Conducting A Design-Based Research EdD Dissertation: Opportunities And Approach

by

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Design-Based research (DBR) provides a different and expanded view of the role of science and knowledge generation in educational improvement as compared to the traditional model that currently dominates educational research. This expanded view of science provides the potential to (a) produce more effective interventions and practices, (b) produce more authentic knowledge about how to improve education, (c) more actively involve leaders in the production of new practices and knowledge, and (d) provide EdD students with an applied option for conducting EdD dissertations.

If we are to make substantial progress in education on some of our most intractable problems we clearly need to develop more powerful interventions and practices and new types of knowledge. The emerging research paradigm of DBR may offer the best hope for producing needed improvements in practice. DBR also offers a way for students to develop an applied dissertation that is scientifically rigorous—but that does not require high levels of technical expertise. It only requires high levels of imagination and leadership.

This chapter (a) defines DBR, (b) describes the background of the emergence of DBR, (c) provides several examples of dramatically effective interventions and describes how they were designed, and (d) describes some of the characteristics of an EdD DBR dissertation.

The Traditional View of How to Apply Science In Education

The classic conception in education of how to discover and develop better interventions, and/or generate better knowledge about how to improve some educational process, is to develop a theoretical basis for an approach, implement it, and then test the effects through a rigorous experimental research design that can establish "causation" by controlling for confounding variables. Hereafter this approach will be referred to as the "traditional model" of scientific discovery and knowledge generation for improving practice. This traditional model has formed the sole basis of how research, theory, and quantitative methods have been applied to educational improvement. This traditional model has predominated because of the perception that this is how science and medicine develops and validates new ideas, tools, and interventions. This traditional model comes from education's desire to be perceived as a profession that has scientifically validated practices.

The traditional model has clearly served science well. For example, the theory of relativity led to the development of more accurate clocks. Similar examples of the successful application of theory to solve a fundamental problem are rare in education. Applying this traditional model of innovation and knowledge generation in education is problematic given the rapid turnover of educational theories with little or no supporting evidence. In addition, the general nature of most theories provide no guidance as to which of the specific implementation parameters out of the almost infinite set of possibilities for implementing a given theory are likely to be effective. For all these reasons Sandoval and Bell (2004) note that it has never been simple to translate theoretical insights into educational practice.

Fortunately, the assumption in education that the traditional model is universally how discovery is made in science and medicine is wrong. Working from theory is but one of two approaches used in science: the other is characterized by the physicist Lisa Randall (2005) as "model building". Many of the important breakthroughs in science have occurred via the alternative "model building" paths of: accident, using metaphor, and doggedly persistent iterative clinical trials/tinkering. This means that we do not have to rely on the limited applicability of the traditional model to apply science and harness scientific discovery in the pursuit of better approaches to improve practice.

Alternative Paths to Scientific Discovery

Accidental Scientific Discovery—The classic case of an accidental discovery was Madame Curie discovering x rays because a photographic plate was left uncovered. The discovery was made because unlike most who might have dismissed it as a faulty plate, she was intensely curious as to what might have caused the shadow on the plate and was persistent in trying to find an explanation.

Metaphor Based Discovery In Science—There are many examples in science where metaphor and intuition, not theory, led to major discoveries. The first manned flying machine was not developed by a scientist applying theoretical principles. The key knowledge that ushered in aviation was discovered by a pair of bicycle builders and repairers. How did they succeed when everyone else before them had failed? Their breakthrough design, the flexible wing that could be bent, came to them by observing birds in flight. They noticed that when birds quickly changed direction they bent their wings. They were then able to use their knowledge of materials and pulleys to design such a wing. The wing was based on metaphor…not theory. In addition, metaphor has also played a role historically in the conceptual development of some of the most important theories in science; what physics calls "thought experiments". The classic example is Einstein imagining what it would be like to travel on a beam of light which helped lead to the theory of relativity.

Scientific Discovery That Resulted From Iterative Clinical Trials/Tinkering—Many of the major discoveries in science and improvements in other fields were the result of iterative clinical tinkering. The classic case is Edison's invention of the light bulb. It was only his dogged tinkering with various combinations of materials that led to this and his many other discoveries. Most theorists and scientists would argue that what Edison did was very inefficient and certainly not intellectually elegant. That is true. But it turned out to be far more efficient than waiting for theory to evolve to the point where it was obvious how to produce a light bulb. How long would the invention of the light bulb been delayed if not for Edison's "tinkering"? Another way to express the value of this clinical tinkering approach is to ask the question: How do you develop a needed improvement in practice where there is insufficient data or theory?

Alternative Path to Discovery in Medicine

Of course, modern medicine would never resort to iterative tinkering. Wrong! Gawande (2007), in his book *Better: A Surgeon's Notes on Performance*, provides a powerful example of how clinical tinkering in medicine has saved lives. He argues that the single greatest improvement in medical practice in the past 50 years in terms of saving lives has been the tremendous reduction in the mortality rate of newborn infants. In the 1950s the mortality rate for newborn infants in the U.S. was 1 in 30. By 2000 only 1 baby out of 500 newborns died. How did this improvement occur? The application of theory? NO! The use of gold standard randomized experiments? NO! The use of evidence-based practices. NO!

Paradoxically, while this life-saving improvement was occurring, obstetrics was ranked dead last among all medical specialties in the use of hard evidence from randomized clinical trials. How did obstetrics do it? Dr. Gawande describes it thus:

> In obstetrics…if a new strategy seemed worth trying, doctors did not wait for research trials to tell them it was all right. They just went ahead and tried it, then looked to see if results improved. (p. 189-90)

Different hospitals tried new approaches and communicated what worked in real time to all other obstetricians. How many more babies would have died if not for the clinical tinkering of hundreds of doctors and nurses?

