Science and Implementation

Please cite as:

Fixsen, D. L., Blase, K. A., & Van Dyke, M. (2018). Science and implementation. Chapel Hill, NC: Active Implementation Research Network. www.activeimplementation.org/resources

Science and Implementation

Dean L. Fixsen, Melissa Van Dyke, Karen A. Blase

Active Implementation Research Network

Implementation science is being developed for use in human services and other domains (Fixsen, Naoom, Blase, Friedman, & Wallace, 2005; Meyers, Durlak, & Wandersman, 2012; Tabak, Khoong, Chambers, & Brownson, 2012; Winter & Szulanski, 2001). While implementation science has been developing for some time (Saetren, 2005), in the last few decades it has begun to develop rapidly. For example, on December 15, 2018 a Google Scholar search for "implementation research" yielded 80,600 returns, 23% of them since 2014. A search for "implementation science" produced 46,100 returns with 40% of them since 2014. Rapid development can be attributed to recognition of the role of implementation in closing the science to service gap: the gap between substantial investments in developing effective innovations and the continuing need for significant improvements in health, education, and social services (Bryk, 2016; Kessler & Glasgow, 2011; Perl, 2011).

Given the increasing attention to implementation science, the purpose of this article is to explore implementation science as a science. The idea of science, and the use of the scientific method to test predictions and hypotheses to advance science are discussed in the practical contexts faced by implementation scientists.

What is Science?

The Merriam-Webster dictionary (https://www.merriam-webster.com/) defines *science* as the "system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method." The *scientific method* is defined as "principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses." In his book *The Invention of Science*, Wootton (2015, p. 393) says, "What makes it science is not that it provides an explanation but that it provides reliable predictions."

What is Implementation Science?

The Merriam-Webster dictionary defines *implement* as "to equip" and as a "device used in the performance of a task." In this sense, implementation science is the science of equipping people to perform tasks. After decades of study, Fixsen, Blase, Metz, and Van Dyke (2015) defines *implementation science* as "the study of factors that influence the full and effective use of innovations in practice. The goal of implementation science is not to answer factual questions about what is, but to determine what is required (mission driven)." That is, "to proceed from wonder to no wonder" as implementation knowledge is developed.

Theory

There are many things that may have some bearing on how to improve the impact of proven or developing interventions. Unfortunately, "may have" does not equate to "does" in science. "Scientific inquiry" demands more than speculation – a clearly stated theory that generates predictions (if … then) and testable hypotheses (Popper, 1963, 2002). There are multiple implementation frameworks (Meyers et al., 2012; Tabak et al., 2012) that could serve as a source of predictions (if-then) and hypotheses (explanations of if-then relationships).

For implementation science, the Improved Clinical Effectiveness through Behavioural Research Group (2006) distinguishes among grand theories, mid-range theories, and micro-theories. A mid-range theory is designed to guide empirical inquiry and is made up of relatively concrete concepts that are operationally defined and relatively concrete propositions that can be empirically tested. The implementation frameworks that have been developed can be considered mid-range theories of implementation.

Predictions and Hypotheses

If reliable predictions define science and if testing predictions is the work of scientists, then implementation science is a science to the extent that a) predictions are made and b) those predictions are tested in practice using the scientific method.

Predictions in the if-then logical format necessarily require a way to first produce the "if." In science, Wootton (2015) distinguishes between discovery and invention. If something already exists, a scientist or explorer can discover it. Gravity already existed before Galileo described the "law of fall" and Newton described it in a mathematical formula. In physics, chemistry, biology, and other "hard sciences" scientists can study natural phenomena that exist everywhere (e.g. every living thing has chromosomes that can be studied at any time; chemical elements already exist and are waiting to be observed). The independent variable often exists in nature.

