

# /Guidebook

to Research on Open Educational  
Resources Adoption

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**OPEN  
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## Introduction

The purpose of this guidebook is to provide ideas for how individual faculty members and those who support them (e.g., librarians, instructional designers, etc.) can research the effect of their adoption of open educational resources (OER). Clearly educational research is a challenging enterprise; this guidebook is not meant to replace the substantive courses and experiences that a PhD in educational research would provide. Rather, our hope is to provide some straightforward suggestions that could be implemented by OER adopters so as to help them identify what has happened as a result of their OER adoption.

Hilton (2016) summarizes and critiques several OER studies that have been done and may be a helpful additional resource for designing your own research study. More up-to-date summaries of OER impact research can be found at <http://openedgroup.org/review>. In addition, the appendix of this document provides a refresher on basic principles of educational research design.

Many questions about the impacts of OER adoption can be addressed through the COUP Framework (Bliss, Robinson, Hilton and Wiley, 2013). This framework focuses on the issues of Cost, Outcomes, Use, and Perceptions. In the following sections we discuss how you could study each of these four aspects of OER impact in your research on OER adoption. We provide varying levels of rigor so that you can determine which approach would best meet your needs.

If you feel stuck at any point along the way, please contact us at [partnerships@openedgroup.org](mailto:partnerships@openedgroup.org).

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## Measuring the Impact of OER Adoption on /Cost

One of the principle reasons for adopting OER is that it saves students—and those who support them—a considerable amount of money. The following two approaches can help you measure the amount of money saved by your OER adoption.

### COST - LEVEL 1

*How much money was saved by this OER adoption?*

**Research Question:** How much money was saved by this OER adoption?

**Measure Variables:** Gather information about the cost of previous textbooks and the number of students enrolled in the course. For the sake of simplicity, use the cost of a new textbook.

**Analyze Data:** Multiply the cost per textbook by the number of students in the sections that used OER.

**Answer the Question:** Assuming that the OER were free, the amount of money calculated is the amount of money saved by the OER adoption. If the OER were not completely free, the amount saved is the difference between the cost of the previous textbook and the cost of the OER.

### COST - LEVEL 2

*How much money was saved by this OER adoption?*

**Research Question:** How much money was saved by this OER adoption?

**Measure Variables:** Gather information about the cost of previous textbooks and the number of students enrolled in the course. Find the costs for new, used, digital, and rental copies of the textbooks.

**Control Confounds:** Survey a sample of students to determine how many of them typically purchase their textbooks in new, used, digital, or rental formats, as well as those who typically do not purchase books.

**Analyze Data:** Multiply the cost of each textbook format by the number of students who typically purchase in that format.

**Answer the Question:** Assuming that the OER were free, the amount of money calculated is the amount of money saved by the OER adoption. If the OER were not free, the amount saved is the difference between the cost of the previous textbook and the cost of the OER.

# Measuring the Impact of OER Adoption on /Student Outcomes

While saving money is important, the majority of teachers are most concerned about the educational outcomes attained by their students. In this section we outline three studies you could do to measure the impact of OER adoption on student outcomes.

## LEVEL 1: FINAL GRADE

*How do students' final grades differ when faculty assign OER instead of commercial textbooks?*

**Research Question:** How do students' final grades differ when faculty assign OER instead of commercial textbooks?

**Measure Variables:** To answer this research question, you will need to collect final grades for every student in the course sections using OER instead of commercial textbooks (the treatment group), as well as final grades for students in other sections of the same class using commercial materials (the control group).

Example. If you have replaced a commercial textbook with OER in two sections of Introduction to Biology, gather final grades for each individual student in those two sections. Then gather final grades for individual students in sections of Introduction to Biology that used commercial materials.

**Control Confounds:** *Differences in teachers.* One potentially large confounding influence on this kind of study is the effect of the teacher on student learning. If we compare the final grades of students taught by a highly effective teacher with those of students taught by a less effective teacher, the influence of the teacher's skill will likely overwhelm the potential impact of adopting OER on student outcomes. This confound is best controlled by using a Constancy strategy, in which the same faculty member teaches both the treatment and control groups. This Constancy is simplest to attain by comparing final grades from the current semester's treatment group with final grades from students the same teacher taught in previous semesters, before adopting OER. This controls for the teacher effect and gives us a better chance of seeing the effect of OER on students' outcomes. If you cannot get data for a control group taught by the same teacher, and instead must use

control data from a different teacher, consider adding a covariate to the model that partially accounts for the teacher effect (like the average grade in sections taught in previous terms). Because student populations can vary across semesters (e.g., the population of students who take biology in the fall may be different than the group that takes it in the spring), it may be better to compare (for example) fall 2015 students with fall 2016 students, rather than fall 2015 students with winter 2016 students.