These alternative paths to discovery are currently starting to be applied to educational improvement in the form of DBR.

What is Design-Based Research (DBR)?

DBR provides the basis for harnessing the alternatives paths of scientific discovery for improving education practice. DBR is academicians, researchers, and practitioners coming together to design a novel approach to solve a problem, test the effects of the approach, and use feedback to make iterative improvements. The recommended characteristics for DBR according to Mingfong, Yam San, and Ek Ming (2010) are (a) using mixed methods, (b) multiple iterations of the design, (c) collaborative partnership between researchers and practitioners, and (d) evolution of design principles. The research feedback indicates what is working and what is not, and iterative changes are made with the goal of continuous improvement. (NOTE: "Iterative changes" is a fancy way of saying "tinkering".)

DBR is an iterative collaborative process of learning by doing, i.e., trying out something, and improving it based on repeated experience—as opposed to a single grand controlled experiment. The research goal is to refine the intervention across multiple iterations and increase the number of sites to test its effectiveness and scalability.

The start of Design-Based Research (DBR) is generally credited to Ann Brown (1992) who came to realize that results from laboratory based research were inherently limited in their ability to explain or predict learning and moved her research to the classroom; a process she called "design experimentation". Sandoval and Bell (2004) quote, Lagemann (2002) as noting that, "…the traditional paradigm of psychology has striven for experimental control at the expense of fidelity to learning as it actually occurs. Thus, although such claims might be scientific in one sense, they do not adequately explain or predict the phenomena they purport to address…" (p. 199). Sandoval and Bell (2004) note that scholars from a wide variety of disciplines became interested in participating in DBR to: "… better understand how to orchestrate innovative learning experiences among children in their everyday educational contexts as well as to simultaneously develop new theoretical insights about the nature of learning." (p. 244) Sandoval and Bell (2004) introduced the concept of "embodied conjectures". These are conjectures (rather than formal hypotheses as generally used in experimental research), and it is about learning within educational designs. A literature review by Anderson and Shattuk (2012) found that the number of articles that discussed DBR increased from almost zero in 2000 to almost 400 in 2010, and after 2006 the nature of the articles shifted from discussing the characteristics of DBR to conducting DBR research.

The collaborative process of DBR is different than what has traditionally occurred in education research. Traditionally academicians dispense some theory, theoretical framework, or research finding and leave it to practitioners and/or vendors to figure out how to apply it. DBR, on the other hand, ideally actively involves a group of academicians and practitioners collaborating to design, implement, and test an intervention. This ongoing active collaboration combines the best of academic knowledge amplified by the experience and instincts of good practitioners to take advantage of their personal theories of action and detailed knowledge of implementation processes and strategies for overcoming organizational impediments.

As this is being written, there seem to be three emerging perspectives on DBR.

1. *Traditionalist DBR.* Traditionalist DBR consists of individuals who are trying to define DBR as simply research that is based in the real world while maintaining all the other elements of the traditional model. They insist on the pre-eminence of theory as justification for the design of the intervention and on judging the results on the basis of whether it generates new theory.

2. *Design Based Implementation Research (DBIR).* The focus of DBIR (Fishman, Penuel, Allen, & Cheng, 2013; Russell, Jackson, Krumm, & Frank, 2013) is to collaboratively design interventions that are then used as the basis for understanding the conditions under which practitioners decide to accept or reject new interventions for the purpose of generating new and better implementation theory.

3. *Networked Improvement Community (NIC).* The goal of NIC (Bryk, Gomez, & Grunow, 2011) is to design a new approach that produces a substantial improvement in a major education problem. The new design is piloted in one or more initial sites, and as iterative improvements are made to the design, it then gets expanded to other pilot sites, and the iterative changes are communicated to all the sites in the network.

I have great misgivings about the approach of the DBIR community (as well as the Traditionalist DBR community) to develop important new approaches that provide major improvement to practice as they are too similar to the traditional model. In my discussions with DBIR researchers they have not been able to provide me with one example where interventions based on theory worked. They justified their conception of the use of theory by citing lots of theory to demonstrate the importance and centrality of theory. The other problem is that the DBIR researchers do not accept the premise that for practitioners to adopt a practice there needs to be evidence that the new approach provides substantial benefits. Alas, educational research evidence typically comprises a finding of statistical significance, or an Effect Size (i.e., the amount of difference between groups) of .2, neither of which indicates that the new practice provided much in the way of observable benefit. I pointed out the example of the Dvorak keyboard. This keyboard increased typing speed by 25% as compared to the standard QWERTY keyboard. However, this alternate keyboard was not adopted because this benefit was not considered to be sufficient enough to warrant disrupting current practice. Alas, the DBIR folks rejected this line of thought and continue to believe that if research finds minute differences favoring an experimental approach—practitioners should implement it. This means that when practitioners judiciously do not exert energy and money to implement such findings, the academicians will inappropriately berate them for not applying research. This also means that the implementation theories derived by the DBIR researchers will inevitably be wrong.

On the other hand, my work and that of others provide convincing evidence that NICs provide the greatest potential for DBR to produce alternative intervention breakthroughs. It also provides the greatest potential to develop an EdD dissertation that provides students with the potential to make a major contribution to practice.

Designing Successful Networked Improvement Communities (NICs)

The motivation to develop an NIC derives from the desire of some individual(s) to solve a major widespread problem. The goal of an NIC is to try and develop a better intervention for solving fundamental problem with high levels of *external validity*. Another way of saying this is that the goal of NICs is to produce an intervention that can be scaled with reliable results; i.e., predictable and consistent outcomes.