On the other hand, inventions are new and do not exist in nature. In the so-called "soft sciences" the independent variable must be produced by the scientist. Unlike waiting for a solar eclipse to test Einstein's predictions of spacetime (Pasachoff, 2009), implementation scientists cannot wait for an expert implementation team (a postulated implementation independent variable) to form and begin to function then assess the outcomes. This may never happen in any predictable and assessable way.

Implementation Independent variables (if this …)

The independent variables in implementation science are inventions. To have an implementation science, implementation scientists must be able to produce the independent variable on demand so that predictions of its effects can be measured (if this, then that). At this point, soft-science increases in complexity. Consider the logic:

1. An implementation scientist must be able to produce the independent variable on demand (if this). For example, a prediction might be that if a high functioning implementation

team supports practitioners' use of an evidence-based program, then the practitioners will use the evidence-based program with high fidelity and good outcomes.

2. Production of the independent variable itself requires implementation knowledge and skill. For example, who produces implementation teams? How can they be produced reliably and effectively so they can be studied within an experimental design?

a. A contributor to the complexity of implementation science is that each independent variable required to test a prediction is, itself, a dependent variable in the context of a test of the prediction.

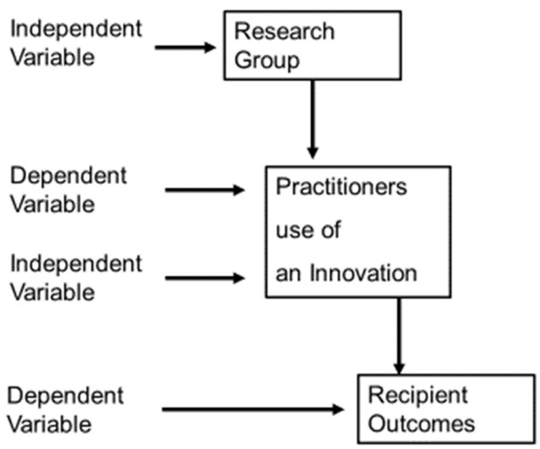

Figure 1. A logic model showing how a dependent variable at one level is an independent variable at the next level.

The overall logic is presented in Figure 1. A research group (the independent variable) must be sufficiently skilled in implementation practice to produce practitioners who use an innovation with fidelity (the dependent variable). At the next level, the practitioners' use of an innovation with fidelity (the independent variable) is assessed in terms of benefits to recipients (the dependent variable). In this example, the fidelity of practitioners' use of an innovation is both a dependent variable and an independent variable. Perhaps this dual role helps to explain the number of studies of fidelity and its role in producing desired outcomes and in analyzing outcome data (e.g. Bartley, Bright, & DePanfilis, 2017; Durlak & DuPre, 2008; Hurley, Lambert, Gross, Thompson, & Farmer, 2017; Naleppa & Cagle, 2010; Sanetti & Kratochwill, 2014; Tommeraas & Ogden, 2016).

Without an assessment of the fidelity of the implementation independent variable it is difficult to interpret the outcomes of intervention independent variables (Harvey, McCormack, Kitson, Lynch, & Titchen, 2018; Rycroft-Malone et al., 2018; Seers et al., 2018).

How, then, can implementation independent variables be produced on purpose so they are used in practice with fidelity? Perhaps by using implementation best practices to produce them? The circularity of developing implementation science as a science becomes apparent – some implementation knowledge and skill are required to produce implementation independent variables suitable for study.

This calls for a different perspective on developing theory and testing hypotheses and predictions in implementation science. For example, Galileo had a powerful (at that time) telescope built to enhance his observations of the night sky. However, he did not have to produce the stars that were the object of the observations. The difference is implementation scientists need to "produce the stars." That is, they need to produce high functioning implementation teams if they want to study implementation teams. The independent variable is not already there waiting to be observed.

