the distance learning group had a greater proportion of females than the face-to-face group, but there were no significant differences in the two groups’ ethnic compositions or SAT scores. After comparing the participants’ course grades in the distance learning and face-to-face course, Carpinelli and his colleagues found that students in distance learning courses earned significantly higher grades than students in face-to-face courses.

Although the sample size of this study is quite large, the design itself has a number of limitations. First and foremost, there is no random assignment of students or attempts to measure or control for differences in the characteristics of students who enroll in face-to-face or distance learning courses. Because the participants in the study self-select into a particular format, there is no way to know to what extent the significantly higher grades are related to the distance learning delivery format itself, and to what extent they are related to the characteristics of the students who enroll in those courses; the most motivated and talented students might be attracted to distance learning courses significantly more so than to face-to-face courses, even if there is no difference in the effectiveness of the different formats.

In addition, the caveats that usually apply to large-scale observational studies comparing distance to face-to-face learning for multiple courses are relevant here as well. For instance, there is no mention of an attempt to standardize course materials, course content, or instructor experience level between face-to-face and distance learning sections of the same course, which can confound interpretation of the results and make comparing the delivery formats per se difficult. Moreover, while the study mentions variability in the distance learning courses included in the sample—with respect to platform and medium of content in the online course—it does not specify how much variability there is, nor do the authors indicate how much variability there is among the face-to-face courses in the sample. Any conclusions reached from this study concerning the effectiveness of the two formats would, at best, have to be drawn with respect to the effectiveness of distance learning courses, on average, relative to face-to-face courses.
While this not a problem as such, it does make it difficult to know to which types of online courses any findings about comparative effectiveness would apply. Finally, the fact that course grades—which often are subjective measures, at least relative to scores on multiple choice exams—are the only measure of performance used to compare students in the two formats raises the question of whether instructors’ grading standards are comparable in the distance learning and face-to-face courses—a question for which the study provides no answer.

**Christou, Dinov & Sanchez (2007)**

Christou, Dinov, and Sanchez essentially conducted two studies with a total sample of about 230 students at the University of California-Los Angeles, in both cases comparing a class of students who used the Statistics Online Computational Resource (SOCR) with a class of students who did not use SOCR, and who took the course during a different semester. SOCR (http://www.socr.ucla.edu/) is a free, web-based resource that provides data-based educational materials and interactive tools in probability and statistics, such as class notes, practice activities, statistical calculators, interactive graphical user interfaces, computational and simulation applets, and tools for data analysis and visualization. One of the two studies involved a total of approximately 160 students in Stats 13: Statistical Methods for the Life and Health Sciences, across the SOCR-based and non-SOCR-based sections; the other study involved a total of 73 students—39 in the SOCR-based section and 34 students in the non-SOCR-based section—of Stats 100A: Introduction to Probability Theory.

In the study involving Stats 13—which primarily enrolls students who intend to go to medical, graduate, and other professional schools after finishing college—both the SOCR-based section and the non-SOCR-based section received five hours of instruction a week, consisting of three lectures, one discussion, and one lab. Each of the two sections, which were each led by two teaching assistants, was split into three sub-sections during the discussions and laboratory sessions. In the lectures for the SOCR-based section, the instructors used SOCR tools for demonstrations and data analysis, and students used the tools to complete projects, labs, and homework assignments. All students were graded according to the same standards. With respect to the study comparing sections of Stats 100A—which attracts mainly mathematics, economics, and computer science majors—the article says that the course met three times a week with the instructor, and once a week for a discussion with a teaching assistant; whether this was true for only one of the sections (the SOCR-based section or the non-SOCR-based section) or for both sections in the study was not clear. In addition, while the abstract of the article states that a “randomized controlled study” was used for these two courses, the description of the study design in the text of the article says nothing about randomly assigning students to one format or the other.

When Christou, Dinov, and Sanchez compared the students’ exam grades and “overall performance” across the two formats, controlling for “all possible predictors (like age, major, learning style, background, attitude towards the subject, etc.),” they found that the section of Stats 13 that used SOCR had significantly higher overall performance. Compared with the section of Stats 13 that did not use SOCR, the SOCR-based section did significantly better on two of five tests, and significantly worse on one of the five tests (for the other two tests, there was
no significant difference between the two formats). In the Stats 100A study, the SOCR section did significantly better on three exams and in terms of overall performance (for the other two tests, there was no significant difference between the two formats). For both the Stats 13 study and the Stats 100A study, the article says that the SOCR-based section and the non-SOCR-based section “had the same grading style (exams and homework) and therefore they are comparable.”

However, the fact that the section that students who used SOCR did significantly better overall should not come as a surprise, as the study, as described in the article, suggests that students in the SOCR-based sections had as much face-to-face instruction as did the students in the non-SOCR-based sections, plus the benefit of the SOCR resources; one would expect students to do as well, if not better, with more resources than with fewer resources. Another complicating factor was the fact that the non-SOCR based section of the Stat 13 control study had a required lab hour in which students used STATA and thereby gained exposure to a type of technology-based instruction.

Finally, even though the abstract to the article describes the research as a “randomized controlled study,” the lack of mention of random assignment of students in the text of the article, as well as the fact that students in the non-SOCR-based sections were taking their courses during a different term than the students in the SOCR-based sections, suggest that random assignment of students did not actually occur. While Christou and his colleagues claim to have controlled for “all possible predictors,” it is unclear how they did so, given that the researchers seem to have used two-sample t-tests of the means to compare the outcomes of students in the two formats. Thus, it is unclear to what extent any differences observed in the outcomes can be attributed to the different formats versus to differences in the students who enrolled in the different formats.

**Dell, Low & Wilker (2010)**

Dell and his colleagues compared an online educational psychology course with a face-to-face version of the same course. Of the 59 undergraduates who were involved in this study (the relevant population given the inclusion criteria for this literature review), 13 were enrolled in the online section of the course, and 23 were enrolled in each of two face-to-face sections of the same course. Of the 46 students in those two face-to-face sections, 13 were male and 33 were female, compared with four males and nine females in the online section. The online course included a forum for asynchronous group discussions; the instructor played only a limited role, occasionally checking in on the discussions, providing limited feedback, clarifying misunderstandings, and occasionally asking questions to prompt critical thinking. The same instructor taught all three sections, using the same assignments, readings, activities, and discussions in the same order. All online students took the final exam with a pre-approved proctor. The researchers compared students’ performance on two assignments: a two – to three – page report on the experiment conducted by students (which was followed by an online or face-to-face discussion of the experiment outcomes); and an essay-format question on final exam about self-efficacy. The latter was graded by “independent raters in a blind review” according to a rubric, and the raters were required to reach an agreement on all ratings. Dell and his colleagues found that, on average, students in the online group did significantly better with respect
to the reports on the experiment, but that there was no significant difference in the two groups’ performance with respect to the analysis of learning episode or the essay-format question on self-efficacy.

Like other studies in this review, this study, by itself, does not hold very much weight. Not only is the sample size relatively small, but the study design is not very rigorous, with no random assignment of students to the online section or face-to-face section and no attempts to measure or control for differences in the populations of students who self-select into the different formats.

**Dinov & Sanchez (2006)**

Dinov and Sanchez compared the performance of 20 students in a hybrid Introduction to Probability course at the University of California-Los Angeles to that of 39 students in a face-to-face version of that same class. The students in the hybrid group, but not the students in the face-to-face group, used modules of SOCR (see description in the Christou et al. study above) and SOCR applets to solve problems and to complete homework assignments. Both groups received instruction three mornings a week, and attended one discussion section per week. Students in both formats were taught using the same Power Point lectures (which were also available on the course website), followed the same syllabus, used the same textbook, and participated in similar discussion sessions. They were also given the same practice midterm and final exams, as well as the same homework assignments, which were graded using the same rubric; however, only the hybrid class was required to use SOCR in some of the homework problems (on which the face-to-face class was required to use the statistical software R). The hybrid class was also assigned additional activities in the homework assignments that also required SOCR. The two groups’ exams were graded at the same time, with the same instructor grading the same few questions on all students’ exams. The students in the face-to-face class and hybrid class were “as similar as possible in all characteristics relevant to the outcome measures of interest,” except that the face-to-face class had more graduate students than did the hybrid class (16 graduate students the face-to-face class versus three graduate students in the hybrid class). At the end of the semester, researchers compared the homework, midterm, and final exam scores and the overall course grades of students in the two classes.