This article focuses on two current examples of NICs that have had major impact. The first NIC is the Carnegie Foundation's Statway initiative to collaboratively redesign the developmental math sequence at the community college level (Bryk, Gomez & Grunow, 2011). The second is my Higher Order Thinking Skills (HOTS) intervention for students receiving Title I and mildly impaired learning disabilities (LD) services in grades 4-8 (Pogrow, 2004; Pogrow, 2005).

Statway is an NIC effort to improve upon one of the greatest systemic failures in American education. Approximately half the students who enroll at a community college (CC) are placed into a remedial/developmental math course sequence of at least a year which they must pass before they can enroll in CC credit earning courses. In this sequence they are essentially asked to relearn high school mathematics. Bryk, Gomez, and Grunow (2011) cite national statistics that 60-70 percent of these students nationally fail to complete the sequence of developmental math courses and drop out without having had the opportunity to earn any CC credit. *This may be the highest dropout rate in American education.*

The HOTS project was established to improve the drop-off in progress that at-risk students make after the third grade and their subsequent decline in performance. While achievement gaps stay stable or decline during the first three grades, by the eighth grade the gaps have rewidened and are large in all measured subject areas despite decades of reform.

In both of these cases the existing approaches were not working, especially for those students who were the most vulnerable.

The Statway initiative has designed and tested a new developmental math sequence that replaces the typical high school Algebra sequence with the statistical knowledge that students need in CC coursework and the types of problems they will encounter in a variety of CC majors. The Statway curriculum was developed collaboratively by researchers, foundation scholars, and CC administrators and faculty. Results from the small-scale field tests show that the percentage of students earning community college math credits increased from 15% after two years of developmental math to 50% after only a single year of Statway developmental math. This certainly qualifies as a substantial difference.

The Higher Order Thinking Skills (HOTS) project started 30 years ago. HOTS replaced the remedial approach to supplemental services for students in grades 4-8 designated as Title I and mildly impaired LD with intensive general thinking development activities. The use of a Socratic learning environment was combined with the use of technology to create an intensive learning environment. This intervention was the only one provided to students; i.e., all the other supplemental "help" services were eliminated. From the beginning, HOTS students showed three times the growth in reading comprehension and twice the growth in math on standardized and state tests without extra "help" in those content areas as compared to students receiving extra instruction in those subjects. The program was subsequently adopted in close to 2600 schools nationally and served close to ½ million Title 1 and LD students.

Surprisingly, HOTS had to overcome resistance from progressive educators who think that general thinking development does not work and that all thinking must be developed in the context of learning specific subject content such as in the regular math and science classes and curriculums. I was amazed to subsequently find out that available research had indeed demonstrated that general thinking development does not work. It turns out that this research had been conducted with university students who were already highly accomplished in learning the content of their major. What did that have to do with the a 4th grader in Harlem or Appalachia who is 2 years behind in reading and math? Nothing!

Fortunately, I did not know about this research on general thinking. It quickly became clear that the intensive general thinking approach of HOTS was working at a very high level. There are the following lessons from this experience:

1. No matter how widely accepted a theory is in academic circles it may be wrong. In addition, a wrong theory inhibits the development of alternative approaches that may be more effective than what has previously been tried; and

2. An intervention designed on the basis of intuition, metaphor, personal theory of action, and feedback, is often likely to work better than one based on theory or research on "effective practices".

This is not to argue that theory is unimportant. It is just that sometimes progress in the development of better theory emerges from successful practice. For example, the success of the HOTS intervention led to the *Theory of cognitive underpinnings*. In this theory at-risk students in grades 4-8 cannot benefit from quality content instruction to their full intellectual potential until they have developed an automated sense of understanding that can only be developed via intensive verbalization experience around sophisticated ideas.

There are also new insights and surprising results from working at scale and trying to find and understand parameters of effectiveness. For example, I thought that no intervention, including HOTS, would work cross-culture. WRONG! We saw the same student reactions and results in Soldatna Alaska, a small isolated bush village and on the Navajo reservation, as in inner city Detroit.

The Statway project produced a better understanding of why community college students who are smart struggle so mightily with mathematics. Givvin, Stigler, and Thompson (2011) documented that the students suffered from "Conceptual Atrophy". Stigler, Givvin, and Thompson (2010) define conceptual atrophy as "the willingness to bring reason to bear on mathematical problems lies dormant." (p. 15) This dormancy is viewed by the researchers as a result of prior mathematics instruction that previously failed to connect the intuitive sense that students have about mathematics to mathematical notation and procedures. The students have been conditioned to think of math as the application of rules. As a result, the Statway intervention became a "…reason focused mathematics class in which they [students] are given opportunities to reason, and tools to support their reasoning". (p. 15)

(A new, and intriguing educational NIC that is just starting to form at the instigation of Bill Gates. This NIC involves a new approach to teaching high school history. Gates became intrigued with an interdisciplinary approach to teaching history at the college level. He funded the developer of this approach to put a team together to convert the college course into a high school course called "Big History". According to Sorkin (2014), in the past 3 years the course has grown from its initial pilot in five high schools to approximately 1,200 schools at no cost to the schools.)

The good news is that so much of what we think we know from the traditional approach to knowledge generation and personal theories of action are wrong! This means there is lots of opportunity for skeptical, creative people to develop better interventions and designs—which is actually the true fundamental basis of science. This more ad-hoc, creative approach to invention also lends itself beautifully to an applied EdD dissertation—if one can design a high-potential intervention.

How to "Design" a DBR Intervention

The term Design-Based Research is self-contradictory. "Design" is an artistic process. Research is a "scientific" process. The processes of "design" and the "conduct of research" are almost independent of each other and require virtually different talents and insights. Individuals are rarely exceptional in both design and research. There are exceptions of course. One would be Gaudi, the Spanish architect of the early 1900s. He was way ahead of his time in both the aesthetic and material science of creating unique structures. More current examples that come to mind are Steve Jobs of Apple and James Dyson of the Dyson Company.

