# Impact Estimation Technical Appendix

OVERVIEW

The RCE Coach will help you determine if an educational technology is moving the needle. Before you load your data, the Coach believes that negative and positive effects are equally likely, and that small impacts are more likely than big impacts. This is what statisticians call the prior distribution, it is depicted in Figure 1. A prior distribution describes the analyst's beliefs about a measurable outcome before any data are taken into account.

Figure 1. *Prior distribution of the effect of the educational technology on the outcome*

> This curve shows that, before looking at the data, the Coach believes that positive and negative impacts are equally likely, and small impacts are more likely than big impacts
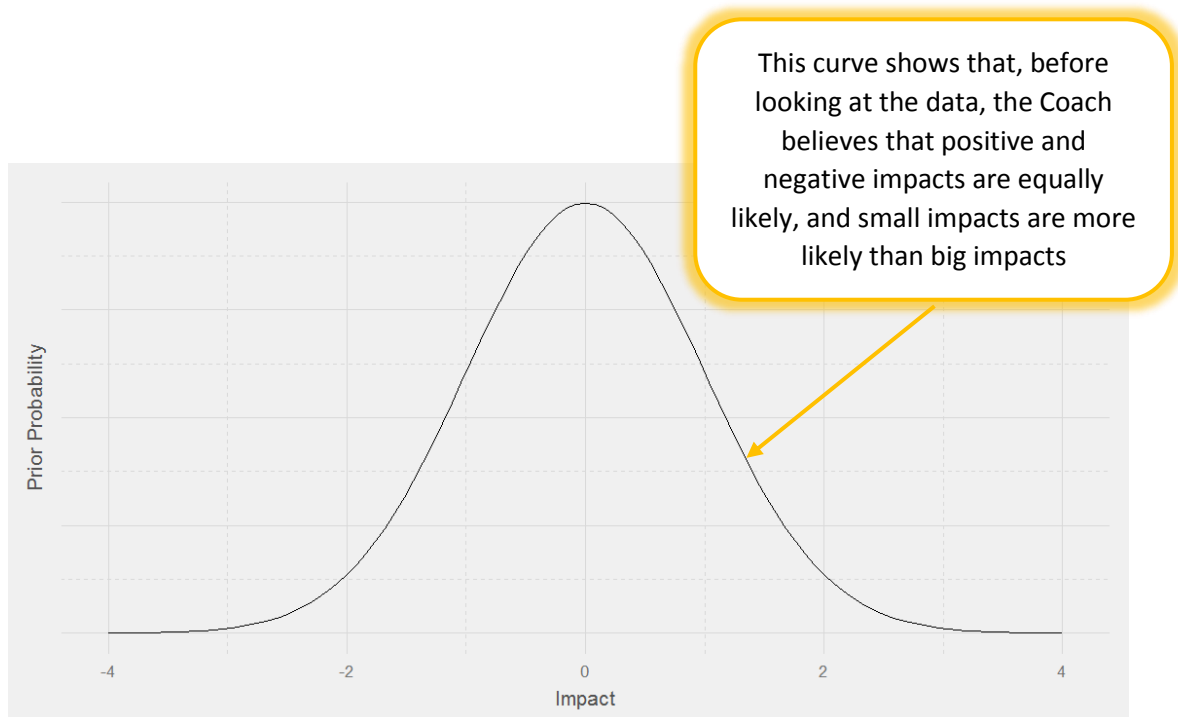
Once the data are loaded and the other inputs are specified, the RCE Coach calculates the probability that the effect of an educational technology is above or below a threshold selected by the user (in Figure 2, the threshold, as indicated by the vertical line, is 0.25). This is the probability that the educational technology is moving the needle. Figure 2 illustrates this.

Figure 2. Probability that the ed tech increases outcomes by 0.25 units or more, given the data uploaded
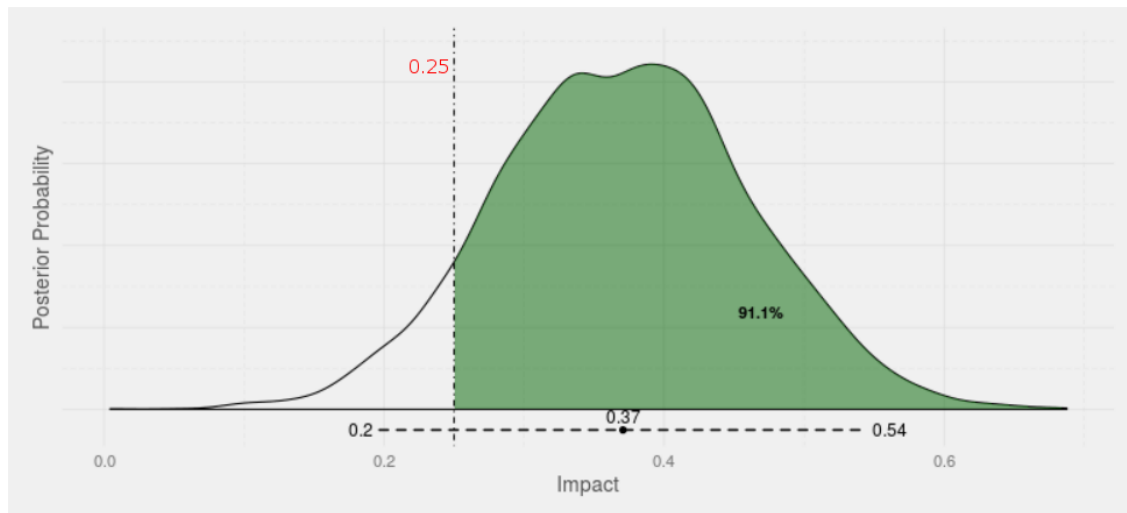
This figure tells us that:

☐ There is a 91.1% probability that the intervention increases the outcome by 0.25 units or more.

☐ The point estimate (e.g., our best guess) for the effect of the educational technology on the outcome is 0.37. This number is calculated as the mean of the posterior distribution.

This information is included in the Findings Brief for each evaluation.

In this example, the user told the RCE Coach that any increase on the outcome larger than 0.25 units would be considered a success. The Coach calculated that there is a 91.1% probability that the educational technology moved the needle by at least that amount.

Note that the answer to whether or not the educational technology is moving the needle will depend on the threshold chosen by the user (0.25 units in this example) and how much uncertainty he or she is willing to tolerate. For example, some users may conclude that a technology is moving the needle if there is at least a 75% probability that the technology is meeting the threshold they chose, while others may want to be more confident, leading them to select a higher probability. In the example above, if the user sets a certainty level of 95%, then this technology would not be found to be moving the needle, since 95 is larger than 91.1.

THE RCE COACH

The RCE Coach uses a program called Stan (see Carpenter et. al) to estimate a linear model using Bayesian statistics. In particular, the Coach uses the R package RStan. The Coach acts as a simple graphic interface to help the user construct a formula. The user has to select the outcome, treatment indicator, and any additional covariates that the user may want to include. Before estimating the effect of the intervention, the Coach temporarily standardizes the data using the R function "`scale`." Then, the Coach estimates the following model:

$$y_i = \alpha + \eta T + \beta x_i + \varepsilon_i$$

$$\varepsilon_i \sim N(0, \sigma)$$

$$\sigma \sim N(0,1)$$

$$\beta_k \sim N(0,1)$$

$$\eta \sim N(0,1),$$

where y_i is the outcome of interest for individual i, T is the treatment indicator, and x_i is a matrix with the other covariates. [1] The term η tells you the effect of the educational technology, i.e., how much higher the outcome was for the average student using the educational technology, $T = 1$, compared to the average student not using it, $T = 0$. The Coach computes the posterior distribution of η, which describes our understanding of the educational technology's effect after observing the data. Using this distribution, the Coach can calculate the probability that the treatment effect is above or below a threshold selected by the user, as shown in Figure 2.

WHICH VARIABLES SHOULD I INCLUDE AS CONTROL VARIABLES?

You should include all the variables that you think can affect the outcome of interest and for which you have good data. In the case of student achievement, it's common to include previous achievement and other characteristics like indicators for English as a second language, free or reduced price lunch eligibility, etc.

Additionally, sometimes you may need to include an element to the model to account for "clusters" in the data. This applies when technology users and non-users are determined based on existing groups they belong to, rather than determined on an individual basis. In order to correctly estimate the effect of the intervention, you will need to tell the Coach that you used clusters during step 5. By giving the Coach this information you allow it to account for the possibility that students belonging to a cluster can do better or worst just because they belong to that cluster and not because they are using the technology. For example, if users and non-users were determined based on classroom, you would want to indicate which variable identifies classroom clusters so that the Engine can account for classroom-based differences in outcomes, such as performance differences associated with teacher quality.

The code for the RCE Coach is open-source under the GPL-V3 license and will be available soon on our GitHub repository.

---

[1] In the clustered case, we add cluster-specific random effects to the regression model that's given.

CITATIONS:

☐ Bob Carpenter, Andrew Gelman, Matt Hoffman, Daniel Lee, Ben Goodrich, Michael Betancourt, Michael A. Brubaker, Jiqiang Guo, Peter Li, and Allen Riddell. 2016. Stan: A probabilistic programming language. Journal of Statistical Software (in press).

☐ Stan Development Team. 2016. RStan: the R interface to Stan, Version 2.10.1. http://mc-stan.org