The researchers found that the undergraduate students in the hybrid group did slightly better on all measures than did the undergraduate students in the face-to-face group, though the authors do not indicate whether these differences were statistically significant. The variance in scores was also much lower in the hybrid group than in the face-to-face group for all performance outcomes. However, when graduate students were included in the analysis, the face-to-face group outperformed the hybrid group (presumably with respect to all outcomes, although the study did not specify this).

Like the other studies, this one also has its limitations. There is no mention of random assignment of participants to the hybrid group or the face-to-face group, and while the authors provide the composition of each group by class year and by major, there does not appear to be any attempt to control for any of the differences between the two formats, with the exception of the fact that the authors show the results with the graduate students in both groups excluded. The
authors do not show how the face-to-face group and the hybrid group compare with respect to other demographic variables, such as age, race, or gender, or with respect to measures indicative of academic preparedness, such as GPA. Finally, the hybrid group had a fair amount of face-to-face instruction—seemingly as much as the face-to-face group. In fact, the only apparent differences between the two formats were that the hybrid group had SOCR-based activities in addition to what the face-to-face group was given, and that the face-to-face group (but not the hybrid group) was required to use the R software for some assignments. Thus, it should not come as a surprise that a class that receives instruction three times a week, attends a discussion once a week, and has additional SOCR-based activities, should outperform a group that receives instruction three times a week and a discussion once a week, but is not given those additional activities.

Enriquez (2010)

Enriquez looked at a sample of students enrolled in an introductory, three-unit course in circuits analysis, which was required for all engineering majors, over two semesters at Cañada College. A member of the California Community College System Cañada College has approximately 6,000 students and a sizeable Latino population (comprising about two-fifths of the student body). Over the course of the two semesters, a total of 25 students enrolled in the online version of the course and 30 students enrolled in the face-to-face version of the course. Students in the online sections logged into an online classroom several times per week for 15 weeks, at the same time face-to-face students were attending lectures. The online students experienced the lectures through a combination of Tablet PC (which replaced Blackboard and was used to generate lecture notes) and Elluminate Live! video-conferencing software (which allows for web-based synchronous delivery). Students accessed the course through the eCollege delivery platform, which included content tools for viewing materials and assignments, and submitted their homework through Moodle, an open-source learning management system that was also used by the face-to-face students in this study. The online students did not attend any face-to-face lectures during the semester; they only needed to come to campus to take four tests and the final exam. Students in both the face-to-face and online sections were given identical tests and homework problems (with the same deadlines).

Compared to the students taking the online sections of the course, the students in the face-to-face sections had a greater proportion of students who were electrical engineering majors (30% versus 16%), as well as a greater proportion of students taking the lab course, which was designed to reinforce concepts learned in lecture, concurrently with the lecture course. According to the author of the study, the latter difference gave the face-to-face students an “advantage over online students in that they’re able to apply and experimentally verify concepts learned in the lecture course.”

At the end of the semester, Enriquez compared the scores of students in the two groups on 15 homework assignments, 4 tests, and the final exam, as well as the proportion of students who completed the course and the proportion of students who earned an A, B, or C in the course. He found that students in the online sections earned slightly higher course grades and scored slightly higher on their homework assignments and on the final exam, but did slightly worse on the other
tests, though these differences were not statistically significant. In addition, the retention rate and the percentage of students who received an A, B, or C were equivalent across the two groups.

However, while the sample sizes in this study are not extremely small, they also are not large, nor is there any mention of randomly assigning students to one format or the other. In addition, all of the online resources available through Moodle were available to both the face-to-face students and the online students, so it is unclear how much difference there actually was between the two groups. The study also mentions a computer projector that “on-campus” students used to view lecture notes, suggesting that the students in the face-to-face format might actually have been experiencing the lecture through a broadcast/telecast rather than face-to-face. Finally, while the author identifies some differences in student populations in the different formats, he makes no effort to control for them in his analysis of the outcomes.

**Holdhusen (2009)**

Holdhusen compared the outcomes of 14 first – or second-year undergraduate engineering students in a face-to-face engineering graphics course with students in three different types of technology-enhanced formats of that same course. Of the 53 students enrolled in technology-enhanced formats, 20 students enrolled in a section that used audiographics technology; 10 students enrolled in a section employing asynchronous online instruction; and 23 students took the engineering course in a hybrid format which combined face-to-face and synchronous online instruction. In the asynchronous online section, instruction was delivered via a learning management system, and included text, images, web videos to demonstrate drawing techniques, and a discussion board for students to post questions and communicate with each other and with instructor. Students submitted their assignments electronically. Students in the synchronous audiographics mode met face-to-face twice a week for 120 minutes each time; of the 120 minutes in each face-to-face meeting, 20 to 30 minutes were spent presenting new material via web-conferencing software, followed by a virtual lab, similar to a chat room, in which students could ask the instructor questions. The course web site used by students in the synchronous section was similar to the website used by students in the face-to-face section. Finally, the hybrid section met once per week for 150 minutes, during which time students and the instructor discussed the material briefly and students could ask the instructor questions about their assignments. Students in the hybrid section also had the option of chatting online with their instructor for 150 minutes once a week, and used a course web site that was similar to the site used by the purely online section. The lab exercises given to students in each of the four sections were said to be “essentially identical,” and the same instructor taught all sections. Students enrolled in a particular section “based on what was offered to them,” where “[t]he different modes were offered based on the geographical location of the instructor as well as the students.”

When Holdhusen compared students’ performance on a post-test consisting of 25 multiple-choices questions, which he himself had developed and administered to all students at the end of the course, he found that students in the audiographics section scored the highest, while students in the asynchronous
online section scored the lowest. However, the only difference that was statistically significant between two sections was significantly better performance by the face-to-face section relative to the hybrid section on one topic. The average overall score of face-to-face students on the post-test was not significantly different from the average overall score of students in any other section (though on one particular post-test topic, the audiographics section and the face-to-face section each did significantly better than the hybrid section). When Holdhusen compared the performance of students on very similar lab exercises that were used to measure students’ ability to apply engineering graphics concepts to computer-aided design software, he found no significant differences between any two of the four formats in the total lab scores, though the sub-scores for students in the audiographics section were significantly higher than were the sub-scores of students in the face-to-face section on one particular topic.

The results of this study need to be interpreted with great caution. The number of students in each condition is extremely small; the largest section has only 23 students. While it is unclear, from the author’s description of the enrollment process and section offerings, how much choice the students had in choosing in which section to enroll, it is extremely unlikely students would enroll in sections completely randomly; there are likely to be differences between the students enrolled in one format and the students enrolled in the other formats. Furthermore, the author notes that there was differential attrition across the sections, and the attrition rate was especially high in the online section, in which about 40% of the students originally enrolled withdrew or stopped participating, compared with a 10% to 15% attrition rate in the other sections; the reason for this discrepancy is unclear. Another fact to be wary of is that students in the hybrid and synchronous audiographics sections had a fair amount (at least two hours per week) of face-to-face contact with their instructor, raising the question of how different these formats were from the face-to-face comparison group. For instance, both the face-to-face and the synchronous audiographics sections had course websites and had two 120-minute meetings each week, consisting of the presentation of new material by the instructor, followed by time spent in a computer lab.

**Mentzer, Cryan & Teclehaimanot (2007)**

At a medium-sized campus (enrolling approximately 20,000 students), Mentzer and his colleagues randomly assigned 36 students, all of whom were enrolled in a bachelor’s degree program within the school’s College of Education, to a face-to-face or online section of an entry-level survey course. The course, Early Childhood Education: Philosophy and Practice, was required for first-year students in the teacher education licensure program and typically enrolled about 100 students. Of the 36 participants, 17 females and 1 male were assigned to each group. All students were required to contact the department office before they were allowed to register for course; once they contacted the department office, they were asked if they wanted to be in the study, and those who agreed to participate were randomly assigned to the face-to-face or online format. (Those who declined were not randomly assigned and could register for sections separate from those of the study participants.) The online students participated in two hour-long “Live Chat” sessions each week in lieu of the class discussions that the face-to-face students attended, and they were assigned to small groups of four to six students each, to complete assignments over the Internet through chat rooms.
Both the online and face-to-face sections involved in the study were taught by the same instructor who used the same syllabi and gave the same group assignments (which took place in class for students in the face-to-face group). Students in the online section did not have face-to-face contact with the instructor during semester, and were not in other courses taught by the instructor. A diagnostic instrument given to all participants at the beginning of the semester showed no significant differences between the face-to-face and online sections in terms of the learning preferences of the students in the two groups.

