Probing the Contents of the Black Box:
Complementary Approaches to Answering the How of "What Works"
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Background.

This work compares two approaches to responding to preliminary results of a randomized trial testing the effectiveness of a high school Geometry program that uses a classroom networked system of graphing calculators. The main objective of this work is to compare and contrast the approaches of two foundational research traditions in education to answering the question of 'What Works?' as well as the inevitable question of 'How so?' as applied to the results of the case. A further goal is to offer a perspective on the question of whether Mixed Methods research would work in this case; that is, whether the responses to concerns by both traditions leads to an approach that is superior to either one by itself.

Table 1.

	Condition	Means	Standard deviations	No. of students	No. of classes	No. of teachers	Effect size	p value	Percentile standing
Adjusted effect size	Control	- 0.06	1.04	199	11	7	0.14	.16	5.57%
	GC + Nav	0.08	0.88	257	17	7			

Table 2.

Date that data was collected	January 5, 2007 Control	January 5, 2007 GC + Nav	March 2, 2007 Control	March 2, 2007 GC + Nav
Angle properties	1	3	1	2
Bisection				1
Circle properties		2	1	
Lines, parallel properties	1	3		2
Lines, perpendicular properties	1			1
Lines, segments, points				3
Measurement		2		1
Proofs	1			1
Quadrilateral properties	1	1	2	1
Transversals		1		
Triangle properties	1	4	3	2

Note. There were a total of 6 control and 7 *GC + Nav* teachers who responded.

Experimental Researcher point.

The experimentalist is primarily concerned with preventing inaccuracy in the estimate of the causal effect of the intervention and, secondarily, in moderators of the effect and the intermediate outcomes that mediate the final effect of interest. We address complexity by starting with a small number of valid estimates and carefully elaborate on the causal picture.
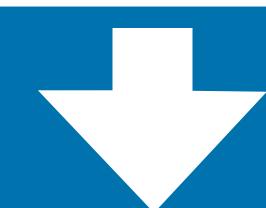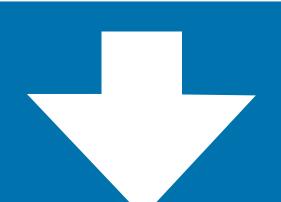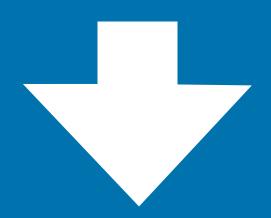
Theory-based Evaluator point.

Theory-based researchers are fundamentally concerned with articulating and distinguishing between program and implementation theory so as to be able to interpret the evaluation data in meaningful and powerful ways. Given that the data in this case indicates that the innovation may have promise and we have unclear theories of why this maybe so, the best move forward is to study the underlying dynamics using predominantly qualitative methodologies.

Theory-based Evaluator counterpoint.

There is no issue with the fundamental approach. For this case however, the lack of articulation of both program and implementation theory makes it difficult to advocate staying on the experimentalist's path when other methods would provide more robust information.

Experimental Researcher counterpoint.

Ideally, to obtain valid measures of the critical outcomes and relations, we need concise theory. But if the goal is to advise in a timely manner, we cannot always go back to the drawing board. Given the usual state of ill-defined theory, we can either avoid the evaluation or go forward with an experiment, admitting that construct validity may be somewhat compromised but that internal validity is intact because we have eliminated selection bias.

Resolution and Conclusion.

Both Experimental Researchers (ER) and Theory-based Evaluators (TBE) agree on the need for solid program and implementation theory. But agreement on this point is insufficient. We call for a change in the process by which educational research is conducted – one that acknowledges that there is a continuum. We should not have to wait until we get to effectiveness trials before we realize that both program and implementation theory is lacking and that standardized outcome measures are insensitive to the intervention. There is an urgent need to develop research programs that provide us better-articulated theory earlier - this will serve all methods. TBE and ER methods are importantly different but not necessarily incommensurable; in fact, one can inform the other so that they are complementary. If we do not want black boxes, we need to dismantle them from the beginning, necessitating embracing various methodologies.

In the meantime, we have to do something with the current system and ER argues for going ahead with experiments instead of going back to the drawing board. Until the process of theory-generating improves, our constructs may be impoverished, but experiments should proceed because they strengthen the internal validity of out claims. TBE suggests that a better approach is to begin with a series of design experiments to uncover program theory, followed by limited field case studies to uncover implementation theory, and then subsequent field experiments to discover impacts.