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Measurement Issues in Implementation Science



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Agenda

1. The importance of measurement in D&I
2. 10 Key Measurement Issues in D&I
3. Preliminary Results of SIRC Systematic Review of Instruments
4. Q & A



Importance of Measurement

- “Science *is* measurement”, but measurement is *not necessarily* science
- Strong measurement (i.e., good psychometrics) allows us to confidently interpret our findings as valid
- Achenbach (2005) said, “Without evidence based assessment, evidence based treatment may be like a magnificent house with no foundation.” (p. 547)



Importance of Measurement

Measurement...

1. Hinges on careful design to maximize internal validity
2. Allows for evaluation of our D&I efforts, sets stage for comparative effectiveness (Proctor & Brownson, 2012)
3. Enables cross study comparison
4. Facilitates building a D&I knowledge base
5. Allows for understanding the mechanisms and approaches responsible for change to ultimately improve public health impact (NIH, PAR RO1)
 - Critical for understanding the core effective components
 - Important for determining incremental utility of components



Importance of Measurement

Unfortunately,

- Grimshaw et al., (2006) reported that D&I strategy effectiveness, and what leads to effectiveness, cannot yet easily be evaluated *because* of measurement issues



Ten Key Measurement Issues in D&I

1. The role of psychometric properties
2. Frameworks, construct identification & definitions
3. What to measure, when, and at what level?
4. Need for communication and instrumentation
5. “Praiseworthy rush” challenges teams to create “homegrown” instruments
6. Instrument specificity and adaptation
7. Shared method bias & pitfalls of self-reports
8. Mixed methods
9. Practicality versus burdensomeness
10. Need for decision-making tools



Seattle Implementation Research Conference

- NIMH-funded biennial conference series
- Mission: Promote rigorous implementation research methodology
- Top priority for our core team:
 - Measurement Issues
 - Embarked on a systematic review of D&I instruments
 - ($N \sim 450$)



#1 Psychometric Properties

- Reliability is necessary but not sufficient component of validity
- Reliability:
 - is the reproducibility or consistency of scores from one assessment to another
 - Indicates items of a particular construct deliver consistent scores



#1 Psychometric Properties

- Validity: addresses whether interpretations are well-grounded and meaningful
 - Construct: degree to which instrument measures what it purportedly measures
 - Five sources of evidence to support validity:
 1. Content
 2. Response process
 3. Internal structure
 4. Relations to other variables
 5. Consequences



#1 Psychometric Properties

- Criterion-Related: degree to which instrument scores correlate with other instrument scores (typically gold standard)
 - Gold standards do not exist for majority of constructs in this field
- Predictive Validity: degree to which instrument scores correlate with scores on established instrument administered at some point in future
 - Need to understand what constructs in each stage predicts constructs or “outcomes” in subsequent or later stages



#2 Frameworks, Constructs, Definitions

- 61 Models (i.e., theories & frameworks)
 - Rated according to: (1) “D” vs “I”, (2) Socioeconomical framework level
 - Evidence synthesis results:
 - Broad models are most common and tended to be “D” focused; Definition: “contain constructs that are more loosely outlined/defined allowing researchers greater flexibility to apply to a wide array of D&I activities”
 - Majority of models ($n = 25$) categorized as “3” on 1=“broad” to 5=“operational” scale
 - Majority emphasized community ($n = 52$) and organization ($n = 59$) with only 8 addressing policy



CFIR Domains	Construct
Characteristics of Individuals	Knowledge & Beliefs about the Intervention Individual Stage of Change Individual Identification with Organization Other Personal Attributes Self-Efficacy
Inner Setting	Culture Implementation Climate Networks and Communications Readiness for Implementation Structural Characteristics
Intervention Characteristics	Adaptability Complexity Cost Design Quality and Packaging Evidence Strength and Quality Intervention Source Relative Advantage Triability
Outer Setting	Cosmopolitanism External Policy and Incentives Patient Needs and Resources Peer Pressure
Process	Engaging Executing Planning Reflecting and Evaluating

Consolidated Framework for Implementation Research

* *Note.* CFIR = Consolidated Framework for Implementation Research. Adapted from Damschroder, Aron, Keither, Kirsch, Alexander, & Lowery, 2009