It is interesting that with all the emerging scholarship about DBR there is virtually nothing about the aesthetic, metaphorical nature of design. Some view design as merely an engineering process, e.g., as something in which specific formulas exist that can be applied. Yet there are many examples of collaboration between aesthetics and science even in the physical sciences. For example, architecture has a very strong aesthetic element, but then there is also the materials science and engineering to make sure the building will remain standing. One interesting example is the iconic, Sydney Opera Building. The design of Jørn Utzon won in a competition based largely on aesthetics. Once the design was selected the realization set in that there was no way to actually build it under existing knowledge and available technology. Fortunately, the decision-makers remained committed to the design and waited for the science to catch up.

Another individual who has successfully combined artistic design and scientific engineering is James Dyson, the inventor of the bagless vacuum cleaner and hand dryer. His inventions have made him one of the richest people in England and earned him a knighthood. His initial background was as a student in the Bryan Shaw School of Art and the Royal College of Art where he studied architecture. Once he had the design skills he then studied engineering. Like Steve Jobs who studied calligraphy, it is the combination of skills in artistic design and scientific engineering that leads to breakthrough inventions.

Clearly, relying on whether a proposed intervention has a strong theoretical basis and whether there are any gold-standard studies supporting the approach provides the comfort of having clear, familiar criteria. However, both HOTS and Statway projects used the alternative, more ad-hoc pathways of scientific discovery to develop their interventions.

The Design of HOTS

What drove things at the start was the insight of the practitioners who approached me to work with them. Their instinctual insight was that their Title I students were bright and they realized that the current remedial approaches were not working.

Based on that insight we decided to design an intervention suitable for bright advantaged kids. (This was technically illegal under the then existing Title I regulations.) The first metaphor used to drive design was to consider our Title I students as individuals attending an elite private school. So we set out to design something that mimicked the type of education we felt that such students would receive—even if only for a small part of the school day. That led to the decision to focus on using an intensive Socratic approach. This intuition was supported by the classic study by Hart and Risley (1995) that found that there is shockingly little conversation in caring low-income households and that this appeared to have an effect on their children's cognitive development. The second metaphor was to think of the HOTS Title 1 intervention as replacing the dinnertable (or any other) conversation that students were not getting in the home.

Once the decision was made to create a conversation rich environment, we used a series of metaphors to design the conversations. We used the metaphor of dinner table conversation to tell us not to link back to classroom instruction, but to use computer-games as a metaphor for the types of ad-hoc life experiences as the basis of our dinnertable conversations. We used the "brain as a muscle" metaphor to tell us that the conversations should be organized around a series of linking concepts.

The model of teacher training emerged from my experience of living in LA while on sabbatical and hanging out with some actors. I discovered that they use a very different strategy for teaching and learning in the theater and that became the basis for how we designed the teacher training: specifically they learned from the context of teaching lessons to each other and critiquing each others lessons.

The point is that the design process is a highly creative endeavor built around instinct, hunches, and one's experiences rather than some formal rational process based on research evidence or theory. (Indeed, if there is in fact strong research evidence on how to solve a given problem, the problem would no longer exist.) Quite the contrary, the key to designing something that is likely to produce substantially better outcomes is to try a highly creative idea/practice and that has not been tried before.

The critical processes in the design and improvement of HOTS were the use of metaphor and persistent clinical tinkering. The key element was in picking the right metaphors initially. That was partly luck; but it was also a result of the intuitions and personal theories of action of the practitioners involved—as well as the openness and creativity of all involved.

Once the initial design was in place and the results of the initial pilots were promising, it then became possible to tap into some research that could elaborate and extend the initial findings. Some of the key work was Vygotsky's (1978) Theory of the "Zone of Proximal Development" which was supported by his own experimental data and was consistent with what we were seeing with HOTS students. This ex post facto application of research to explain and extend what was being found in the design is not how academicians tend to think about the application of research to improve practice. Indeed, now when I tell cognitive psychologists of the brain as a muscle metaphor they think that is "moronic". I tell them in response that… "It is not moronic but good design". At that point they generally turn away shaking their heads.

Similarities To The Design of Statway

I interviewed three of the original designers/conceptualizes of the Statway approach. While there were some differences between the Statway and HOTS design process, they were overshadowed by the many similarities such as:

- The initial design approaches were not driven by theory, but were driven primarily by metaphor, vision, instinct, and pragmatics based on the beliefs that (a) there was no point in trying to improve the existing failed approach, and (b) it was important to develop a very different approach if there was to be a "short-circuiting of the major problems that students were experiencing";

- A key element in the 'very different approach' was to find something that would engage the students. In the case of HOTS, students were told that they were in the program because they were considered to be potentially gifted students and that they would learn how to apply their considerable skills in solving video games to learning in school. Statway told students that what they were learning was "not math" or that it was not "high-school math", and that what they were learning would help them with all their other courses and provide critical career skills;

- Making sure that students experienced high levels of success initially;

- All the aspects of the intervention, e.g., curriculum and training, needed to have very clear and detailed specification;

- There was extensive development and iterative improvement of all aspects of the intervention;

- There was extensive reliance on basic traditional metrics to constantly measure the degree of improvement that was occurring and extensive field-based observation to identify implementation problems;

- No one had any idea of whether the interventions would actually work. Once the initial design approach was established the philosophy was let's try it out and see if it works and, if the initial results are promising, engage in continuous improvement;
- There were very promising results right from the very beginning;
- As the project scaled-up new adaptations became necessary and possible; and
- It was only after the design was in operation that research on student learning was brought to bear on solving problems or for enhancing the effects of the intervention.