*Differences in students.* Another potential confounding influence on this study is differences in the students in the control and treatment groups. For example, if the majority of control-group students are eligible for Pell Grants and very few students in the treatment group are, this difference between student groups may also overwhelm the potential impact of adopting OER. Or, if one group has higher GPAs or more subject-matter knowledge to begin with, that would have a significant impact on the difference between the two groups. If possible, collect basic demographic information about students in both the control and treatment groups. You might consider collecting students' age, gender, race, Pell eligibility, prior GPA, enrollment status (full or part-time), previous GPA, and other data you have reason to believe might influence student outcomes. These confounding variables can be used to create interaction terms during data analysis; they can be used as covariates and their effects can be removed from the differences between the treatment and control groups. Another effective approach would be to do a subject-matter pretest with both groups, so that you could establish the extent to which the groups are equivalent in their initial knowledge of subject matter.

*Noise in final grades.* The final grades of some courses include components that do not directly reflect student learning. For example, some courses grade attendance, class participation, or provide significant extra-credit opportunities. In courses where the final grade may not be an accurate reflection of students' learning, you may want to use students' scores on a common, cumulative final exam rather than their final grade.

**Analyze Data:** In order to analyze these data, first convert the students' final letter grades into their numeric GPA equivalents (for example, A = 4, B+ = 3.3, B = 3). If you did not collect demographic information about students, conduct a t-test to determine if the average final grade among students in the treatment group (OER users) differs significantly from the average final grade among students in the control group (users of commercial materials). If you did collect demographic information about students, conduct a multiple regression using each student's group (treatment or control) and the demographic data you collected to predict their final grade. Covariates and interaction terms can be included in the multiple regression equation. (Simpler approaches that you might be more familiar with that also employ a limited number of confounds include Factorial ANOVA or ANCOVA.)

**Answer the Question:** If you did not collect demographic data about students, the results of the t-test will indicate whether the average scores of the two groups differed from each other by a statistically significant amount. If you did collect demographic data about students, the results of the regression will include a coefficient indicating the influence of OER adoption on students' final grades, and will be adjusted for the influence of their demographics.

## LEVEL 2: COURSE THROUGHPUT RATES

*How do course throughput rates change when faculty assign OER instead of commercial textbooks or digital content as the required materials for a course?*

**Research Question:** How do Course Throughput Rates change when faculty assign OER instead of commercial textbooks or digital content as the required materials for a course? (The Course Throughput Rate or CTR, combines the effect of drop rates, withdraw rates, and final grades to show the percentage of students present on the first day of class who complete the course with a final grade of C or better.)

**Measure Variables:** To answer this research question, you will need to collect the following information for every student who is registered on the first day of class in the course sections using OER instead of commercial textbooks, as well as for students in other sections of the same class using commercial materials. Often these kind of data are only accessible through your university's institutional research office.

- Did the student drop the course?
- Did the student withdraw from the course?
- Final grade

**Control Confounds:** Inasmuch as it is feasible, you will want to control for confounds as outlined in the previous section. In this case, the purpose for controlling for confounds is not to do multiple regression analysis, but simply to verify that you are working with two equivalent groups. For example, if by administering a pretest you determine that the students' subject-matter knowledge was equivalent at the outset, it will strengthen the overall validity of your results.

**Analyze Data:** For each section, calculate the following information:

- Percentage of students who dropped
- Percentage of students who withdrew
- Percentage of students who received a final grade of C or better

Multiply these three values together for each section in order to calculate the CTR per section. Then conduct a z-test of proportions to determine if the CTR of sections in the treatment group differs significantly from the CTR of sections in the control group.

Answer the Question: The results of the z-test of proportions will indicate whether the CTR of the two groups differed from each other by a statistically significant amount.

### LEVEL 3: ENROLLMENT INTENSITY AND PERSISTENCE

*How do students' enrollment intensity (number of credits taken) and semester-to-semester persistence change when faculty assign OER instead of commercial textbooks or digital content as the required materials for a course?*

**Research Question:** How do students' enrollment intensity (number of credits taken) and semester-to-semester persistence change when faculty assign OER instead of commercial textbooks or digital content as the required materials for a course?