<http://www.implementationscience.com/content/4/1/50/additional/>



Implementation Outcomes Framework	Construct
Service Outcomes	Effectiveness
	Efficiency
	Equity
	Patient-Centeredness
	Safety
	Timeliness
Client Outcomes	Function
	Satisfaction
	Symptomology
Implementation Outcomes	Acceptability
	Adoption
	Appropriateness
	Feasibility
	Fidelity
	Penetration
	Sustainability
	Cost

Implementation Outcomes Framework

* *Note.* Implementation Outcomes Framework; Adapted from Proctor, Landsverk, Aarons, Chambers, Glisson, & Mittman, 2009



#2 Frameworks, Constructs, Definitions

- Inconsistent, or lack of, definitions provided
 - Need a consensual common language (Michie, Fixsen, Grimshaw, & Eccles, 2009)
 - Validity of instrument hinges on construct, requiring clear definition as first step (Cook & Beckman, 2006)
- Consolidated Framework for Implementation Research Wiki
- Goal: to provide online collaborative space to refine and establish terms and definitions related to D&I
 - To promote consistent use of these terms and definitions
 - To provide a foundation on which a knowledge-base of findings related to implementation can be developed.



#2 Frameworks, Constructs, Definitions

- Inconsistent identification and evaluation of constructs limits cross-study comparison
- Construct definitions and synonyms
 - How different are:
 - ***Appropriateness***
 - Perceived Fit
 - Fitness
 - Relevance
 - Compatibility
 - Suitability
 - Usefulness
 - Practicality
 - Applicability



#2 Frameworks, Constructs, Definitions

- Important to present a model of the relation between constructs you intend to evaluate in D&I project
 - E.g.,
 - *Implementation success (low) = f of effectiveness (high/low) + acceptability (moderate) + cost (high) + sustainability (low)*



#3 What to measure, when?

- CFIR constructs = predictors, moderators, and mediators
(Damschroder et al., 2009)
- Implementation Outcomes = dependent variables
(Proctor et al., 2010)
 - Implicated at several stages of implementation
- RE-AIM framework constructs (e.g., reach, adoption, implementation, maintenance) = mediators
(Rabin, Brownson, Haire-Joshu, Kreuter, & Weaver, 2008)
- More recently Aarons, Hurlburt, & Horwitz (2011) as well as Wandersman, Chien, & Katz (2012) present models that help us to know *what to measure when*



#3 What to measure, when?

- Current state of the field
 - Studies not consistent (in terms of time frame) as to when constructs are measured
 - Others not reporting during what stage of implementation the instruments are administered