At the end of the semester, when the researchers compared the midterm and final exam grades, and the overall course grades, of the students in the two formats, they found that exam performance was not significantly different across the two conditions. However, final course grades were significantly lower for students in the online group (an average of a B for online students, versus an A – for face-to-face students) because the students in the online group were less likely to complete assignments that counted toward their final course grades.

While this is one of the few studies reviewed that used random assignment of students to an online group or face-to-face group, it is difficult to draw any firm conclusions from the results because the sample size is quite small. In addition, while the researchers specify that the gender composition and the learning preferences were the same or very similar in the two formats, it is unclear whether they controlled for these variables or for other possible predictors of performance (for instance, high school GPA for first-year students or family’s income level) in their analysis.

Parsons-Pollard, Lacks & Grant (2008)

At an urban public university in the southeast with a total of enrollment of about 30,000 students, Parsons-Pollard, Lacks, and Grant examined a sample of 425 students in an online justice system survey course and 305 students who took a face-to-face version of that same course the previous semester. In both the online course and the face-to-face course, females outnumbered males, and of all the class years (freshmen, sophomore, juniors, and seniors), freshmen were the most well-represented. However, relative to the face-to-face course, the online course had a higher proportion of students who had not declared their majors or were majoring in a field outside criminal justice, as well as a lower withdrawal rate.

In the online course, students were divided into five discussion groups, in which they completed specific discussion forum assignments that involved analysis of a relevant video clip. Online students also had several face-to-face meetings in which mini-lectures were given (rendering the term “hybrid” more appropriate than “online” for this group, though “online” is how the group is described in the article). Both the online and face-to-face groups used the same textbook and took very similar multiple-choice exams, and their test grades were weighted similarly. At the end of the semester, Parsons-Pollard and his colleagues compared the students’ scores on three exams and their final course grades.

The researchers found that while both the online and face-to-face group had acquired “sufficient knowledge” with respect to four of the five learning objectives within the course (though not the same four), the final course grades were significantly higher in the face-to-face group. However, online students did
significantly better than the face-to-face group on the third exam. For the first and second exams, there was no significant difference between the two groups’ performance.

Although Parson-Pollard and his colleagues obtained a large sample, their design (comparing the performance of online students taking a course one semester to the performance of face-to-face students taking the same course a different semester) did not allow them to randomly assign students to one format or the other, leaving open the possibility of self-selection bias. In addition, while the researchers noted the differences between the students in the face-to-face course and the students in the online course, they did not appear to control for any of these differences in their analysis.

Moreover, there were also some notable differences in the content and assignments given to the two groups. Whereas the face-to-face group used lectures and discussions only, the online students had access to websites on related topics, video interviews of professionals in the field, and discussion boards, the result of which, the authors note, might have been that the online course was more accommodating of “varying learning styles” than the face-to-face course. In addition, while the online students were assigned discussion forum exercises aimed at promoting critical thinking, the face-to-face students were not given a similar assignment, precluding a comparison of the critical thinking skills of the two groups.

The researchers also report various types of technical problems that arose for the online students. Not only might have these impeded learning, but some of the problems might have made academic integrity violations harder to detect; the researchers note that at times it could be difficult to tell whether students who claimed they were “locked out” of the course were actually having technical problems, or whether they had been trying to cheat. The fact that the online students did not take tests in classrooms raises additional questions about the accuracy of the results.

Plumb & LaMeres (2011)

Plumb and LaMeres compared the performance of a face-to-face course in Introduction to Logic Circuits at Montana State University, offered in fall 2010, to an online version of that course, offered in spring 2011. Introduction to Logic Circuits is a 16-week, sophomore-level course that typically enrolls 30 to 40 students a semester. While it is a requirement for students studying electrical and computer engineering, who collectively comprise about 90% of the course enrollments, it can be taken as an elective by other majors. The authors say little about online course itself other than that it consists of “modular materials developed summer 2010 for an online application.” The study states that the online class and the face-to-face class used these same materials, but that, for online students, these materials were accompanied by recordings of lectures, whereas the face-to-face students attended those lectures in person. While the student populations of the face-to-face and online courses were not significantly different from each other in terms of number of credits accrued, cumulative college GPAs, or SAT scores, the online students had, on average, significantly lower high school GPAs, were older, and were more likely to be non-degree or transfer students, relative to the students in the face-to-face class.
In comparing the performance of students in the two courses with respect to students’ final exam and final course grades, Plumb and LaMeres found no significant difference between the two groups with respect to either variable. The researchers also examined students’ performance on eight modules throughout the semester, on each of which students were responsible for participating in one or more discussions, completing one or more homework assignments, and taking one quiz. For six of the eight modules, Plumb and LaMeres found no difference in the average scores of students in the face-to-face and online sections. Of the two modules where the face-to-face and online students performed significantly differently, the online group did better on one module, and the face-to-face group did better on the other.

The results of this study, however, need to be interpreted with caution. Because the two formats were offered during different semesters, it is highly unlikely there was random assignment of students to one format or the other. More importantly, both the online and face-to-face sections had access to the same online materials; the only difference between the two formats seemed to be whether the students viewed the lectures accompanying these materials in person or via recordings. Thus, there was very little difference between the two formats, and little reason to expect that viewing a recording of a lecture and viewing a lecture live should result in significantly different learning outcomes.

Furthermore, although Plumb and LaMeres compared the student populations of the two groups, they did not appear to take any measures to control for the differences in these populations; they used only two sample-tests in comparing the outcome measures of students in the two groups. Finally, while no sample sizes were explicitly given, even if all the students enrolled in the course participated in the study (about 40 students in each format), the sample size still would not be very large.


Poirier and Feldman randomly assigned 23 undergraduates at a large state university to a face-to-face or online version of an introductory psychology course. Of the 23 study volunteers, 12 were assigned to the online course and the remainder to the face-to-face course, though two of the face-to-face students dropped the course and were consequently excluded from the analysis.

Students in the online course met in an online classroom several times per week for 15 weeks, accessing the course through the eCollege course delivery platform, which includes course materials such as text and audiofiles, reading and short paper assignments and web activities, short paper assignments, and practice exams, as well as communication tools. Twice a week, students participated in two online discussions, completed course activities, and received general feedback from the instructor regarding the course content. Students also communicated with each other and with the instructor through email and threaded discussion. The students in the online section had no face-to-face lectures, and the only time they were required to come to campus for the course was when they needed to take exams (which they took at the same time as the students in the face-to-face section). By contrast, students in face-to-face sections had two meetings per week that lasted for 75 minutes each, and that consisted of a combination of lectures, videos, discussions, activities, in-class writing assignments,
and exams. Face-to-face sections were also asked to participate in three online discussions, using WebCT software to post comments, and to complete three short paper assignments. Students in both sections were given the same paper assignments and used the same textbook. The performance of the two sections on the four exams and three papers formed the basis of the researchers’ comparisons of the two formats.

Poirier and Feldman found that online students answered a significantly higher percentage of exam questions correctly relative to face-to-face students (an average of 79.6% correct for the former and an average of 71.9% correct for the latter), but that there was no significant difference in the students’ grades on papers.

While this study’s randomized assignment design make it more rigorous than many of the other studies in our review, its findings should still be interpreted with caution because of the small sample size. Additionally, the fact that volunteers for the study had to agree to be randomly assigned to an online format or to a face-to-face format in order to participate might have caused the sample to be unrepresentative of the student population as a whole, which would also include nonparticipants, i.e. students who were not indifferent about the delivery mode in which they took introductory psychology. To their credit, Poirier and Feldman do compare participants to nonparticipants, and they report that there were no significant differences between the study participants and the nonparticipants, suggesting to the researchers that the participants were representative of the entire class. However, it is unclear what characteristics Poirier and Feldman compared in order to reach that conclusion, and there is still the possibility that the participants and nonparticipants were different from each other with respect to unobservable characteristics. Finally, the class size differences between the two formats—the traditional participants were taught in the context of a large-lecture formats, whereas the size of the online section was very small—leave open the possibility that any difference in outcomes may be caused more by differences in class size than by delivery mode.

Rich & Dereshiwsky (2011)

Rich and Dereshiwsky conducted their study with about 100 students in four sections of an intermediate accounting course, called Foundations of Accounting, at Central Connecticut State University. Two of the sections were face-to-face and met during the daytime; a total of 52 students participated in the study from these two sections. Another 30 participants came from a third section that also met face-to-face, but during the evening. The final section, a purely online section, had 19 students participating in the study; the online course used in this section was developed by one of the study authors, and the semester in which the study took place was the first time that online course was implemented. Of the students participating in the study, all but two were able to enroll in the delivery format of their first choice.