**Measure Variables:** To answer this research question, you will need to collect the following information for every student in the course sections using OER instead of commercial textbooks as well as for students in other sections of the same class using commercial materials:

- The number of credits for which each student receives a final grade in the term they belonged to the treatment or control group
- Whether or not each student registered for one or more classes in the semester following the term in which they belonged to the treatment or control group

**Control Confounds:** Differences in teachers. One potentially large confounding influence on this kind of study is the effect of the teacher on student learning. If we compare the final grades of students taught by a highly effective teacher with those of students taught by a less effective teacher, the influence of the teacher's skill will likely overwhelm the potential impact of adopting OER on student outcomes. This confound is best controlled by using a Constancy strategy, in which the same faculty member teaches both the treatment and control groups. This Constancy is simplest to attain by comparing final grades from this semester's treatment group students with final grades from students the same teacher taught in previous semesters, before adopting OER. This controls for the teacher effect and gives us a better chance of seeing the effect of OER on students' outcomes. If you cannot get data for a control group taught by the same teacher, and instead must use control data from a different teacher, consider adding a covariate to the model that partially accounts for the teacher effect (like the average class grade in sections taught in previous terms). Because student populations can vary across semesters (e.g., the population of students who take biology in the fall may be different than the group that takes it in the spring), it may be better to compare (for example) fall 2015 students with fall 2016 students, rather than fall 2015 students with winter 2016 students.

*Differences in Students.* Another potential confounding influence on this kind of study is differences in the students in the control and treatment groups. For example, if the majority of control group students are eligible for Pell Grants and very few students in the treatment group are, this difference between student groups may overwhelm the potential impact of adopting OER. If possible, collect basic demographic information about students in both the control and treatment groups. You might consider collecting their age, gender, race, Pell eligibility, prior GPA, enrollment status (full or part-time), and other data you have reason to believe might influence student outcomes.

**Analyze Data:** If you did not collect demographic information about students:

- Conduct a t-test to determine if the number of credits taken by students in the treatment group differs significantly from the enrollment intensity for students in the control group.
- Conduct a chi-square test of independence to determine if the rate at which students returned the following term (persistence rate) among students in the treatment group differs significantly from the persistence rate in the control group.

If you did collect demographic information about students:

- Conduct a multiple regression using each student's group (treatment or control) and demographic data to predict the number of credits taken.
- Conduct a logistic regression using each student's group and demographic data to predict whether or not they register for credits in the following term.

**Answer the Question:** The results of the t-test or multiple regression will indicate whether or not there is a significant difference in enrollment intensity between the control and treatment groups. The results of the chi-square test or logistic regression will indicate whether or not there is a significant difference in persistence between the control and treatment groups.

## Measuring the Impact of OER Adoption on /Student and Faculty Use

Historically the “use” aspect of OER has been the least studied. “Use” has at least two meanings. First, it can be viewed how students use the OER. Is student use of OER different than that of traditional materials? A second aspect of use concerns how students and teachers utilize the additional legal freedoms that OER provides. For example, OER allow teachers to remix two different pieces of OER to create a new and improved resource. Do teachers actually “use” this right? These are the types of issues that we now examine.

### LEVEL 1: COMPARING USE OF TRADITIONAL MATERIALS AND OER

*How does student use of resources differ between traditional learning resources and OER?*

**Research Question:** How does student use of resources differ between traditional learning resources and OER?

**Measure Variables:** It is difficult to get objective measures of student use of resources. Most likely you will need to collect self-reported data from the students via a survey sometime during the course. This data could include how much time the student spent using the resources or the proportion of the resource they used.

Example. You have replaced a traditional textbook with OER in several sections of a statistics course. You want to see if the usage differs between students in the OER sections with those in the traditional sections. During the course, you have students in the OER sections and those in the traditional sections complete a survey, reporting the time that they spent using the resources and a proportion of the material read.

**Controls and Confounds:** To see the difference in resource use between students using OER and those using traditional materials, an equivalent comparison group needs to be identified. To boost validity, these two groups should be as equivalent as possible. This means that the only difference between the groups should be the type of resource (OER versus traditional)

that they are using. Ideally, the groups would be in the same course, with the same instructor, who teaches one section with OER and another with a traditional textbook. Another possibility could be student use across time (e.g., students in fall 2015 use traditional textbooks while students in 2016 use OER. Was there a difference between the two groups?).