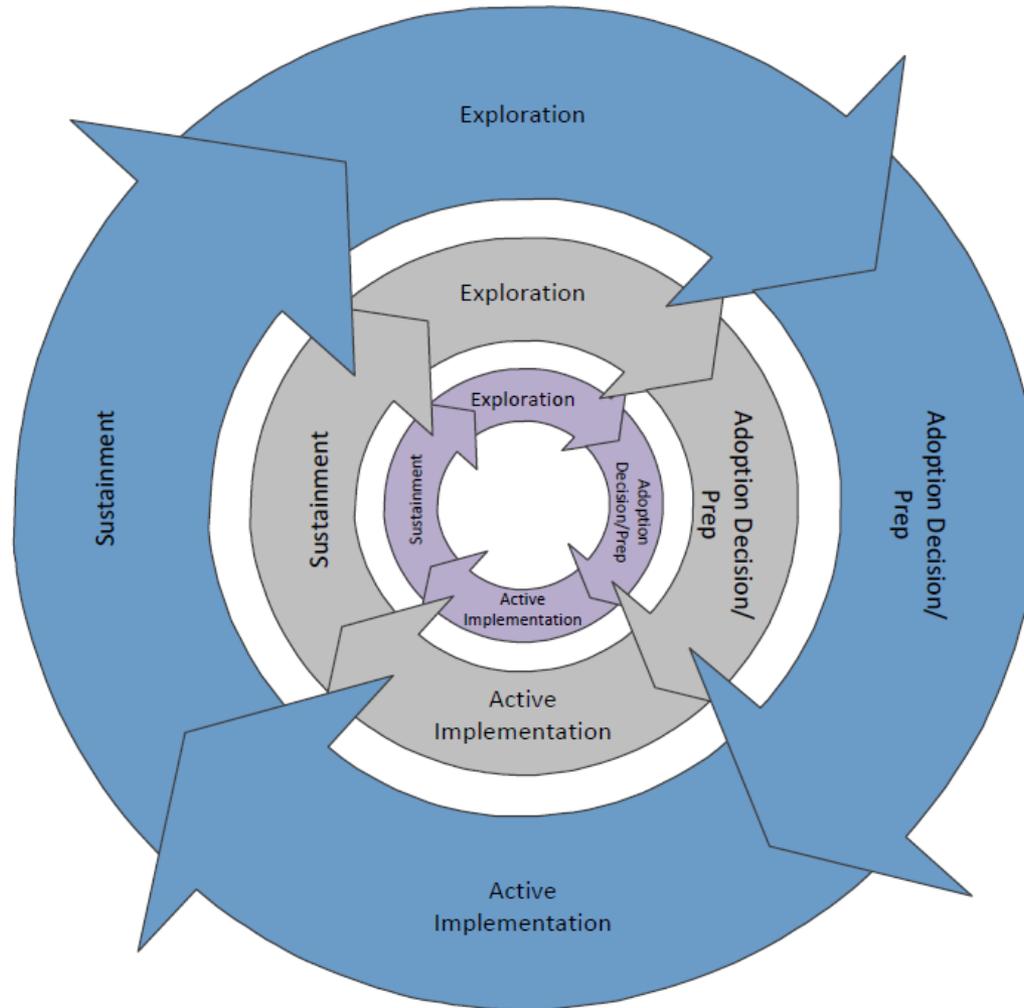


#3 What to measure, when & at what level

- Many of the conceptual papers have intentionally laid out the levels of analysis at which D&I constructs are relevant
 - Individual
 - Consumer, Provider, Management/Supervisor, Administration
 - Organization
 - Community
 - System
 - Policy



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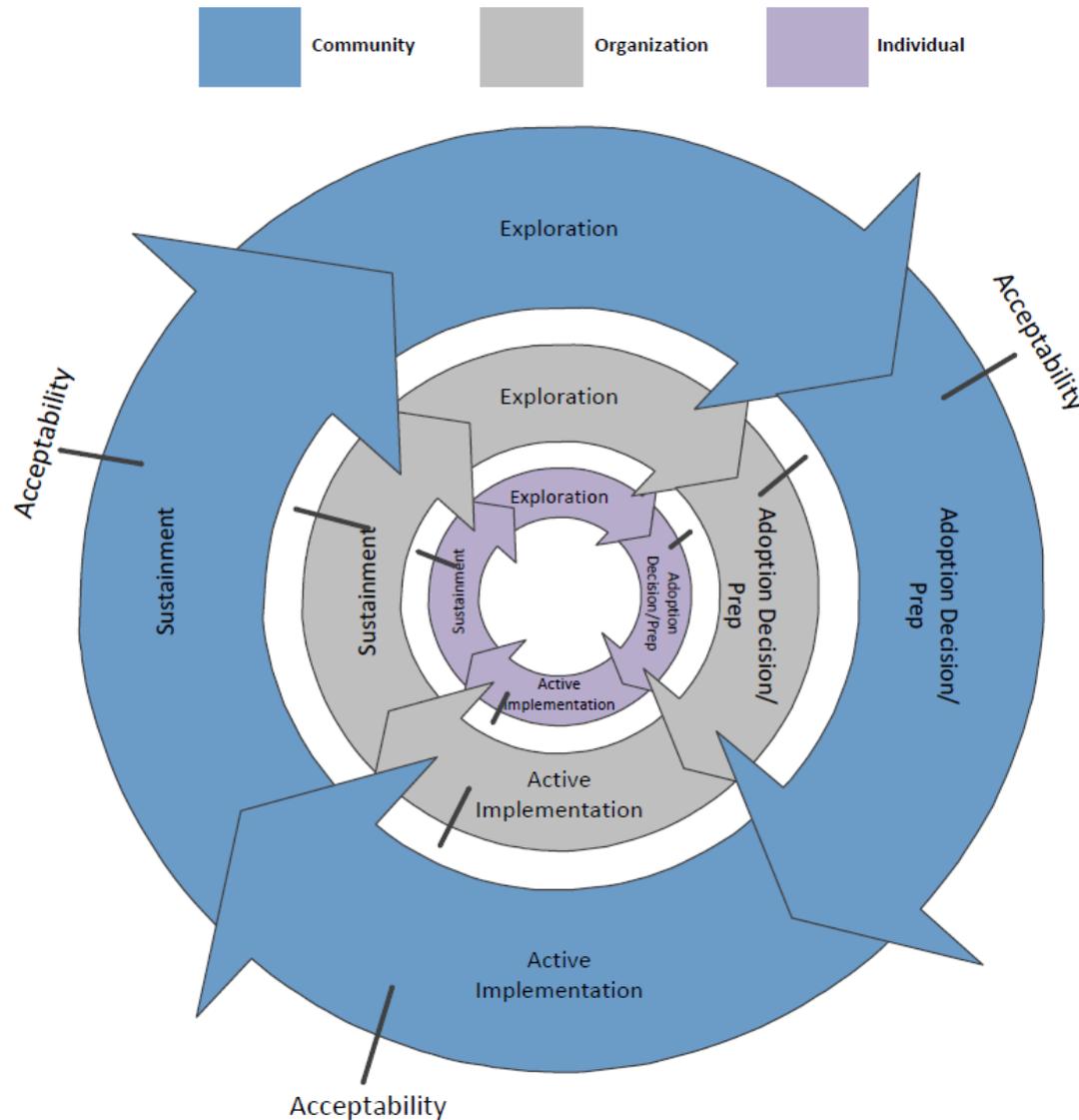