The performance of the students in the different sections was compared based on their scores on 9 “objective” online homework assignments, which were graded by the “publisher’s website” (presumably a textbook publisher, though this is not specified), and their scores on a two – to three-paragraph essay on what it means to students to be a professional, which were graded by instructors using a rubric.
Of the four sections involved in the study, all except for the evening section were taught by the same instructor, and all study participants completed the same assignments. However, there were some substantial differences between the students enrolled in the different sections. Students enrolled in the online section were fairly similar to the students in the evening face-to-face section of the course; they were more than twice as likely to be older than 22, much more likely to have full-time jobs, and more likely to be enrolled part-time, relative to the students in the daytime face-to-face sections. Compared with all three face-to-face sections, the online section tended to attract more students who were majoring in a field other than accounting.

Rich and Dereshiwsky found no significant difference in performance on homework assignments by students in the evening face-to-face section, daytime face-to-face sections, or online section, with one exception, which was that students in the evening section did significantly better than the daytime or online students on one topic covered in the course. For all topics covered in the homework assignments, there was no significant difference between the performance of the online students and that of the daytime face-to-face students. Students in the online sections also did better than the students in the daytime or evening face-to-face sections on the essay on professional characteristics, though there was no indication of whether this difference was statistically significant.

However, there are several limitations to this study, the largest of which was that almost all the participants were allowed to self-select into the format of their choice, which resulted in substantially different student populations enrolling in the different sections. In addition, the researchers made no effort to control for other possibly confounding student characteristics, such as demographic variables other than age (such as race, gender, and socioeconomic status) and prior academic performance indicators (such as GPA), that may be correlated with course outcomes. Moreover, without the random assignment of participants into the different sections, the possibility of further, unobservable differences between the student populations in the two sections affecting the outcomes cannot be eliminated. The study also would have been improved had the researchers controlled for instructor effects, even in the presence of objective or standardized ways of grading assignments, and included among the outcome measures scores from one or more proctored tests, for which the researchers would be better able to guard against the possibility that the participants were submitting work that was not their own.

**Riffell & Sibley (2005)**

In this study, Riffell and Sibley compared the post-test scores and performance on an active-learning activity of 55 students who were enrolled in a hybrid introductory biology course, with those of 74 students who were enrolled in a face-to-face version of that same course. The participants were all resident, non-science majors at Michigan State University who were drawn from the 102 students taking Applications of Environmental Biology in a traditional format, and the 85 students taking the course in the hybrid format. In the study, students were allowed to enroll in the sector of their choice, but they did know about the study at the time they were registering.
The students taking the hybrid version of the course had one 50-minute face-to-face session each week, described in the study as an “active lecture.” During an “active lecture,” a non-tenure instructor gave brief lectures at the beginning and the end of the sessions, and, in between, students worked together in groups to complete “active-learning” exercises. In addition, the students in the hybrid course completed bi-weekly homework problem sets, each containing about fifty questions, using a web-based, open source platform called LON-CAPA (http://www.lon-capa.org/). LON-CAPA provided the students with individual questions (on which they were allowed multiple attempts at answering correctly), with pre-programmed hints and instant feedback, and graded assignments automatically. By contrast, students in the traditional, face-to-face format of the course spent three hours each week in lecture: they participated in one “active-learning” session each week, plus two additional hours of more passive lecturing, in which instructors covered the same material that the hybrid students learned through their homework assignments in LON-CAPA but did not “directly query” students.

Both the face-to-face course and the hybrid course covered the same subject matter, and were taught by the same instructor. The two classes were also similar to each other in terms of the gender composition, the proportion of students who had previous experience with online courses, the proportion of students who were full-time rather than part-time students, and the proportion of students who had previous taken an integrative studies biology course at Michigan State. However, in other respects the populations differed: the face-to-face group contained significantly more freshmen and significantly fewer commuter students.

In their analysis, the researchers controlled for gender, performance on a pre-course assessment, attendance at active-learning lectures, participation in online activities (for hybrid students) or passive lectures (for face-to-face students), previous experience with online courses, commuter student status, class year, and active-learning activity performance. They also included as controls the interaction of delivery format with gender, the interaction of delivery format with previous experience with online courses, and the interaction of delivery format with class year. Riffell and Sibley found that the students in the hybrid group performed better on the post-course assessment than did students in the face-to-face group; while both upperclassmen and freshmen did better in the hybrid class than in the face-to-face class, the difference was significant only for upperclassmen. In addition, the researchers found, among the questions on the post-test assessment that pertained to material covered by the active-learning sessions, hybrid students did better than face-to-face students, suggesting that active-learning exercises were more effective when they were coupled with online activities than when they were coupled with passive lectures. None of the interactions of format with covariates was significant for the post-test questions related to content covered in the active-learning sessions.

While Riffell and Sibley were more diligent about controlling for differences in the student populations in the face-to-face and hybrid classes than the authors of a number of the other studies in this review, there are other controls which might have helped to isolate the effect of the delivery format that they might have included but did not, such as race or ethnicity, age, and GPA. In addition, as is also true for much of the literature, allowing students to self-select into the for-
mat of their choice, even if the students did not know about the study when they registered for the class, leaves open the possibility of unobservable differences in the student populations confounding the results.

**Wagner, Garippo & Lovaas (2011)**

Wagner, Garippo, and Lovaas conducted a longitudinal observational study of students who were enrolled in sections of an introductory undergraduate course in the use of business application software offered between fall 2001 and spring 2010. The sample included 435 students in 19 face-to-face sections and 171 students in 11 face-to-face sections, excluding the 18 students who withdrew from the study. Fifty-two percent of the participants were female. The same instructor taught both the face-to-face and online formats, using the same syllabus, giving the same assignments and course exams, and grading according to the same standards. At the end of the course, an independent samples t-test showed no significant difference in final grade percentages when looking at the entire sample. While an independent samples t-test revealed no significant difference in the final grade percentages of males and females when delivery format was not considered, the researchers found a gender main effect when they looked at the data with gender and course delivery factored together, with males earning lower average grades in the online courses than in traditional courses (an average final grade of 84.2% versus 87.7%).

However, the study has a number of limitations. The authors allowed students to self-select into the format they wanted, and they did not examine the effects of the delivery format on any other subgroups other than males and females, nor did they attempt to identify or control for other differences in the student populations of the face-to-face and online sections. There also did not appear to be any attempts during the study to make sure there were no academic integrity violations, particularly by online students who were not “directly supervised” while taking exams or completing assignments (which determined students' final grade percentages).

**Weber & Lennon (2007)**

Weber and Lennon conducted two similar studies at two private southeastern universities, both involving sections of a junior-level course called “Principles of Marketing.” In Study 1, the researchers compared the performance of 31 face-to-face students to that of 17 online students. In both groups, females outnumbered males but, relative to students in the face-to-face section, students in the online section had significantly lower GPAs, significantly greater experience with online course components, and greater perceived knowledge of web-based courses. In Study 2, Weber and Lennon compared the performance of 35 face-to-face students to that of 34 online students. As was true for Study 1 sections, females outnumbered males in both the face-to-face and online sections in Study 2; in addition, more than half of both sections in Study 2 consisted of juniors. As in Study 1, students in the online sections of Study 2 had slightly lower GPAs, slightly greater experience with online course components, and a higher perceived knowledge of web-based courses. In general, students in Study 2 had more experience with web-based courses than students in Study 1.
Students in the web-based sections of the course used “a modular format which presented information and incorporated learning activities” each week and had access to all course lectures and materials via websites. Projects assigned to these sections generally focused on “some type of business entity with an online perspective.” The learning activities and information presented to online sections were said to be comparable to those presented to traditional sections, and the instructor, textbook, exams, assignments, projects, and material coverage were the same across all sections.

At the end of the semester, researchers compared the two groups’ scores on the final exam (which consisted of 50 multiple choice questions and three short-answer essays) and on a semester project, and students’ overall course grades (which were based on their grades on exams and on the semester project). In addition, Weber and Lennon collected information via questionnaires at the beginning of the semester about students’ GPA, gender, class year, web-based experiences in classroom settings, and perceived knowledge about the Internet; they then looked at the extent to which these predictor variables (as well as course format) were correlated with outcomes.