Of course, once an intervention has been designed and implemented, the next step is to research its effectiveness.

Quantitative Methodology for DBR vs. the Traditional Model

Qualitative research is critical to the goal of continuous improvement in DBR projects. This section focuses on quantitative research because that is the research approach that differs the most from that of the traditional model.

Given the iterative nature of DBR implementation and the goal of substantial improvement, DBR research can use a much simpler and more authentic form of quantitative analysis. The traditional approach to research emphasizes a gold standard design study to compare the performance of students receiving the intervention to those that do not. The emphasis is on methodological controls to maximize *internal validity* by using a design that minimizes the possibility that the result may have been *caused* by variables/factors not included in the study. On the other hand, DBR usually uses mixed method research on repeated pilot study field tests using simple metrics of success and process during the iterative scale-up process as opposed to a single gold standard study. The purposes of the field tests are to determine (a) whether the intervention is having the desired effect, (b) what iterative improvements are needed to improve the outcomes and scalability, (c) the conditions/parameters of use needed for the intervention to be effective: e.g., the amount of intervention, grade level, types of students, etc., wherein the intervention is effective, and (d) the robustness and consistency of effects across diverse settings and students. The repeated field test research focuses on *external validity* to determine whether the intervention is scalable and whether the benefits are robust, i.e., sustained across diverse settings.

Producing substantial and consistent improvement in DBR research across diverse sites is more important than having adequate methodological controls or proving causation.

Finally, the best way to analyze outcomes is to simply see how the experimental students did on an absolute basis relative to an existing benchmark. This benchmark can be based on statewide, national, and/or local results. So the question becomes: Does the actual unweighted performance of the experimental students represent a substantial improvement compared to a benchmark, and can we say that their actual performance can be considered a success on an absolute basis? There is no need to compare an experimental and control group. This dramatically simplifies the analysis.

Focus on Determining the Parameters of Effectiveness

While traditional researchers seek to validate practice by conducting gold-standard research to establish that the intervention *caused* the outcome, NIC researchers need to conduct research in a way that enables them to determine the parameters of intervention effectiveness across multiple sites. In designing an intervention there are many parameters that can vary. How intensive does the intervention need to be? Which students benefit? What kinds of professional learning/development, curricular strategy, technology support, etc. work best. Trying to do experimental research around each of these concerns would be impossibly expensive and take forever. Equally problematic is that traditional experimental research cannot realistically determine which of the infinite possible combinations of the parameters work most effectively together. Nor are leaders seeking proof of *causality*. They need predictive and *external validity*. They need research to tell them the specific conditions, or parameters of implementation, under which an intervention is consistently effective within the uncontrolled environment that they deal with. They can then make an educated guess as to whether it will benefit their school(s).

The table below summarizes the methodological differences between the traditional approach to research and DBR.

Key Research Differences Between the Traditional Approach and Design-Based Research

	Traditional	Design-Based Research
Role of theory	Basis of the design of the intervention which is essentially a process of engineering from existing knowledge/theory.	Not as important as metaphor, intuition, experience, evidence

Type of research	Gold standard research Focus on *internal* validity	Series of pilot studies Focus on *external* validity/generalizability in the form of consistent BIG gains
Criteria of effectiveness	Statistically Significant ES Effect Size greater than .2	Substantial, consistent improvement Major reduction in the problem
Research approach	Establish causation via controlled experiments	Determine parameters of effectiveness via iterative expanding pilots

Embedded in this section are the following two heretical (to statisticians) ideas:

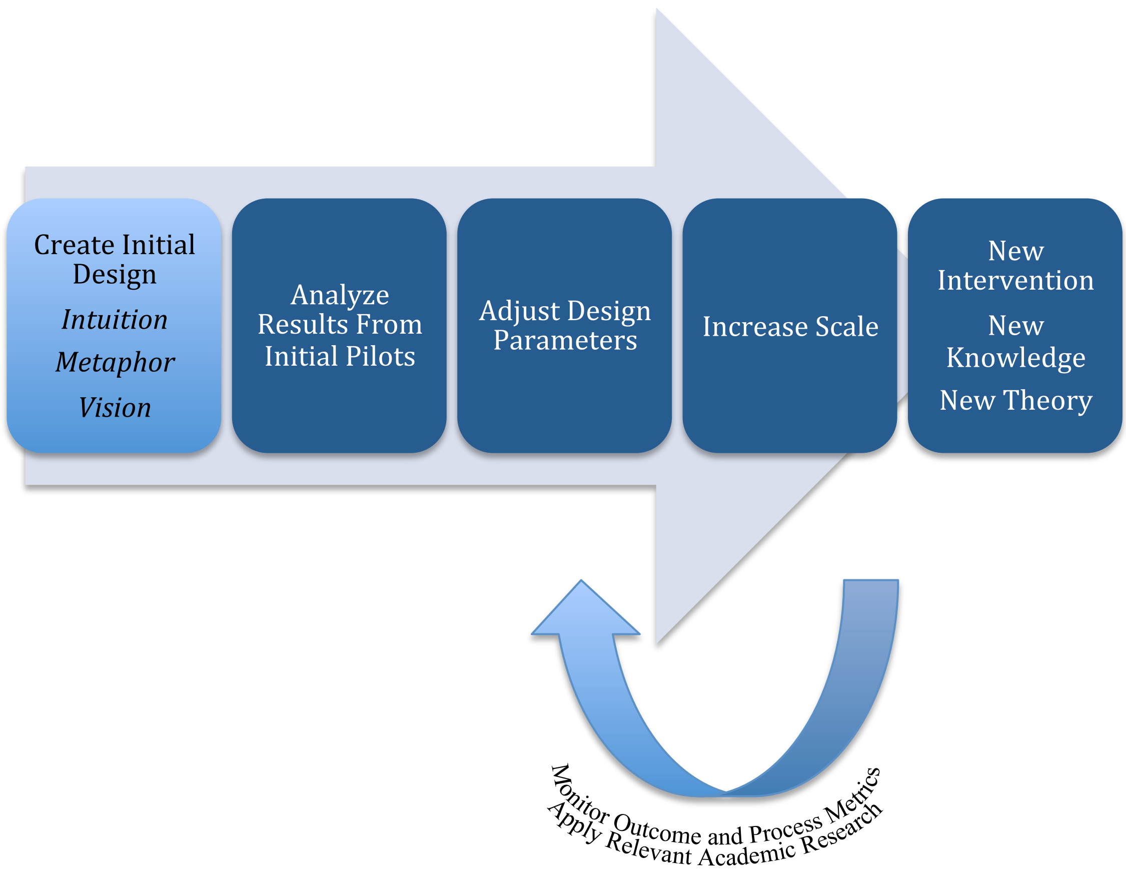
1) If research can show consistent substantial improvements relative to existing benchmarks of success there is no need for advanced statistics or randomized control groups to demonstrate that the findings did not occur by chance; and