Temporal heuristic for thinking through measurement issues at multiple stakeholder levels



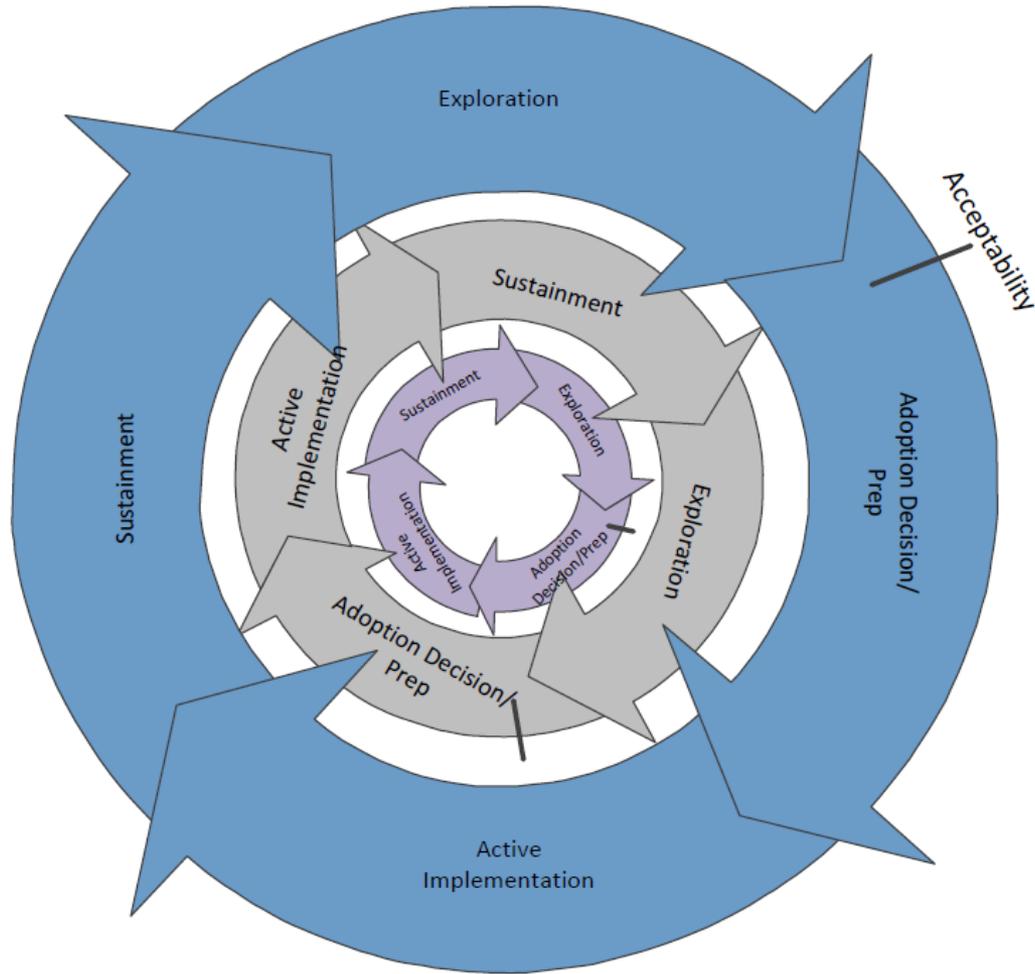
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Temporal heuristic for thinking through measurement issues at multiple stakeholder levels and across multiple stages of an implementation