Weber and Lennon found that, relative to the face-to-face sections, the online sections had a higher drop-out rate, though they did not indicate whether the difference was significant. Online students also did significantly worse than the face-to-face sections in both Study 1 and 2 with respect to the final project grade, final exam grade, and the final course grade. However, when the researchers ran regressions which included controls for predictor variables, they found that course format was not a significant predictor of “learning achievement.”

While the authors attempted to reduce self-selection bias by not announcing that one section would be online until the first week of class, there was no random assignment. Students were allowed to switch sections if their section turned out to be web-based and they had a “strong objection” to this format; the fact that no students acted on this option does not negate the fact that the option was available (and the fact that the students elected to remain in their assigned sections still reveals a selection bias). While Weber and Lennon collected information about and controlled for, some predictor variables, they did not appear to collect information about other predictor variables that might be correlated with students’ performance, such as socioeconomic status, race or ethnicity, or number of hours worked per week for pay. Finally, the sample sizes, while not extremely small, were still not large enough for Weber and Lennon’s studies, by themselves, to offer conclusive evidence about the effectiveness of (one particular type of) online learning.

**Xu and Jaggars (2011)**

The researchers followed 18,896 students who lived in Washington State, who were enrolled in the Washington State Community and Technical College System in fall 2004, with the intent to transfer to a four-year college, through the summer of 2009. Over this five-year period, Xu and Jaggars collected information about 126,317 course enrollments. None of these enrollments was in a remedial course, and none of the enrollments was in a course for which only one delivery format of that course was available at the student’s campus. Of the enrollments examined, approximately 22% were for “online” courses, which, in
this study, meant courses in which at least 51% of instruction and student-teacher interaction took place online. The researchers also collected an assortment of background data on students, and determined that, relative to the students taking courses in the traditional format, the students who took courses online were more likely to be older, female, white, and enrolled part-time, and more likely to receive financial aid. In addition, online students tended, in general, to be better academically prepared, to come from families of higher socioeconomic status, to work more hours for pay while taking courses, and to have been dual enrolled before entering college. Given that the researchers were comparing students’ performance in a variety of different courses, the outcomes compared in this study were students’ final course grades and their likelihood of withdrawing from a course.

Xu and Jaggars performed these comparisons of the two formats using different statistical models. First, they used a basic ordinary least squares (OLS) model, and controlling for a number of student-level variables (such as demographic information, academic preparation level, and semester-level information like the number of hours the student was working for pay that semester) and for fixed effects for the semester, the subject of the course, and the campus; in this model, Xu and Jaggars also clustered standard errors at both the student level and at the course level. They found that students in online courses were about 4.4 percentage points more likely to withdraw relative to students in face-to-face courses, and among the students who finished the course, online students tended to earn grades that were about 0.3 point lower than the grades earned by face-to-face students. In addition, Xu and Jaggars used an instrumental variable (IV) approach in which the distance between a student’s home and their college campus served as an instrument for that student’s likelihood of choosing to take an online course rather than the face-to-face version of that course. The IV approach resulted in coefficients with greater magnitudes than the OLS estimates, suggesting that the latter may have understated the difference between the two formats.

Xu and Jaggars also looked at whether the difference between the online format and the face-to-face format varied with certain student characteristics. They found that males taking online courses were significantly more likely to drop out than were females taking online courses, but that both genders faced equivalent “penalties” with respect to earning lower grades in online courses. Younger students (defined as students below age 25) also faced significantly larger penalties with respect to grades and withdrawal rates than did older students, who, when prior grade point average (GPA) and credits taken were controlled for, appeared to do just as well in online classes as in face-to-face classes. Finally, students with lower GPAs (defined as GPAs below 3.0) were significantly more likely to drop out, and earned significantly lower grades, compared to students with higher GPAs.

Relative to much of the other literature, this study included a large number of controls and sophisticated analysis. However, there was no random assignment of participants to one format or the other. Consequently, the extent to which the researchers were able to control for unobservable as well as observable differences between students in online courses and students in face-to-face courses using an IV approach would depend, on part, on the appropriateness of the instrument chosen. The authors identified three concerns with using distance
between a student’s home and campus as an instrument for the likelihood of enrolling in an online course. However, some of the assumptions they relied on in allaying the concerns are arguably questionable—and this is assuming all the concerns have been identified. For instance, the researchers assumed that proximity to college had no direct effect on the outcome variables, which might not be true if students who live closer to campus had better access to the facilities and instructors they needed to do well in the course. Xu and Jaggars ruled out this possibility based on an analysis limited to a sub-sample of face-to-face courses, in which they found no relationship between distance and outcomes for these face-to-face courses. This conclusion might not have been warranted, however, if the manner in which students in online courses made use of on-campus instructors and facilities differed substantially from the ways students in face-to-face courses made use of these resources.

Finally, and perhaps most importantly, the definition of “online courses” used in this study was very general, encompassing not only purely online courses but also courses where as much as 49% of the instruction took place face-to-face. The authors also gave no indication about what the online courses involved in this study entailed or how much variation existed among those courses (which is unlikely to be negligible, given that about 28,000 of the enrollments in the course were online). Without this information, it is difficult to know the kinds of online courses to which the study’s findings are most applicable, and at most the study shows that the “average” online course in the sample tends to be correlated with higher drop-out rates and lower grades than the “average” face-to-face course in the sample.

Works Cited


Existing Evidence Regarding the Effectiveness of McGraw-Hill’s Connect Platform and the Limitations of that Research

by Kelly A. Lack
January 25, 2012

Thousands of colleges and universities across the country use commercially-provided digital learning platforms with the intention of better serving their students through creating a more convenient and personalized learning experience and ultimately increasing their students’ learning. In the course of marketing their products to institutions, commercial providers are often quick to claim that their platforms are particularly effective at accomplishing these goals. Whether improved learning outcomes actually result from the use of such commercial platforms, however, is far from clear. Some vendors make available studies which they can (and do) cite to bolster their laudatory claims about their products. One example of such a provider is McGraw-Hill, which has released more than a dozen studies purportedly demonstrating the effectiveness of its “Connect” platform.

Targeted at the higher education sector, Connect is an online assignment and assessment platform through which instructors can upload presentations and recorded class lectures, highlight and annotate electronic McGraw-Hill textbooks, and assign activities and exercises to students, whose submitted work is then immediately and automatically graded by the platform (and synchronized with gradebooks in LMSs like Blackboard). Connect also includes a student study center with practice materials and personalized learning plans, and an instructor library with resources—such as eBook readings, ready-made PowerPoint presentations, and assignments—instructors can use in teaching their courses. In addition, instructors can track the progress of their whole class and of individual students. Specific discipline-oriented variations of Connect exist for business and economics (13 variations), career education and student success (4), humanities and social sciences (13), biological sciences and nutrition (5), physical and Earth sciences (7), engineering (1), mathematics and statistics (9).

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McGraw-Hill asserts that its platform “connects students to their professors and to a range of engaging, interactive content for more effective learning.” The blog associated with Connect boasts several reports about the product, the majority of which are case studies, described individually in the table below, or aggregations of case studies. The studies by and large show improved learning outcomes from using the product. The specific learning outcomes involved differ from case study to case study, but generally include one or more of the following: higher average test scores, higher average homework scores, higher average course grades, increased course retention rates, and increased course pass rates. Some of the studies also show a reallocation of the instructor’s time from administrative or tedious duties to more meaningful interactions with students.

McGraw-Hill’s claims of “more effective learning,” however, are more promotional than proven. The studies about the products’ effectiveness rely on anecdotes and questionable methodology. The case studies, described individually in the table below, are plagued by several major flaws, as well as study-specific ones.

- The first of the limitations is that, like a fair amount of research evaluating the effectiveness of particular products or strategies, there is no random assignment of participants to a treatment group (in this case, a class using Connect) or a control group (a class that does not use Connect). Rather, in many studies, the class is offered one semester without Connect and a separate semester using Connect (similar to the before-and-after methodology used by Carol Twigg in her NCAT studies). Even if the students signing up to take the course in a given semester do not have a choice over whether they want to take the course using Connect or not using Connect, in which case the students may not be consciously selecting to take one format over the other, there is nothing to ensure that the students taking the course in semester $t$ (without Connect) are similar, in all characteristics relevant to performance, to students taking the course in semester $t + 1$ (with Connect). In other studies, in which the professor appears to have taught a class with Connect and another class without Connect simultaneously, there is still no mention of randomization, in which case students taking the course during that semester may have been able to select to take either the class with Connect or the class without Connect. In such a situation, there is no guarantee that the students signing up for the Connect version of the course are not significantly different from students signing up for the version of the course that does not use Connect.