## LEVEL 2: COMPARING USE OF TRADITIONAL AND OER

*How does student use of resources differ between traditional learning resources and OER?*

**Research Question:** How does student use of resources differ between traditional learning resources and OER?

**Measure Variables:** Rather than rely on student self-reports, gather usage data via learning management systems. This usage data may include downloads, page views, or session time.

Example. You have replaced a traditional textbook with OER in several sections of a statistics course. You want to see if the usage differs between students in the OER sections with those in the traditional sections. During the course, you have students in the OER sections and those in the traditional sections complete a survey, reporting the time that they spent using the resources, and a proportion of the material read.

**Controls and Confounds:** To see the difference in resource use between students using OER and those using traditional materials, an equivalent comparison group needs to be identified. To boost validity, these two groups should be equivalent as possible. This means that the only difference between the groups should be the type of resource (OER versus traditional) that they are using. Ideally, it would be in the same course, with the same instructor, who teaches one section with OER and another with a traditional textbook. Another possibility could be to student use across time (e.g., students in fall 2015 use traditional textbooks while students in 2016 use OER. Was there a difference between the two groups?).

**Analyze Data:** To make comparisons between student use of OER with that of traditional resources, you will need to conduct a t-test between the course sections to determine if there is a difference in the proportion of the resources used by the students, or the time spent using the resource.

**Answer the Question:** The results of the t-test will indicate whether the average resource time or proportion of the material used is different between the two sections by a statistically significant amount. Additionally, you can use a Cohen's D calculation to determine the effect size—or magnitude of the difference between the two groups.

### LEVEL 3: UTILIZING THE LEGAL PERMISSIONS FACILITATED BY OER

*To what extent (if any) are faculty and students utilizing the legal permissions facilitated by OER?*

**Research Question:** To what extent (if any) are faculty and students utilizing the legal permissions facilitated by OER?

**Measure Variables:** Have focus groups or individual interviews with faculty and students who have used OER and talk with them about the way they used them. Consider asking questions like the following: Did you do anything different in class as a result of adopting OER? Did you do anything different outside of class as a result of adopting OER? How much time (if any) did you spend revising or remixing content? What influence (if any) did that have on your approach to the class?

**Control Confounds:** Because your sample of is likely to be small, and may be self-selected, it will be challenging to control for confounds. If this is the case, acknowledge these limitations in your study. Where possible, seek to mitigate this bias by randomly selecting faculty and students for inclusion.

**Analyze Data:** After the interviews and focus groups are completed, carefully read the transcripts of these interviews. What themes seem to emerge in the responses? Are there clear patterns in the percentage of faculty and students who answer questions in a particular way?

# Measuring Student and Teacher /Perceptions of OER

Measuring student and teacher perceptions of OER is relatively straightforward and valuable. Those who actively use OER may be in the best position to judge its value. The following four approaches can help you measure how students and faculty perceive the OER that they have utilized.

## STUDENT PERCEPTIONS - LEVEL 1

*How do students perceive the quality of the OER?*

**Research Question:** How do students perceive the quality of the OER?

**Measure Variables:** Administer one of the student surveys found at <http://openedgroup.org/toolkit> in the appendices of this article (or a remix of these surveys) to students. You can do this in person during class or using an online survey tool such as Survey Monkey or Qualtrics.

**Analyze Data:** Aggregate student responses using descriptive statistics like averages for each selected response survey item. Online survey tools will often do this for you. You might do additional analysis by comparing the results of groups of students using a statistical test. For example, you might use a t-test to determine if students who are eligible for Pell Grants respond differently on key questions than students who are not.

## STUDENT PERCEPTIONS - LEVEL 2

*How do students perceive the quality of the OER?*

**Research Question:** How do students perceive the quality of the OER?

**Measure Variables:** Have focus groups or individual interviews with students to talk to them about their perceptions of the OER materials assigned for their class. How do students perceive the value of OER relative to traditional textbooks? How do they use them? What is working well? What concerns do they have? What suggestions do they have for improvement?

**Control Confounds:** Because your sample of students is likely to be small, strongly consider randomly selecting students to participate. If you handpick ten students, you will potentially be introducing bias into the results.

**Analyze Data:** After the interviews and focus groups are completed, carefully read the transcripts of these interviews. What common themes seem to emerge in the responses of the students?

## FACULTY PERCEPTIONS - LEVEL 1

### *How do faculty perceive the quality of the OER?*

**Research Question:** How do faculty perceive the quality of the OER?

**Measure Variables:** Administer one of the surveys found at <http://openedgroup.org/toolkit> (or a remix of these surveys) to faculty. You can most easily do this via an online survey tool such as Survey Monkey or Qualtrics.