2) When there are many choices, iterative tinkering is the best approach to finding an effective intervention.

These perspectives have been incorporated into the latest medical initiative—precision medicine. Kolata (2015) describes this new research effort as ”unlike previous efforts that looked for small differences between a new treatment and an older one…researchers are gambling on finding huge effects” (p. 2 of download). The article goes on to note that the scientists are finding a patient response rate to the new drugs of 50-60% as compared to existing treatments that give a response rate of only 10-20 percent. In addition, finding a substantial improvement over what currently exists in terms of tumor response rates is used as a substitute to randomized controls and sophisticated statistics to show that the effect is not happening by chance. *Furthermore, the Food and Drug Administration (FDA) is planning to approve new treatments on the basis of substantial improvements without randomized clinical controlled trials.* Kolata (2015) describes the approach to finding such large effects as “basket studies”. This is a trial and error process done with small samples of individuals to try and discover as many matches between one of many drugs to one of many types of tumors as possible. Trying to test each possible combination with a random experimental controlled trial would take way too long and be way too expensive. So an iterative trial and error process is used.

Figure 2 below summarizes the key characteristics of the non-traditional approach to innovation and discovery inherent in the NIC approach. The recommended improvement research methodology for NICs is a series of simple pilot studies without sophisticated research designs to study (a) whether there are substantial gains on some outcome (*practical significance*), (b) the degree of consistency of such success across sites and (c) the impact of iterative parameter adjustment across sites. The pilot studies can use simple statistical reporting of the outcomes at each site relative to some statewide or national benchmark such as the known existing dropout rate.

Figure 2
Characteristics of the NIC Approach to DBR



The Application of DBR and NIC to Leadership Practice

The concepts of DBR and NICs are very relevant to efforts by leaders to improve practice. Leaders are part of a community and are constantly looking for new and better ways to solve problems. Leaders also face the issue of scaling up practices that prove to be successful—either to more classrooms, departments, or schools. All good educators are tinkerers who are constantly redesigning approaches when faced with problems. Over the years I have met many educators who had indeed designed a novel and wonderful approach to something. This is an important source of innovation and a credit to our profession.

The biggest implication of the non-traditional approach of DBR for leadership practice is that when faced with a seemingly intractable problem, and there is no research that has practical significance on how to solve it, leaders should think of themselves as designers. They should commit to organizing and participating in the design of a very different approach. The most important elements of such design are to (a) change the context in which you are trying to solve the problem; i.e., simply doing more of the same is unlikely to solve the problem, (b) use intuition/metaphor to develop a completely original, creative approach, and (c) start small with 1-2 classes or 1-2 schools. Try to create a "design team" that includes one or more academicians subject to the condition that such individuals do not serve as "the" expert bringing the gift of knowledge. Rather, the process needs to be collaborative brainstorming with everyone contributing ideas and agreeing to move forward with the chosen design even though no one is sure what will happen. The key is for the design team to be committed to problem solving and learning together. If the initial results are not promising, quickly change course.

This is different from the typical leadership practice of implementing a new approach in an organization. Typically the leader "sells" the idea to others and is a/the key persuader to adopt the new approach, and needs to exude confidence that it will work. In the case of implementing the result of an intuitive DBR design, the leader has to signal that it is okay to not be sure whether it will work.

Clearly, you should not use the intuitive DBR strategy with every problem you face. However, somewhere in your mix of problems, there is one that would probably benefit from the DBR approach to innovation. There is no reason why you and your team cannot be the ones who invent a new highly effective approach.

The other significance for leadership practice is that DBR represents a shift away from a focus on change leadership and theories of change to a focus on leadership for improvement.

Conducting a Design-Based Research (DBR) Dissertation

The NIC approach to DBR provides a great context for quantitative EdD dissertations. It provides a basis for students who do not want to be statisticians to engage in quantitative analyss in which they apply their instincts to engage in a scientific process that has the potential to improve a practice they care about. Thus a DBR dissertation enables EdD students to apply quantitative and mixed methods research towards a valuable goal.

A DBR dissertation is one in which the student collaboratively designs a new intervention and studies its impact. A student (a) designs the intervention in collaboration with others, (b) negotiates its implementation, (c) collects pre-post data over some extended period of time, and (d) ideally engages in at least one iteration of the design based on preliminary empirical data. This differs from the more traditional evaluation dissertation in that the latter is usually conducted with a pre-existing intervention designed and implemented by others.