- Some social science studies that do not involve random assignment of participants attempt to account for differences in predictor variables—for instance, in previous grade point average, income level, gender, or age—by including controls for these variables in their analyses of data. The authors of the McGraw-Hill case studies do not do this. They neither account for differences in the populations of students taking the two formats of the course (using Connect and not using Connect), nor attempt to measure them. It is possible that the students taking the course with Connect are more academically competent students than those taking the course without Connect, and

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so any improvement in learning outcomes might be attributable not to the effectiveness of Connect, but to pre-existing differences in the populations of students in the control and treatment groups.

- Similarly, in many of the case studies, there is little mention of what efforts, if any, were taken to ensure that the class using Connect and the class not using Connect were as similar as possible, apart from the use (or lack thereof) of Connect. The only element that seems to be consistent between the course that uses Connect and the course that does not use Connect is the instructor, in which case differences in the instructors teaching the two classes are unlikely to be a confounding variable. However, the authors do not say anything about consistency in the curriculum, readings, assignments, the order in which the materials are presented, or other aspects of the course, between the class that uses Connect and the class that does not. The authors of the case studies often compare the homework and test averages of students in the class using Connect and of students in the class not using Connect, but these comparisons are not very meaningful, without knowing whether the homework assignments or test scores in these two classes are similar, with respect to difficulty, grading standards, content, format, and so on.

- In addition, the case studies omit information which is usually included in research of this type and which would be useful in interpreting the results. First and foremost, while the authors provide the outcomes both using Connect and the outcomes not using Connect, there is no indication of whether the differences are statistically significant. There is no mention of standard errors or tests of significance. Many of the alleged improvements seen from using Connect could be due to chance variation alone. Second, the sample sizes are not provided. While the case studies tell how many students take the course with a certain instructor each year (or, in a few cases, each term), this number might not be the same as the number of participants in the study. The instructor might teach the course in more than one term each year and/or teach sections of the course that are not involved in the study. Knowing how many students the instructor teaches each year provides no more than an upper bound on the number of participants involved in the study.

- Finally, a reader must wonder about the rationale behind comparing different outcomes in the different case studies. In some studies, improvements in test scores and in homework grades for classes using Connect are cited as evidence of the effectiveness of the platform; in other case studies, the author chooses to focus on higher pass and retention rates only. There may of course be a valid explanation: the classes in the latter kind of studies may not have taken sufficiently similar tests or completed sufficiently similar homework assignments to justify a comparison of their scores. In addition, the fact that some case studies compare how the instructor used his time before and after integrating Connect into his instruction, whereas other case studies do not, may be the result of some instructors not being willing and/or able to document how they spend their time. However, one might expect that some basic measures on the course level that involve data that are (most likely) regularly collected, such as retention and pass rates in the classes with and without Connect, would be reported for all case studies, which is not the case. While evaluating different outcomes in different case studies does not necessarily
indicate that the authors are cherry-picking the outcomes they report so as to demonstrate improvements for the group using Connect over the comparison group in every case, an explanation of how the authors chose which outcomes to examine in the various case studies would be useful for interpreting the results.

In addition to the individual case studies, McGraw-Hill has also released some reports which essentially aggregate the results of these case studies. The “McGraw-Hill Connect Effectiveness Study,” for example, looks at case studies from 18 “diverse colleges and universities in the United States” using Connect. The study compares classes using Connect and classes not using Connect with respect to several measures, including course grades (based on case study data from nine institutions), retention rates (four institutions), pass rates (five institutions), and attendance rates (two institutions). According to the data presented in this report, each of those four measures was higher for the sections using Connect. Course grades averaged 79.3% with Connect, compared with 73.6% without Connect; the retention rate averaged 93.8% with Connect, compared with 71.2% without Connect; the pass rate averaged 77.3% with Connect, compared with 64.6% without Connect; and the attendance rate averaged 95% with Connect, compared with 73% without Connect. After looking at the individual case studies, these results are not surprising; but, for the reasons discussed above, they are not particularly informative either. The other evidence presented in this report, which is intended to support the statement “instructors and students alike have experienced improvements in grades and class averages, student engagement, time management, in-class discussions and lectures, and overall satisfaction with the course and coursework,” consists of anecdotes from the professors at the 18 institutions.

The other meta-analysis available on the Connect website, “McGraw-Hill LearnSmart Effectiveness Study,” focuses on LearnSmart, an adaptive learning platform within Connect that assesses students’ skills on different topics and then adjusts the learning content students receive accordingly. The meta-analysis claims that LearnSmart “helps students with true concept retention and learning” and cites an “independent” study of about 700 students (358 students taking the course with Connect and 334 students taking the course without Connect) taking courses in anatomy and physiology at six different institutions across the United States. The study found that retention rates were 10.5 percentage points higher for classes using Connect (80.5% versus 70%). The finding with respect to pass rates was similar; pass rates were higher by 12.5 percentage points for classes using Connect (70.5% versus 58%). Of the students taking the course

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24 For each metric (e.g. pass rates, retention rates), the authors of the study essentially found the average of that metric for the “with Connect” group in all the relevant case studies, and subtracted from that the average of that metric for the “without Connect” group in all the relevant case studies, to obtain what the authors (oddly) called the “average variation.” Whether the “with Connect” average consisted of all the “with Connect” observations from all the relevant case studies (effectively giving more weight to case studies with more students in the “with Connect”-“without Connect” difference calculation), or of just the “with Connect” averages of the case studies, was unclear.

without Connect, about 19% earned A’s, about 39% earned B’s, and about 28% earned C’s; by contrast, of the students taking the course with Connect, about 31% earned A’s, about 33% earned B’s, and about 22% earned C’s. According to the authors, this shows that, in courses that use Connect, “more B students improve their learning and earn A’s; and more C students get B’s” than in courses that do not use Connect.

Here, too, the claims that the study proves LearnSmart improves students’ performance can be questioned by critically examining the methodology. The methodology section of the report says, “While the studies were carried out independently from one another and present variations in the way data was gathered and analyzed, they all measure changes in grades and/or test scores between sample and test groups. Due to these variations in the methodology, there is no way of measuring an average rate of improvement from the various studies.” Moreover, the conclusion the authors draw based on the different proportions of students who earned A’s and B’s in the two conditions—with no evidence that the control group and experimental group had the same kinds of students, assignments, or grading standards, or that there were any other measures of consistency in the two groups apart from the instructor—further calls into question the authors’ credibility. (Similar to the other meta-analysis report, this study proceeds to make claims about greater student engagement and career readiness based on anecdotal evidence.)