**Control Confounds:** Because your sample of faculty is likely to be small, strongly consider randomly selecting faculty to participate. If you handpick ten faculty members, you will potentially be introducing bias into the results.

**Analyze Data:** Aggregate faculty responses using descriptive statistics like averages for each selected response survey item. Online survey tools will often do this for you. You might do additional analysis by comparing the results of groups of faculty using a statistical test. For example, you might use a t-test to determine if faculty who are full-time respond differently on key questions than adjuncts.

## FACULTY PERCEPTIONS - LEVEL 2

### *How do faculty perceive the OER?*

**Research Questions:** How do faculty perceive the OER?

**Measure Variables:** Have focus groups or individual interviews with faculty who have used OER to talk to them about their perceptions of the OER materials. How do faculty perceive the value of OER relative to traditional textbooks? What is working well? What concerns do they have? What suggestions do they have for improvement? One area that some faculty may be concerned about is the availability of ancillary materials. Is this an issue for your faculty? Why or why not? If so, how is it being resolved?

**Control Confounds:** Because your sample of faculty is likely to be small and self-selected, it will be challenging to control for confounds. If this is the case, acknowledge these limitations in your study. When possible randomly select the faculty you will interview.

**Analyze Data:** After the interviews and focus groups are completed, carefully read the transcripts of these interviews. What common themes seem to emerge in the responses of the faculty?

## Conclusion

There are many additional resources for learning more about OER and OER research. Please visit <http://openedgroup.org/toolkit> for helpful links, including the following:

- Data collection templates
- Data definitions
- Sample student surveys
- Sample faculty surveys
- Links to completed sample studies
- Resources for completing Institutional Review Board protocols

The Open Education Group is also happy to partner with you on your OER research projects. Please contact us at [partnerships@openedgroup.org](mailto:partnerships@openedgroup.org) if we can be of service.

# Appendix

## A Brief Refresher on Research Design

### INTRODUCTION

The purpose of this section is to review some basic elements of research design. The following six phases of research are adapted from Robinson, (1976). They are: (1) hypotheses/research questions, (2) variables and measurement, (3) manage confounds, (4) data acquisition, (5) data analysis, (6) interpretation of results. While these phases of research design and analysis are not necessarily linear, we will present them in this order for the sake of simplicity.

### 1. HYPOTHESES/RESEARCH QUESTIONS

A hypothesis is a proposed relationship among variables. This assumes that variables are measureable and accessible. It does not have to assume causation; it can be predictive only. It can be stated as a directional hypothesis with an affirmative bias in how the variables will relate to one another. It can also be stated as a “null” hypothesis (no relationship) that lends itself to statistical reasoning.

For example, if you propose that using OER materials and open pedagogy is related to better student outcomes, then a directional hypothesis might read, courses using OER will show higher average grades on the final exam than courses that use traditional print textbooks. The null hypothesis would read, there will be no difference between courses using OER and courses using traditional print textbooks in terms of the average grades on the final exam.

Although you may have a desired outcome and bias about what the results should show, it is highly recommended that you state a null hypothesis as well as a directional hypothesis. Statistical reasoning and estimates of error are based on the null hypothesis that there are no relationships among the variables of interest.

### 2. VARIABLES AND MEASUREMENT

Measurement is the assignment of numbers to observations according to previously designed rules. Each of the following four scales of measurement are progressively more useful and sensitive.

A variable measured on a nominal scale carries no assumption of quantity.

The numbers used in a nominal scale are simply exchanges for names (hence, the term Nom-in-al). Categorical variables are often measured on a nominal scale. For example, ethnicity is a categorical variable in which self-identified ethnic identities are converted to numbers (e.g., Caucasian = 0, African American = 1, etc.). The numbers associated with the names do not represent greater or lesser ethnicity. There is no assumption of quantity.

A variable measured on an ordinal scale is assumed to represent increasing quantity across points on the scale, optimally with higher numbers representing more of the measured attribute. Although there is an assumption of quantity, there are unequal intervals along the scale and an arbitrary zero as the starting point of the scale. For example, variables that are measured using Likert scales (e.g., 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree) have the attributes of an ordinal scale. The difference between 4 and 3 is not necessarily the same as the difference between 3 and 2 and the starting point is arbitrary. As another example, the distance between coming in 1st and 2nd in a race, is probably not the same as the distance between coming in 2nd and 3rd. Ordinal variables are more useful than nominal variables.