All of the following recommendations will follow the NIC branch of DBR dissertation and its use of the alternative pathways of scientific discovery. Such a dissertation should ideally involve leaders and practitioners from several schools/districts if possible—along with faculty. This would broaden the collaborative process, and increase the likelihood that the design is geared to trying to solve a broad problem as opposed to helping a single school solve a problem specific to its context.

Completing a DBR dissertation within a reasonable time frame requires careful programmatic planning. It is critical that there be at least one presentation about the potential of DBR in the first year of the program. My experience is that such a presentation can be done in less than 2 hours, and that students with prior and current leadership experience respond extremely positively, and a significant number begin to push to do a DBR dissertation. Once students express such interest faculty become more open to supporting such dissertations. Some EdD programs are starting to offer more substantial instruction in DBR.

Once information about DBR is presented in the first year of the program, it is ideal if students interested in doing a DBR dissertation have a design in mind by the end of the first summer, and implement the initial phase of the design in year 2 of their program. The iteration of the design can them be done in the third year. In the meantime students can typically use the emerging design and implementation and research experience with the initial pilot effort as the basis for papers in a variety of their courses.

The <u>ideal</u> design goals of a DBR dissertation are to:

- Set an ambitious improvement goal for the design, and
- Design something that has never been tried before.

These are not absolute goals, but ones that are consistent with the spirit of the NICs described earlier.

The first goal is useful for avoiding the need to engage in sophisticated quantitative analysis. While some push for doing some comparative analysis between an experimental and comparison group and then seeing if the Effect Size statistic is at least .2, this standard is clearly inadequate for leadership decision-making. Hattie (2009) notes that the average ES historically across al intervention research meta-analyses is .4—so why settle for .2. An important aspect of leadership practice to seek substantial improvement, and if there is obvious substantial improvement relative to some benchmark there is no need to conduct a sophisticated analysis or experimental design or calculate an Effect Size. However, there is no formula for clearly defining what substantial improvement is. This is something that should be negotiated among the participants in the project. For example, the goal is to reduce the suspension rate in a district, a reasonable ambitious goal would be to cut it in half. If 50% of the fourth graders are scoring below basic, try to get that percentage down to 30%—then see how close you can get to this goal on the initial pilot and subsequently on the first iteration of the intervention.

The setting of an ambitious improvement goal then informs the second design goal. Seeking extensive improvement requires a highly creative intervention. While existing research or theory can be used to inform the design of the intervention, it is questionable from the experience of the NICs as to whether that will provide the best chance to produce substantial improvement. The experience of the NICs is that the best chance is to design something that has never been tried before, as opposed to minor variations on a tried and untrue approach. The key is to get students or staff inspired. Creative insight or intuition from some life experience is essential. Any good practitioner has had such moments of inspiration when they wondered "what if." What if we tried this crazy idea or that one? What would happen. The DBR dissertation is an opportunity to test this creative thought—even if there is no research or theoretical basis.

The idea for using cyclonic action as the key to eliminating the vacuum bag and filter in the vaccum cleaner was happenstance. The idea came to Dyson while walking by a junkyard and observing a huge cyclonic tower and wondered if a smaller version could be made for use in a vacuum cleaner (Science Friday, 2014). As I mentioned earlier, the design for the HOTS teacher training came from my experience of being on sabbatical in LA and hanging out with some actors. Everyone has some unique happenstance life experiences, creative insight, or intuitions that can be brought to bear to come up with some original design for an intervention.

Another option for creating a design is to use an approach that has not been successful in the past as documented in the research literature, but which was implemented in a half-hearted fashion. That was the case with the previous failure of general thinking interventions. Indeed, all the general thinking research with k-12 students had involved a very short duration: in some cases as short as a day or two. That does not tell you whether general thinking development would work if the intervention was sustained over a longer period of time.

However, once the initial design idea is developed, existing research <u>can possibly</u> help with some of the initial parameter setting, or in the development of the supporting activities such as training and curriculum—or maybe not.

This process obviously requires a very different perspective on the part of faculty in terms of how they advise students doing a DBR dissertation. For example, while it is important for students to know the research and theory behind previous attempts to improve outcomes as part of the scholarship process of doing any dissertation, and while students may find some aspect of theory and/or research evidence helpful, it is not appropriate to require that the design of the intervention be based on such knowledge. Faculty need to (a) respect the alternative pathways to scientific discovery, and (b) at least one member of the dissertation committee should be someone who is involved in the collaborative discussions of establishing the design.

Structure of a DBR Dissertation

The following is a chapter by chapter description of some of the recommended key elements of each part of a DBR dissertation.

> *Chapter 1*—Identify the problem you are trying to solve. Pick a specific problem. For example, the first DBR dissertation that I am chairing involves trying to design a better approach for approximately 20 high school freshman and sophomores who are not responding to the school's existing array of supports. Trying to solve a problem such as "poor teaching" is way too general. Use primary source data wherever possible to describe the nature and extent of the problem you are trying to solve. Describe the extent of the problem in the setting the research will take place, and also in the broader context of district, state and national outcomes.
>
> *Chapter 2*—Use the literature review to, among other things, review the actual level of achievement different approaches to the problem have produced. This is harder to do than it seems since most quality research focuses on relative differences between groups after making a variety of adjustment to the Means of each group. Unless the researcher presents the unadjusted outcome Means for the experimental group it is impossible to determine how well the experimental students actually ended up doing. Indeed, just because an experimental group performs better than the comparison group in a research study does not necessarily indicate that it did well; or even better than your own students are already doing.
>
> *Chapter 3*—The key in this chapter is to describe the initial design of the intervention that will be implemented, the rationale for this approach, and the ambitious improvement goal being sought. As already discussed, the rationale does not have to be based on research or theory (though it can be). When you try a novel design there is no way to know whether it will actually work—and that is okay.
>
> The data analysis should consist of two phases—the initial pilot and then the testing of the iteratively improved version of the intervention. This chapter should describe the types of mixed data that will be collected at the end of the first phase of the intervention and at the end of the iterative phase. You want to have qualitative data for the formative evaluation. However, it is best if the qualitative work is primarily real-time observation as the intervention is being used. The summative evaluation should describe the basic statistical analysis that will be conducted to determine whether the benchmark improvement goal(s) is being met. This can probably be done with basic descriptive statistics. You are not trying to determine if benefits are merely statistically significant but whether there are widespread