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Temporal heuristic for thinking through measurement issues at multiple stakeholder levels and across multiple stages of an implementation, when stakeholders are not aligned within the process



#4 Need for Communication and Instrumentation

- SIRC aims to collect instruments ‘in development’ to avoid unnecessarily redundant efforts
- 54% of constructs are of high priority for instrument development

High Priority (<5 instruments)	Medium Priority (5-10 instruments)	Low Priority (10+ instruments)
Design Quality and Packaging (0)	RI: Leadership Engagement (5)	Safety (11)
Engaging: Formally Appointed Internal Implementation (0)	Penetration (5)	Networks & Communications (12)
Engaging: Champions (0)	Evidence Strength and Quality (6)	Satisfaction (client) (12)
Executing (0)	Appropriateness (Applicability) (7)	Feasibility (15)
External Policy & Incentives (0)	Patient Needs and Resources (Needs Assessment) (7)	IC: Learning Climate (15)
IC: Goals and Feedback (0)	Individual Stage of Change (7)	Readiness for Implementation (RI) (18)
Intervention Source (0)	Sustainability (8)	Client Satisfaction (19)
Peer Pressure (0)	Relative Advantage(Innovativeness) (9)	Reflecting and Evaluating (Workshop evaluation) (20)
Adaptability (1)	Individual Identification with Organization (9)	Combined (Functioning , Context) (21)
Cosmopolitanism (1)		Culture (21)
Effectiveness (1)		Implementation Climate (IC) (23)
Engaging (1)		Adoption (Uptake, Knowledge Translation) (24)
Engaging: External Change Agents (1)		Planning(Conceptualization) (28)
IC: Compatability (1)		Other Personal Attributes(Demographics) (33)
IC: Relative Priority (1)		Acceptability (52)
		Knowledge & Beliefs about the Intervention (Attitudes, Beliefs, Perceived Barriers) (56)
IC: Tension for Change (2)		
RI: Available Resources (2)		
RI: Access to Knowledge and Information (Basic Knowledge) (2)		
Structural Characteristics (2)		
Cost (3)		
Complexity (3)		
Engaging: Opinion Leaders (3)		
Trialability (3)		
Feasibility (Transferability, Disseminability) (4)		
IC: Organizational Incentives & Rewards (4)		
Self-Efficacy (4)		



#5 'Homegrown' Instruments

- Due to “praiseworthy rush” to implement evidence based interventions, we have observed an influx in ‘homegrown’ instruments
 - ‘Homegrown’ loosely defined: Developed in haste without systematically using theory, not engaging in the necessary steps of appropriate instrument development, notably without conducting tests of psychometrics
 - 41% of SIRC’s Implementation Outcomes repository ($N = 92$) fall within this definition of ‘homegrown’



#5 Stages of Instrument Development

- Item generation
 - Borrow from related instruments with good psychometrics
 - Review literature relevant to construct
 - Discuss with working group
 - Subject to expert review
 - Establish rating scheme
- Pilot instrument
 - Solicit suggestions for modification
 - Refine and narrow item pool
 - Subject to second expert review



#5 Stages of Instrument Development

- Establish Psychometrics
 - Exploratory factor analysis on random halves of a large sample, EFA followed by CFA to assess structural validity
 - Examine: internal consistency
 - Evaluate instrument with respect to already established instruments to assess:
 - convergent, divergent, concurrent validity



#6 Instrument Specificity and Adaptation

- Certain constructs tend to necessarily be intervention-, population-, or setting-specific
 - Intervention-specific: Fidelity
 - Population-specific: Client outcomes
 - Setting-specific: Patient needs and resources
- Makes it challenging to compare across studies
- Countless research teams are adapting instruments
 - In ways that affect psychometrics
 - Without delineating how it has been adapted



#7 Shared Method Bias and Pitfalls of Self-reports

- Shared method bias particularly problematic when predictor and criterion data obtained from same person
- Capitalize on opportunities for direct observation or independent assessor as opposed to relying on self-report
 - Minimize burden



#7 Shared Method Bias and Pitfalls of Self-reports

- Self-report is less accurate for particular D&I constructs such as adherence
- Self-report
 - Provides restricted range of content
 - Can be influenced by intentional false reporting or presentation bias
 - Subject to inattentive responding
 - Cognitive or memory limits
 - Differential responding due to unintentional item ambiguity



#8 Mixed Methods: What is the role of this in D&I?