To establish implementation independent variables, implementation science must rely on implementation practice. Fortunately, implementation practice has been developing and improving since the middle of the 20th century. Best practices have been summarized and operationalized and lists of best practices have been organized into coherent frameworks to guide implementation practice in human services and other fields (for recent examples, see: Allanson et al., 2017; Blanchard et al., 2017; Blase, Fixsen, Naoom, & Wallace, 2005; Fixsen et al., 2005; Glennan Jr., Bodilly, Galegher, & Kerr, 2004; Greenhalgh, Robert, MacFarlane, Bate, & Kyriakidou, 2004; Meyers et al., 2012; Øvretveit, Mittman, Rubenstein, & Ganz, 2017; Schoenwald & Garland, 2013). Implementation best practices are needed to establish implementation independent variables at the right time and place and with the quality required to test predictions and hypotheses.

Observation

Predictions in the if-then logical format require a way to observe the "then" to see if a prediction is disconfirmed in practice. When describing the invention of science, Wootton (2015, pp. 258-259) states that "Before the Scientific Revolution facts were few and far between: they were handmade, bespoke rather than mass produced, they were poorly distributed, they were often unreliable."… "Establishing facts depends upon instruments ... which have to be standardized." … "Precision was pointless when units of measurement were local." Centuries ago, telescopes and microscopes provided new ways to observe with clarity and precision that far exceeded human sensory capacity. Observation became reliable and repeatable from one group of scientists to another to inform science.

In implementation science, observation is a problem. If implementation independent variables must be produced, then there must be some way to detect the presence and strength of the independent variable in practice. Otherwise, the risk of Type III errors increases; that is, attempting to study the impact of a variable that does not exist in practice (Dobson & Cook, 1980). In implementation studies, the fidelity with which implementation supports are provided is an important factor. Pinnock et al. (2017) have proposed criteria for publishing research on implementation that include specific descriptions of intervention methods and outcomes, and specific descriptions of implementation methods and outcomes. These criteria hold promise for advancing the field.

Various measures do exist and typically fit the "handmade" and "often unreliable" versions that pre-date the Scientific Revolution. Lewis et al. (2015) catalogued 104 existing implementation-related measures and found them lacking in reliability, validity, and conceptual clarity. Proctor et al. (2011) described potential measures derived from a review of concepts in the literature. Of the eight proposed measures four relate to implementation (feasibility, fidelity, cost, sustainability), one relates to scaling (penetration), and the remainder concern the intervention (acceptability, adoption, appropriateness). Weiner et al. (2017) sought to remedy this situation by developing new implementation outcome measures that concern the innovation ("this EBP meets my approval;" "This EBP seems applicable"). A review of the implementation research literature noted that it was unusual for any measure to be used by more than one researcher

(Fixsen et al., 2005). Implementation science will progress when implementation measures permit reliable and replicable observations of implementation phenomena.

Conclusion

At this point, implementation science is approaching the criteria for being a science. It is not yet a "system of knowledge covering general truths" nor does it make regular predictions (if-then) that are tested in practice (then-what). In general, implementation research is poorly designed, does not systematically test theory, and has few ways to generate implementation variables on purpose to study hypotheses related to theory.

Yet, the field is on the cusp on rapid and dramatic development. Potentially powerful implementation variables have been identified and operationalized. The efforts of so many over the past half century are about to bear fruit.

References

Allanson, E. R., Tunçalp, Ö., Vogel, J. P., Khan, D. N., Oladapo, O. T., Long, Q., & Gülmezoglu, A. M. (2017). Implementation of effective practices in health facilities: a systematic review of cluster randomised trials. *BMJ Global Health, 2*(2). doi:10.1136/bmjgh-2016-000266

Bartley, L. H., Bright, C. L., & DePanfilis, D. (2017). Contributors to Fidelity of Child Welfare-Related Interventions: A Review. *Journal of Public Child Welfare, 11*(4-5), 433-463. doi:10.1080/15548732.2017.1340222