substantial benefits. Such analysis is primarily what the practitioner community is most interested in. In addition, this is similar to the approach being taken by precision medicine.

However, if one intends to publish the results in a research journal, then a more sophisticated research design would be needed. Pogrow (2015) provides a simple way to learn the basics of research design and the associated statistics.

The sample will probably be a small sample of convenience. It is ideal if in the iteration phase the sample size increases somewhat to give it some scaling effect. In addition, it may be that the initial pilot may be of a shorter time duration than would be ideal given the time constraints of finishing the dissertation in a reasonable amount of time.

It is important to provide a good bit of detail about the intervention. One of the big problems in the educational research literature is that there is usually little information about the actual intervention that is being experimented with. Simply knowing that a study has researched the use of bilingual education, or balanced literacy, does not mean much if there is no information about the details of the design of the intervention. Multiple studies of bilingual education might have had very different approaches. So the description of the details of the intervention's design can be a strength of DBR dissertations. Part of the description of the design should indicate the sample to be served in the initial phase, and whether and how the scale will be increased for the iterative phase. The increase in scale can be minor: e.g., incorporating a few more classrooms, a few more grades, a few more teachers, etc.

Chapter 4—This chapter describes the results from the initial phase of implementation and how such data were used to change the design parameters for the iterative phase. Clearly, there needs to be a very quick analysis of the data from the first phase in order to have the revised design ready to be implemented for the iterative phase of the research. The chapter should then describe the data resulting from the iterative phase of the research.

Chapter 5—This chapter is dedicated to the student's reflections on whether the design met the benchmark improvement hoped for, and why it did or did not. Given the context of the realities of a dissertation there will not be sufficient scaling up experience to be able to say for certain how consistent results in other settings will be, or that the intervention *caused* the outcomes. However, that does not mean that the student cannot draw some interesting insights from the iterative experience during the dissertation process. If the results did meet the target benchmark, then the reflection is about why he/she thinks it worked, and the implications for theory and future research. The outcome may have confirmed or disconfirmed an existing theory, or the results may suggest the need for a new theory. If the design did not work, the reflection is about why he/she thinks it did not succeed, and whether it would be worthwhile to engage in additional iterations—and if so how the design should be modified for the next phase of the research. The value of the latter insights is that another student may want to pick up the torch and try to further improve the design, and/or the student might want to continue to refine the approach within his/her leadership role.

Summary and Conclusions

DBR is an emergent approach for designing and testing alternative approaches for improving practice that appears to be gathering momentum. The NIC version of the DBR movement, and its openness to the application of the alternative pathways to scientific discovery, appears to have the greatest potential. In addition, of all the programs in a college of education, DBR is probably most closely allied with the traditions and goals of the EdD. This means that Educational Leadership programs can take the lead in their colleges in promoting the ideas and ideals of DBR. This year is the first one where I have started to hear reports of educational leadership programs initiating coursework or units on DBR.

The purpose of this chapter has not been to suggest that programs should push their students to conduct DBR dissertations: only that EdD students should be made aware of the option of conducting such a dissertation early in their program and supporting students who choose to pursue that avenue of inquiry.

Clearly, supporting the type of EdD dissertation described in this chapter will require some adaptation on the part of faculty. Such adaptation and consideration should be done within the context of the general ongoing national effort to define the EdD dissertation as a rigorous but applied endeavor that is distinct from the PhD dissertation. Pogrow (2015) provides a comprehensive presentation of suggested desired characteristics of the EdD dissertation.

At the same time, adding the option for students to conduct a DBR dissertation is of value to programs and to expanding conceptions of leadership practice—even for students who do not choose that option—for the following reasons:

- DBR reaffirms that in this era in which sterile, rational conceptions of leadership decision-making driven by big data predominate, that there is still a place and need for intuition and individual creativity in leadership decision-making and research.

- Many students enter an EdD program with the desire to figure out a way to improve their school(s), and many of those have always harbored ideas in the back of their heads as to whether some very different type of approach they have thought of would work. A DBR dissertation provides a venue for such students to formally pursue and test such beliefs.

- DBR dissertations will increase the variety of interventions that are researched, and it can be expected that some will prove to be highly successful. This will increase the options available to leaders.

- DBR dissertations provide the ability for students to apply quantitative methods in a more authentic "continuous improvement" fashion that is consistent with how they will need to apply data in their leadership roles.

- DBR dissertations not only build on the wisdom and instincts of successful leaders, they also take advantage of EdD students' access to schools, students, teachers, and parents for conducting experiments that they believe in.

- DBR dissertations provide faculty with the opportunity to not only be involved in advising students, but to also have "skin in the game": i.e., they can be active participants in the collaborative design of the intervention.

For all these reasons, providing opportunities for students to explore the implications of DBR for practice and research, and for developing a dissertation, enriches EdD programs. It is not intended that such work replace the traditional model of research. Rather, DBR provides a broadened perspective of the conduct and application of research and scientific discovery to the improvement of education and leadership practice.

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