None of this is to say that Connect or the LearnSmart platform does not help improve students’ learning, produce higher scores on homework or exams, or increase students’ likelihood of completing and passing the course. However, the evidence made available by McGraw-Hill, while providing encouraging “hints” of the products’ effectiveness, fails to support conclusively the claims made by the company about increasing students’ mastery of the subject matter or performance in the course. To say that these studies consistently “suggest an improvement in learning and teaching efficiencies” is not dishonest, but it also should be noted that the studies do just that—“suggest” an improvement—and no more.
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<td>Connect Economics</td>
<td>Principles of Economics (face-to-face)</td>
<td>100/year (instructor total); 700–800/year (university total)</td>
<td>Private 4-year university in Smithfield, Rhode Island; enrolls 3,600 students</td>
<td>The number of hours the professor spent grading each week dropped from 10 (without Connect) to 1 (with Connect).</td>
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| Bunker Hill Community College | Fall 2009 and Spring 2010        | Connect Anatomy & Physiology | Anatomy & Physiology I and Anatomy & Physiology II (both face-to-face and hybrid) | 1,250/year        | Public 2-year institution in Boston metropolitan area; has 4 campuses; enrolls more than 11,000 students | ● Average homework grades were higher in classes using Connect than in classes not using Connect: 99% vs. 73% in Anatomy & Physiology (A&P) I, and 98% vs. 78% in A&P II.  
● Average exam grades were higher with Connect: 73% vs. 61% in A&P I and 70% vs. 79% in A&P II.  
● Retention rate rose, from about 80% in Spring 2009 (not using Connect) to 100% in Fall 2009 (using Connect) and 97% in Spring 2010 (using Connect). |
| College of Charleston         | Fall 2010                        | Connect Chemistry        | Principles of Chemistry I (face-to-face) | 80/year (instructor total); 500/year (university total) | Public 4-year university in downtown Charleston, South Carolina; enrolls 11,000 students        | ● In class without Connect, 14% of the students had course grade averages in the 90's, 25% in the 80's, 33% in the 70's, 18% in the 60's, and 6% in the 50's. In class using Connect, the corresponding proportions were 17%, 47%, 19%, 11%, and 6%, respectively.  
● Students had a higher exam average in class using Connect than in class not using Connect (about 77.8% vs. about 73.2%).  
● Students in class using Connect performed above the national mean on American Chemical Society national standardized exam (Connect class average of 46 out of 70 vs. national mean of 42.3 out of 70). |
| Florida State College at Jacksonville | Spring 2011 (Fall 2010 – comparison group) | Connect Psychology      | General Psychology (hybrid)          | 120/term (instructor total); 1200/year (university total) | Public 4-year institution; enrolls more than 85,000 students                                  | ● Overall class grade averages were higher for sections using Connect. The averages of 2 sections not using Connect were about 81% and 76%. Of the 3 sections using Connect, one section had an average of about 83%, and the other 2 sections had averages of about 88%.  
● Average pass rates increased as well, from 75% (without Connect) to 83.6% (with Connect). (Sections without Connect had pass rates of about 78% and 72%. Sections using Connect had pass rates of about 95%, 80%, and 76%.)  
● Professor found a 100% correlation between completion of LearnSmart modules and pass rates. |
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| Franklin University         | Fall 2010 (2007 – likely comparison group) | Connect Accounting       | Financial Accounting (hybrid)                                                   | 75/year (instructor total); 1,050/year (university total) | Private 4-year institution in Ohio; has 5 campuses; enrolls 11,000 students | - In classes that did not use Connect, 14% earned A's, 28% earned B's, 32% earned C's, 11% earned D's, and 14% earned F's. In classes using Connect, the corresponding figures were 27%; 30.5%; 22%; 6%, and 13%, respectively (all figures are approximations).  
  - The average proportion of students passing course exams increased from about 61.5% (without Connect) to 70% (with Connect).  
  - The proportion of students repeating the course fell from 25% to 5%.  
  - Class attendance rates rose from 74% to 95%.  
  - Using Connect, the professor spent less time each week reviewing homework (0.25 hour vs. 1.25 hours), giving quizzes and exams (0 hours vs. 0.6 hour), and grading assignments (12 hours vs. “practically zero” hours), and more time on concept application and active learning (1.25 hours to 2.7 hours). |
| Front Range Community College | Spring 2011 (Spring 2010 – comparison group) | Connect Anatomy & Physiology | Human Anatomy & Physiology ("lecture and lab")                               | 48/year (instructor total); 350/year (university total) | Public 2-year institution; largest community college in Colorado; enrolls more than 25,000 students | - For each of 4 exams, students’ average scores were higher with Connect: 77% (without Connect) vs. 80.5% (with Connect) for Exam 1; 78% vs. 81% for Exam 2; 71% vs. 85.5% for Exam 3; and 74% vs. 83% for Exam 4 (all figures are approximate averages).  
  - Without Connect, 41% of the students earned A’s; 17.5%, B’s; 29.5%, C’s; and 11%, F’s. With Connect, 46% earned A’s; 23.5%, B’s; 27%, C’s; and 4%, F’s (all approximations).  
  - Pass rate rose from 75% to 86%.  |
| Miami Dade College          | Summer 2009      | Connect Writing          | College Prep Writing III (6-week hybrid version—with 3 hours lecture, 1 hour on-campus lab, and online work, per week—version of 16-week traditional-format course) | 300/year (but in this study class size was less than 30 students) | Public 4-year institutions; has 8 campuses; enrolls about 170,000 students | - Retention rate was 92% (for section not using Connect) vs. 100% (for section using Connect).  
  - Pass rate was 58% (without Connect) vs. 78% for (with Connect).  |
<p>| Monroe Community College    | Fall 2009        | Connect Marketing        | Principles of Marketing (traditional)                                           | 152/year (instructor total); 560/year (university total); average class size was 38 | Public 2-year institution; part of State University of New York system; has 2 campuses; enrolls 37,000 students; 70% of students are enrolled in transfer programs | For section 1 (without Connect), overall exam average was 76%. For sections 2 and 3 (with Connect), overall exam averages were 80% and 79%. On each of 4 exams, students using Connect had higher average scores than did students not using Connect: 76% (for section 1) vs. 80% (section 2) and 79% (section 3) for Exam 1; 75% vs. 78% and 78% for Exam 2; 78% vs. 82% and 83% for Exam 3; and 74% vs. 78% and 77% for Exam 4 (all figures are approximations). |</p>
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| New Mexico Junior College   | Fall 2010 (Spring 2010 – comparison  | Connect Music  | Music Appreciation (online)          | 200/year (instructor total); 700/year (university total) | Public 2-year institution in Hobbs, New Mexico; enrolls 2,500 students                                                                                                                                                                                                                             | ● More students in course taught with Connect received A’s than in previous semester (about 35% vs. 21%); slightly fewer students failed the course (about 8% vs. 9%).  
  ● Students using Connect spent much more time actively listening and applying concepts (90 min. vs. 50 min.).                                                                                                                                                                                                                                                                     |
| San Diego State University  | Spring 2010 and Summer 2010          | Connect Marketing | Principles of Marketing (hybrid, with 3 hours per week of lecture and online instruction, Spring 2010; online, Summer 2010) | 960/year (instructor total); 1,400/year (university total); section size generally about 230 students | Public 4-year university; part of the California State University system; enrolls 33,000 students                                                                                                                                                                                                                                           | ● Spring 2010 section using Connect had a test average of 78%, vs. 73%, for “students in previous classes” who did not use Connect. Summer 2010 section using Connect had a test average of 79.5%, vs. 73% for “students in previous online courses” who did not use Connect (figures are approximations).  
  ● Using Connect, the professor spent less time each week on assignment preparation and grading (0.5 hour vs. 4.5 hours).                                                                                                                                                                                                                                                                         |
| San Jacinto College         | Fall 2010 (Spring 2010 – comparison  | Connect Lucas  | Public Speaking (both face-to-face and online formats offered) | 200/year (instructor total); 750/year (university total) | Public 2-year college outside Houston, TX; has 3 campuses; enrolls more than 28,000 students                                                                                                                                                                                                                                               | ● Retention rate was higher with Connect: 85% vs. 75%.  
  ● Pass rate using Connect exceeded average departmental pass rate (about 75% vs. 65%).  
  ● Professor spent fewer hours grading each week (5 without Connect vs. 3 with Connect) and fewer hours preparing for lecture (5 vs. 2).  
  ● Without Connect, professor split her time evenly between reviewing homework, active learning, and giving quizzes; with Connect she spent 90% of her time on active learning and 10% on reviewing homework.                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
<p>| University of Cincinnati    | Fall 2009 (Spring 2009 – comparison  | Connect Biology | Biology 104: Life on Earth (online)  | 120/year (instructor total) | Public 4-year research university; part of University System of Ohio; has 15 campuses; enrolls 40,000 students                                                                                                                                                                                                                                         | ● Retention rate increased from 70% (without Connect) to 90% (with Connect).                                                                                                                                                                                                                                                                                                                                                                                                            |
| University of Cincinnati    | Fall 2009 (Spring 2009 – comparison  | Connect Biology | Biology 104: Life on Earth (online)  | 120/year (instructor total) | Public 4-year research university; part of University System of Ohio; has 15 campuses; enrolls 40,000 students                                                                                                                                                                                                                                         | ● Retention rate increased from 70% (without Connect) to 90% (with Connect).                                                                                                                                                                                                                                                                                                                                                                                                            |
| University of Colorado      | Spring 2010 and Fall 2010 (Fall 2009 | Connect Psychology | Introduction to Psychology I (hybrid, with 3 hours per week of lecture and online instruction) | 200/year (instructor total); 1,000/year (university total) | Public 4-year university in greater metropolitan Denver area; has 2 campuses; enrolls 29,000 students                                                                                                                                                                                                                                               | Students’ average scores on 3 tests were higher in classes using Connect than in class not using Connect. On Test 1, students’ average score on was 72.5% for Fall 2009 (without Connect) vs. 78.5% for Spring 2010 and 79% for Fall 2010 (both with Connect). On Test 2, students’ average score was 74% in Fall 2009, compared with 74.5% in Spring 2010 and 77.5% in Fall 2010. Students in Fall 2009 scored an average of about 71.5% on Test 3 vs. 74.5% in Spring 2010 and 75% in Fall 2010 (all figures are approximations). |</p>
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| Virginia Polytechnic and State University | Spring 2011 (Fall 2010 – comparison group)   | Connect Personal Health | Personal Health (online) | 700/year (instructor total); 1,500/year (university total) | Public 4-year university in Blacksburg, Virginia; enrolls 30,000 students | - For each of 4 exams, students’ average scores increased, from 88% (without Connect) to 96% (with Connect) for Exam 1; from 86% to 95% for Exams 2 and 3; and from 85% to 97% for Exam 4 (all figures are approximations).  
- Retention rate rose from 93% to 98%.  
- Pass rate rose from 85% to 99%. |

Endnotes

25 “Digital Course Solution Improves Student Success and Increases Engagement.” McGraw-Hill. Accessed January 12, 2012, http://create.mcgraw-hill.com/wordpress-mu/connectblog/files/2011/09/Case_Accounting_ARC_Pollard.pdf. In the class using Connect, the instructor assigned end-of-chapter homework assignments from Connect (which contained about 10 questions each) and gave her students access to parallel practice problems for unlimited practice. The professor also created practice multiple-choice quizzes. The professor used the exercises and problems in Connect to prepare for her lectures.