Blanchard, C., Livet, M., Ward, C., Sorge, L., Sorensen, T. D., & McClurg, M. R. (2017). The Active Implementation Frameworks: A roadmap for advancing implementation of Comprehensive Medication Management in Primary care. *Research in Social and Administrative Pharmacy, 13*(5), 922–929. doi:10.1016/j.sapharm.2017.05.006

Blase, K. A., Fixsen, D. L., Naoom, S. F., & Wallace, F. (2005). *Operationalizing implementation: Strategies and methods*. Retrieved from University of South Florida: National Implementation Research Network:

Bryk, A. S. (2016). Accelerating How We Learn to Improve. *Educational Researcher, 44*(9), 467-477. doi:10.3102/0013189X15621543

Dobson, L., & Cook, T. (1980). Avoiding Type III error in program evaluation: results from a field experiment. *Evaluation and Program Planning, 3*, 269 - 276.

Durlak, J. A., & DuPre, E. P. (2008). Implementation matters: A review of research on the influence of implementation on program outcomes and the factors affecting implementation. *American Journal of Community Psychology, 41*, 327-350. doi:10.1007/s10464-008-9165-0

Fixsen, D. L., Blase, K. A., Metz, A., & Van Dyke, M. (2015). Implementation science. In J. D. Wright (Ed.), *International encyclopedia of the social and behavioral sciences* (2nd ed., Vol. 11, pp. 695-702). Oxford: Elsevier, Ltd.

Fixsen, D. L., Naoom, S. F., Blase, K. A., Friedman, R. M., & Wallace, F. (2005). *Implementation research: A synthesis of the literature*. Tampa, FL: University of South Florida, National Implementation Research Network.

Glennan Jr., T. K., Bodilly, S. J., Galegher, J. R., & Kerr, K. A. (2004). *Expanding the reach of education reforms*. Santa Monica, CA: RAND Corporation.

Greenhalgh, T., Robert, G., MacFarlane, F., Bate, P., & Kyriakidou, O. (2004). Diffusion of innovations in service organizations: Systematic review and recommendations. *The Milbank Quarterly, 82*(4), 581-629.

Harvey, G., McCormack, B., Kitson, A., Lynch, E., & Titchen, A. (2018). Designing and implementing two facilitation interventions within the 'Facilitating Implementation of Research Evidence (FIRE)' study: a qualitative analysis from an external facilitators' perspective. *Implementation Science, 13*(1), 141. doi:10.1186/s13012-018-0812-z

Hurley, K. D., Lambert, M. C., Gross, T. J., Thompson, R. W., & Farmer, E. M. Z. (2017). The Role of Therapeutic Alliance and Fidelity in Predicting Youth Outcomes During Therapeutic Residential Care. *Journal of Emotional and Behavioral Disorders, 25*(1), 37-45. doi:10.1177/1063426616686756

Kessler, R. C., & Glasgow, R. E. (2011). A proposal to speed translation of healthcare research into practice: Dramatic change is needed. *American Journal of Preventive Medicine, 40*(6), 637-644.

Lewis, C. C., Fischer, S., Weiner, B. J., Stanick, C., Kim, M., & Martinez, R. G. (2015). Outcomes for implementation science: an enhanced systematic review of instruments using evidence-based rating criteria. *Implementation Science, 10*(1), 155. doi:10.1186/s13012-015-0342-x

Meyers, D. C., Durlak, J. A., & Wandersman, A. (2012). The quality implementation framework: A synthesis of critical steps in the implementation process. *American Journal of Community Psychology, 50*(3-4), 462-480. doi:10.1007/s10464-012-9522-x

Naleppa, M. J., & Cagle, J. G. (2010). Treatment fidelity in social work intervention research: A review of published studies. *Research on Social Work Practice, 20*(6), 674-681. doi:10.1177/1049731509352088