A variable measured on an interval scale is assumed to represent increasing quantity across points on the scale with equal intervals along the scale but with an arbitrary zero point. For example, grade point average is measured on an interval scale. The difference between 2.0 and 2.5 should be the same as the difference between 2.5 and 3.0. But the zero point probably does not represent absolutely zero learning. The zero point is still arbitrary. Interval scale variables are more useful than ordinal scale variables.

A variable measured on a ratio scale is assumed to have an increasing quantity, have equal intervals along the scale, and have an absolute zero point. Ratio scale variables are extremely rare in social and educational research. Weight is a ratio scale variable as it has an absolute-zero point and the difference between ten and twenty pounds is the same as the difference between ninety and one hundred pounds. Ratio scale is the most useful of all.

For most purposes, interval and ratio scales of measurement are treated the same in our statistical analyses. If, however, you truly do have a ratio scale variable you can make conclusions about ratios of outcomes, for example, that one group's measured attribute is twice as large as another group's measured attribute.

In general, try to measure variables on the most useful scale possible.

### 3. MANAGE CONFOUNDS

Although we hypothesize relationships among variables, those variables are confounded by myriad other co-occurring variables. For example, we may notice that the more ice cream that is sold, the more people tend to drown. Does eating ice cream cause drowning? Perhaps, but there may be a confounding variable. Maybe on hotter days people buy more ice cream, and also go swimming more. In this case, outside temperature would be a confound. In social science research, we manage these confounds in four major ways. Although we have sophisticated sounding procedures and experimental designs, management procedures are always an expression of one or a combination of the following four approaches. The reality in educational research is that we will never manage all the variables that confound our estimates of relationships. We can have cleaner or muddier results, but never perfectly clean.

#### **Constancy**

Constancy is holding a confounding variable at one level. In an OER research setting you might maintain constancy by using the same end-of-semester exam across multiple semesters and materials so that there is a standard-measuring benchmark. Or one teacher could teach two groups of students, with each group using different materials. This could hold the influence of the teacher constant.

#### **Randomization**

Randomly selecting or assigning subjects to specific conditions is a powerful management technique. Randomization does not hold constant the confounding variables. It does eliminate systematic bias associated with those confounds. One of the major benefits of randomization is that it controls many confounds that we might not even be aware of. In an OER research setting it would be very effective if you could randomly assign students to an “OER version of the class” and another group to a “traditional learning materials” version of the class. If it is possible to use randomization, do it; however, it is often not possible.

#### **Secondary Independent Variable / Predictor**

If you suspect that a confounding variable is critical and measurable, an important management procedure is to measure it and treat it as a predictor that interacts with the other variables of interest. Interaction processes indicate that conditions operate differently for some groups than for others. For example, if the relationship initially proposed is between OER and student achievement—and gender is easily measured—it may be shown that OER functions differently for one gender than for others. Although data analysis is a bit more complicated when it accounts for interactions, it is doable and informative.

### **Ex Post Facto Statistical Control**

If you suspect that a confounding variable is important and measurable, it can be treated as a covariate. Analysis of covariance is a process by which the influence of the covariate is statistically removed from the association between the target variables. For example, if gender is suspected to confound the association, its influence can be factored out to generate a cleaner estimate of the association between OER and student achievement.

## **4. DATA ACQUISITION**

Data can be acquired in a myriad of ways. Take the time to think through how the data will be acquired. For example, if obtaining data from multiple sources, provide a standardized template that includes specific coding procedures for every variable of interest and covariates. For example, you may have data where some schools provide percentages and others give raw scores. Standardize the form by which grades will be reported. Do this for every possible variable. Create standardized scripts and procedures that should be followed by every site and researcher. Please visit <http://openedgroup.org/toolkit> for a sample data collection template.

## **5. DATA ANALYSIS**

The data analysis should be consistent with and will be determined by the nature of the data and the nature of the research question. For example, if the research question is one of differences between three groups in terms of mean values, and the outcome variables are at least interval-scale variables, then a correct analytical procedure would be analysis of variance (ANOVA).

## **6. INTERPRETATION OF RESULTS**

The interpretation of the results should answer the research question. Be cautious in overstating results; for example, if your research design does not support causation, do not claim it. Stronger research designs will support stronger interpretations.

## **CONCLUSION**

Educational research is particularly messy. The type of randomized clinical controls that are done in other branches of research are extremely difficult to do in education. The myriad of confounds make all of our conclusions murky. And yet, as we are careful in our designs, we can obtain clearer answers and be able to understand the limitations of our approach.

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