- To provide better understanding than either approach alone
 - Qualitative: exploratory, to gain a deeper understanding
 - Quantitative: test hypotheses
- Range of mixed method designs from simple to complex, dependent on stage of implementation



#9 Practicality versus Burdensomeness

- Factors to consider in terms of practicality
 - Cost
 - Accessibility (in the public domain?)
 - Length/burdensomeness
 - User friendly
 - Applicable
 - Scoring

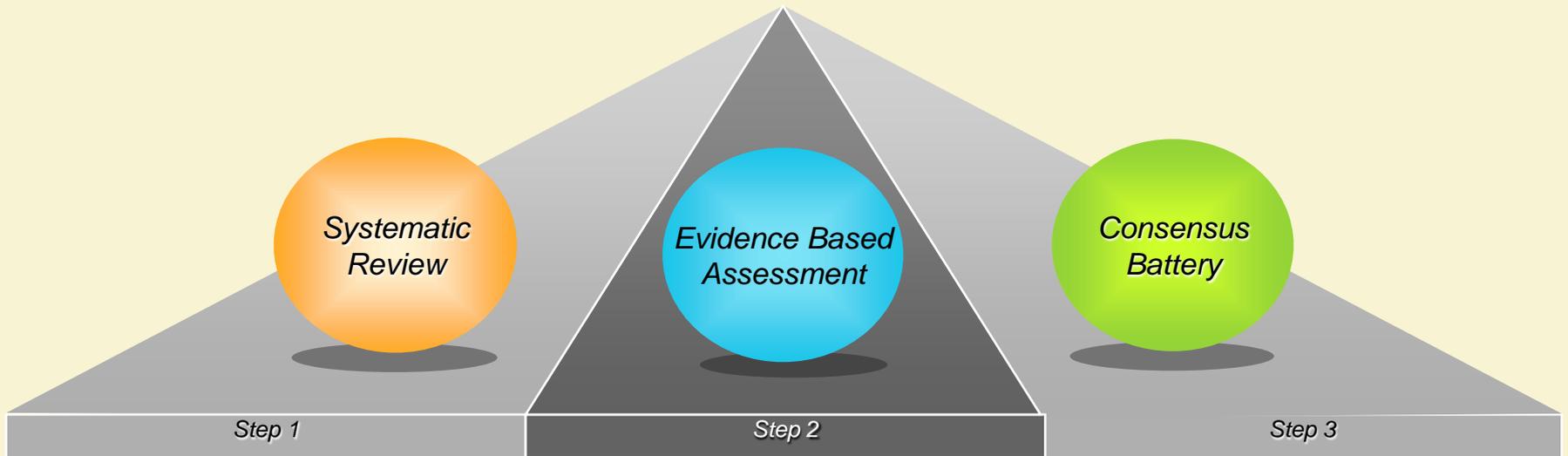


#10 Need for Decision Making Tools

- Some constructs (e.g., culture, $n = 21$) have several instruments from which to select, 3 of which have the same name
- Factors influencing instrument choice
 - Theory
 - Previous Research
 - Psychometrics
 - Practicality of instruments
- Grid-Enabled Measures Project
- SIRC Systematic Review of Instruments Project



Instrument Repository



Goals



SIRC Systematic Review of Instruments

- Build capacity
 - University of Montana, North Carolina, Indiana
 - Task Force of approximately 60 members
- Information gathering:
 - Systematic review of constructs
 - Systematic review of specific instruments





SIRC Systematic Review of Instruments

- Evidence Based Assessment Criteria
 - Hunsley & Mash, 2010
 - Terwee, Bot, De Boer, et al., 2007
- Core criteria
 - Validity – structural + predictive
 - Reliability – internal consistency
 - Usability – number of items
- If at least “good” (score of 3 on 5-point scale) on core then additional criteria applied
 - Norms, responsiveness (i.e., sensitivity to change)