Øvretveit, J., Mittman, B., Rubenstein, L., & Ganz, D. A. (2017). Using Implementation Tools to Design and Conduct Quality Improvement Projects for Faster and More Effective Improvement. *International Journal of Health Care Quality Assurance, 0*(ja), 00-00. doi:doi:10.1108/IJHCQA-01-2017-0019

Pasachoff, J. M. (2009). Solar eclipses as an astrophysical laboratory. *Nature, 459*, 789. doi:10.1038/nature07987

Perl, H. I. (2011). Addicted to discovery: Does the quest for new knowledge hinder practice improvement? *Addictive Behaviors, 36*(6), 590-596. doi:10.1016/j.addbeh.2011.01.027

Pinnock, H., Barwick, M., Carpenter, C. R., Eldridge, S., Grandes, G., Griffiths, C. J., . . . for the StaRI Group. (2017). Standards for Reporting Implementation Studies: (StaRI) Statement. *British Medical Journal, 356*(16795).

Popper, K. (1963). *Conjectures and refutations: The growth of scientific knowledge*. New York: Harper Torchbooks.

Popper, K. (2002). *The logic of scientific discovery*. New York: Routledge.

Proctor, E. K., Silmere, H., Raghavan, R., Hovmand, P., Aarons, G., Bunger, A., . . . Hensley, M. (2011). Outcomes for Implementation Research: Conceptual Distinctions, Measurement Challenges, and Research Agenda. *Administration and Policy in Mental Health, 38*, 65-76. doi:10.1007/s10488-010-0319-7

Rycroft-Malone, J., Seers, K., Eldh, A. C., Cox, K., Crichton, N., Harvey, G., . . . Wallin, L. (2018). A realist process evaluation within the Facilitating Implementation of Research Evidence (FIRE) cluster randomised controlled international trial: an exemplar. *Implementation Science, 13*(1), 138. doi:10.1186/s13012-018-0811-0

Saetren, H. (2005). Facts and myths about research on public policy implementation: Out-of-fashion, allegedly dead, but still very much alive and relevant. *The Policy Studies Journal, 33*(4), 559-582.

Sanetti, L. M. H., & Kratochwill, T. (Eds.). (2014). *Treatment Integrity: A foundation for evidence-based practice in applied psychology* Washington, DC: American Psychological Association Press (Division 16).

Schoenwald, S. K., & Garland, A. F. (2013). A review of treatment adherence measurement methods. *Psychological Assessment, 25*(1), 146-156. doi:10.1037/a0029715

Seers, K., Rycroft-Malone, J., Cox, K., Crichton, N., Edwards, R. T., Eldh, A. C., . . . Wallin, L. (2018). Facilitating Implementation of Research Evidence (FIRE): an international cluster randomised controlled trial to evaluate two models of facilitation informed by the Promoting Action on Research Implementation in Health Services (PARIHS) framework. *Implementation Science, 13*(1), 137. doi:10.1186/s13012-018-0831-9

Tabak, R. G., Khoong, E. C., Chambers, D. A., & Brownson, R. C. (2012). Bridging research and practice: Models for dissemination and implementation research. *American Journal of Preventive Medicine, 43*(3), 337-350.

Tommeraas, T., & Ogden, T. (2016). Is There a Scale-up Penalty? Testing Behavioral Change in the Scaling up of Parent Management Training in Norway. *Administration and Policy in Mental Health and Mental Health Services Research, 44*, 203-216. doi:10.1007/s10488-015-0712-3

Weiner, B., Lewis, C. C., Stanick, C., Powell, B. J., Dorsey, C. N., Clary, A. S., . . . Halko, H. (2017). Psychometric assessment of three newly developed implementation outcome measures. *Implementation Science, 12*(1), 108. doi:10.1186/s13012-017-0635-3

Winter, S. G., & Szulanski, G. (2001). Replication as Strategy. *Organization Science, 12*(6), 730-743.

Wootton, D. (2015). *The invention of science: A new history of the scientific revolution*. New York: Harper Collins.