26 “Digital Course Solution Increases Instructor Efficiency.” McGraw-Hill. Accessed January 12, 2012, http://create.mcgraw-hill.com/wordpress-mu/connectblog/files/2011/09/Case_Bryant_Economics_Mirmirani.pdf. The professor gave the students in the class using Connect one online assignment in Connect each week, which generally included 25 to 30 questions, and posted the results of the assignments from Connect into Blackboard. The professor also updated his lecture notes based on the data from Connect that showed which topics students were having the most trouble understanding.

27 “Digital Course Solution Improves Student Success and Increases Student Retention.” McGraw-Hill. Accessed January 12, 2012, http://create.mcgraw-hill.com/wordpress-mu/connectblog/files/2011/10/blog3.pdf. The two-semester sequence course was offered in both a traditional face-to-face format (with 3 hours of lecture and 3 hours of lab per week) and a hybrid format (with online lectures and an on-campus lab). The 15 adjunct instructors teaching the course with Connect created a master course using Connect’s course-sharing tools so that all instructors could teach with the same course materials, assignments, and assessments. Students completed and submitted all assignments online; these assignments were graded instantly and automatically. The instructors also required students to complete modules in LearnSmart, an adaptive learning platform within Connect, before attending lecture, and encouraged them to watch recorded lectures via a lecture capture service called Tegrity.

28 “Digital Course Solution Improves Student Success.” McGraw-Hill. Accessed January 12, 2012, http://www.mhhe.com/success/chemistry/Case_Chemistry_Charleston_Overby.pdf. The professor used the “share” feature of the integrated eBook within Connect to share his own highlights and notes with the students in his sections using Connect so as to indicate the material he thought was most important. After every lecture, the professor assigned students in his classes homework assignments within Connect. Students were also required to complete three to seven assignments, each consisting of two to four questions, for every chapter assigned. The professor used the information provided by Connect about students’ performance on homework assignments to decide which material to cover in the next lecture.

29 “Digital Course Solution Improves Student Success and Increases Engagement.” McGraw-Hill. Accessed January 12, 2012, http://create.mcgraw-hill.com/wordpress-mu/connectblog/files/2011/09/Case_FSC_Psychology_Tuckwiller.pdf. Students in the section using Connect were required to complete at least 10 LearnSmart modules over the course of the semester; each time, they were required to complete the assignment before the professor lectured on the subject. Students completed, on average, one interactive homework assignment in Connect each week, which professor had created using the “suggested syllabus” feature. This assignment usually included 20 questions—a mixture of automatically graded multiple choice and essay questions—which were built around an interactive learning activity or a video demonstrating a key concept from the chapter. The students took all their exams via Connect using the integrated test bank.
In the class taught using Connect, the professor assigned an average of three or four assignments a week, using Connect’s filter feature to choose exercises and problems that aligned specifically with departmental learning outcomes. Before each lecture, the professor assigned students a set of exercises, which students could work through multiple times for practice, as well as a timed 20-minute quiz. During his lectures the professor taught the concepts students need to know to complete their weekly assignments in Connect, and demonstrated the problem-solving process using exercises similar to the ones the students would encounter on that week’s Connect assignment. After his lectures, the professor assigned students another set of exercises that was due on the Sunday after each week’s class meetings. (The professor did not count the first problem set and quiz toward students’ grades in order to give them an opportunity to familiarize themselves with Connect without penalty.) The students took their exams online, with a 75-minute time limit.

The professor used Connect Writing in one of her two summer sections to evaluate its effect on student comprehension and application of grammar rules and conventions and to have more in-class time to focus on writing. (The other section, by contrast, was taught as a traditional, face-to-face section.) While both the section using Connect and the section not using Connect had one introductory face-to-face lecture for each element of grammar, students in the former section used Connect for grammar exercises, whereas students in the latter section class completed in-class drills during a second lecture.

The fall 2010 professor used Connect in conjunction with Blackboard and assigned weekly listening activities with streaming music. These activities consisted of two to four listening guides, in which students followed visual representations of moving musical scores while they listened to the same music playing, and 10 to 15 multiple choice listening identification questions. The students also completed the Connect Music quizzes and tests online.

Throughout the course she never met face-to-face with her students.
chose to have their performance on the Connect assignments factored into their grades, and nine of the six who did not choose this option still completed at least some of the Connect quizzes, even though these students’ performance on the Connect quizzes would not affect their grades.) The professor used Connect’s reporting feature to track which topics students were and were not mastering. Students also used the eBooks in Connect rather than physical textbooks.

37 “Digital Course Solution Improves Student Success and Increases Instructor Efficiency.” McGraw-Hill. Accessed January 12, 2012, http://create.mcgraw-hill.com/wordpress-mu/connectblog/files/2011/09/Case_PublicSpeaking_SJC_Williams.pdf. In the traditional sections that used Connect Lucas, the professor recorded every student speech, uploaded the recordings of the speeches onto Connect Lucas, and required each student to watch the video of his or her own speech and evaluate the speech using an assessment form. Students were also assigned chapter readings and had to take related quizzes in Connect Lucas before attending lectures. The class time was generally used to answer specific student questions.

In the online classes using Connect Lucas, students were required to record themselves giving speeches in front of their own audiences. The professor then used a rubric in Connect Lucas to grade those speeches, and provided comments to students that were embedded in their speeches to provide the students with real-time feedback. The professor also organized the online students into groups and required that students review each group member’s speeches as well as their own speeches.

In both the traditional and online classes using Connect Lucas, the professor recommended students use flashcards, practice quizzes, and sample videos in Connect to prepare for quizzes, assignments, and the midterm and final exams, which students completed using Connect. The students were also assigned to watch and evaluate at least one of the Top 100 American Speeches.

38 “Digital Course Solution Improves Student Retention and Increases Engagement.” McGraw-Hill. Accessed January 12, 2012, http://create.mcgraw-hill.com/wordpress-mu/connectblog/files/2011/09/blog5.pdf. The professor used Connect in fall 2009 to assign homework, quizzes, eBook and custom assignments, and modules of the LearnSmart system within Connect. The professor gave students four assignments each week, on average, each of which covered at least one section of the eBook and which consisted of about six questions on average (in the case of interactive and animation assignments) or 20 to 25 questions (in the case of homework assignments). The professor used Connect’s Student Progress Tracking, Diagnostic and Learning Plan, and Reporting features, and also used Connect in conjunction with Blackboard.


In spring 2010, the professor required students to complete LearnSmart modules within Connect before they attended class; the professor was then able to adapt her lectures based on the students’ performance so that she could focus on more advanced topics.

40 “Digital Course Solution Improves Student Success and Increases Instructor Efficiency.” McGraw-Hill. Accessed January 12, 2012, http://create.mcgraw-hill.com/wordpress-mu/connectblog/files/2011/11/Case_Health_VT_Smith.pdf. Although the course that used Connect was online and self-paced, the professor required students to adhere to deadlines for five personal health assessments, one assignment, and four exams. In addition, there was a mandatory workshop for students in the course; while the students in the course who lived on campus were required to attend the one-time, on-campus workshop in person, those students who did not live on campus could complete the workshop content in Connect Personal Health. Each of the four exams given in the course covered three or four textbook chapters, and students had access to sample exam questions that could help them prepare for the exams. The professor used individual Connect reports and assignment reports to track student activity so that she would know if she needed to address any issues with her students.