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SIRC Instrument Review Project

<http://www.seattleimplementation.org/sirc-projects/sirc-instrument-project/>



	Theoretical	Empirical	Psychometric	Practical
1. Psychometric Properties	Carefully define constructs to be sure that core features/ components are made clear	Be certain to have the sample size necessary to maximize evaluation of psychometrics particularly with new instrument	Evaluate and explicitly report both reliability and validity	Prioritize instruments with strong psychometrics (and fewest number of items as a marker of practicality)
2. Frameworks, Construct Identification & Definitions	Identify a theory to guide the project and contribute to evaluation of said theory through careful measurement; Use shared/consensus definitions of constructs wherever possible	Evaluate models of D&I to determine relation between constructs; Determine if nuanced terms are distinct constructs or synonyms	Contribute to the literature by using previously established instruments when conceptually and theoretically appropriate	Consider measuring the key constructs relevant to the D&I effort with a focus on mechanisms of change
3. What to measure, when, and at what level?	Determine at which level of analysis each construct is implicated; Use theory and empirical evidence to inform what should be measured when	Report exactly at what stage/time and level of analysis each construct was measured	Carefully consider the role of predictive validity (and concurrent, convergent, divergent)	Carefully define D&I model being tested to be clear on top priority constructs to measure
4. Need for Communication & Instrumentation	Search carefully for instruments tapping synonyms for constructs of interest; Avoid modifying scales	If scale modification is necessary report specifically how it was modified	Carefully report all potentially meaningful statistics (e.g., norms, internal consistency) for the specific sample	Consider sharing psychometrically valid instruments with GEM or SIRC initiatives
5. "Homegrown" Instruments versus Rigorous Test Development	Carefully define constructs to be sure that core features/ components are made clear	Consider engaging a test developer if high priority construct without established instrumentation identified	Evaluate and report psychometrics of "homegrown" instruments if administered	Avoid use of "homegrown" instruments for core constructs
6. Instrument Specificity versus Adaptation	Consider assessing core D&I constructs in reproducible ways to test and inform theory development	If scale modification is necessary report specifically how it was modified	Conduct psychometric analyses (e.g., to assess structural validity) whenever possible	Choose to adapt an instrument if possible over generating entirely new one
7. Shared Method Bias & Pitfalls of Relying Solely on Self-Report	Try to assess constructs that tap higher levels of analysis (e.g., organizational readiness) appropriately as opposed to drawing inferences about individual perspectives	Consider observations in addition to surveys	Understand the influence of psychometrics on the variables in the study	Consider alternative ways to measure constructs in addition to self-report to reduce problem of common method bias, or measure at different time points
8. The Role of Mixed Methods	Contribute to theory development by employing mixed methods to deepen our understanding of less established constructs	Consider the specific role and utility of qualitative and quantitative data depending on the stage of the project and the design	Employ experts, particularly with respect to qualitative data analysis to strengthen inferences made	Carefully define role and purpose to maximize utility of mixed method design
9. Practicality to Promote Stakeholder Engagement	Consider only assessing core D&I constructs theorized to be essential mechanisms of change relevant to the question/study, potentially based on previous research	Consider using instruments that have well-established psychometrics to maximize the potential of the study to contribute to knowledge base & be confident in interpretations made	Do not ignore psychometrics in favor of practicality because psychometrics reflect the capacity to accurately interpret scores	Strive for developing the shortest instruments possible; Identify psychometrically sound alternatives when cost prohibits use of well-established instrument
10. Decision-Making Aids	Carefully define constructs to be sure that core features/ components are made clear and the instrument selected taps the intended features	Consider using instruments that have been well-established to further contribute to the knowledge base	Assess psychometrics of "competing" instruments and use the most reliable and valid	Consider prioritizing strong psychometrics wherever possible



Acknowledgements

- SIRC Core Team



- Cameo Borntrager



- Bryan Weiner



- TRIP Lab



	Theoretical	Empirical	Psychometric	Practical	Notes
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10. Decision-Making Aids	Carefully define constructs to be sure that core features/components are made clear and the instrument selected taps the intended features	Consider using instruments that have been well-established to further contribute to the knowledge base	Assess psychometrics of “competing” instruments and use the most reliable and valid	Consider prioritizing strong psychometrics wherever possible	
Notes					

Suggested Readings/Reference List

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