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Innovations in Mixed Methods Evaluations

Lawrence A. Palinkas,[1] Sapna J. Mendon,[1] and Alison B. Hamilton[2,3]

[1]Department of Children, Youth and Families, Suzanne Dworak-Peck School of Social Work, University of Southern California, Los Angeles, California 90089, USA; email: Palinkas@usc.edu, smendon@usc.edu

[2]UCLA Department of Psychiatry and Biobehavioral Sciences, University of California, Los Angeles, California 90024-1759, USA; email: alisonh@ucla.edu

[3]VA Center for the Study of Healthcare Innovation, Implementation, and Policy, VA Greater Los Angeles Healthcare System, Los Angeles, California 90073, USA

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Abstract

Mixed methods research—i.e., research that draws on both qualitative and quantitative methods in varying configurations—is well suited to address the increasing complexity of public health problems and their solutions. This review focuses specifically on innovations in mixed methods evaluations of intervention, program or policy (i.e., practice) effectiveness, and implementation. The article begins with an overview of the structure, function, and process of different mixed methods designs and then provides illustrations of their use in effectiveness studies, implementation studies, and combined effectiveness–implementation hybrid studies. The article then examines four specific innovations: procedures for transforming (or "quantitizing") qualitative data, application of rapid assessment and analysis procedures in the context of mixed methods studies, development of measures to assess implementation outcomes, and strategies for conducting both random and purposive sampling, particularly in implementation-focused evaluation research. The article concludes with an assessment of challenges to integrating qualitative and quantitative data in evaluation research.

INTRODUCTION

As in any field of science, our understanding of the complexity of public health problems and the solutions to these problems has required more complex tools to advance that understanding. Among the tools that have gained increasing attention in recent years in health services research and health promotion and disease prevention are designs that have been referred to as mixed methods. Mixed methods is defined as "research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry" (30). However, we qualify this definition in the following manner. First, integration may occur during the design and data collection phases of the research process in addition to the data analysis and interpretation phases (17). Second, mixed methods is often conducted by a team of investigators rather than by a single investigator; each member contributes specific expertise to the process of integrating qualitative and quantitative methods. Third, a program of inquiry may involve more than one study, but the studies are themselves linked by the challenge of answering a single question or set of related questions. Finally, the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than does either approach alone (17, 59, 71). In a mixed methods design, each set of methods plays an important role in achieving the project's overall goals and is enhanced in value and outcome by its ability to offset the weaknesses inherent in the other set and by its engagement with the other set of methods in a synergistic fashion (73, 86, 88).

Although mixed methods research is not new (72), the use of mixed methods designs has become increasingly common in the evaluation of the process and outcomes of health care intervention, program or policy effectiveness, and implementation (63–65, 67). A number of guides for conducting mixed methods evaluations are available (16, 39, 65). In this article, we review some recent innovations in mixed methods evaluations in health services effectiveness and implementation. Specifically, we highlight techniques for "quantitizing" qualitative data, applying rapid assessment procedures to collecting and analyzing evaluation data, developing measures of implementation outcomes, and sampling study participants in mixed methods investigations.

CHARACTERISTICS OF MIXED METHODS DESIGNS IN EVALUATION RESEARCH

Several typologies exist in mixed methods designs, including convergent, explanatory, exploratory, embedded, transformative, and multiphase designs (17). These, along with other mixed methods designs in evaluation research, can be categorized in terms of their structure, function, and process (1, 4, 62, 63, 65, 73).

Quantitative and qualitative methods may be used simultaneously (e.g., QUAN + qual) or sequentially (e.g., QUAN → qual), with one method viewed as dominant or primary and the other viewed as secondary (e.g., QUAL + quan) (59), although equal weight can be given to both methods (e.g., QUAN + QUAL) (17, 64, 70). Sequencing of methods may also vary according to the phase of the research process such that quantitative and qualitative data may be collected (dc) simultaneously (e.g., $QUAN_{dc}$ + $qual_{dc}$) but analyzed (da) sequentially (e.g., $QUAN_{da}$ → $qual_{da}$). However, data collection and analysis of both methods occur in iterative fashion (e.g., $QUAN_{dc/da}$ → $qual_{da}$ → $QUAN2_{dc/da}$).

In evaluation research, mixed methods designs have been used to achieve different functions. Palinkas and colleagues (63, 65) identified five such functions: (*a*) convergence, where one type of data is used to validate or confirm conclusions reached from analysis of the other type of data (also known as triangulation), or the sequential quantification of qualitative data (also known as transformation) (17); (*b*) complementarity, where quantitative data are used to evaluate outcomes

while qualitative data are used to evaluate process or qualitative methods are used to provide depth of understanding and quantitative methods are used to provide breadth of understanding; (*c*) expansion or explanation, where qualitative methods are used to explain or elaborate on the findings of quantitative studies but may also serve as the impetus for follow-up quantitative investigations; (*d*) development, where one method may be used to develop instruments, concepts, or interventions that will enable the use of the other method to answer other questions; and (*e*) sampling (80), the sequential use of one method to identify a sample of participants for use with the other method.

The process of integrating quantitative and qualitative data occurs in three forms: merging, connecting, and embedding the data (17, 63, 65). In general, quantitative and qualitative data are merged when the two sets of data are used to provide answers to the same questions, connected when used to provide answers to related questions sequentially, and embedded when used to provide answers to related questions simultaneously.

ILLUSTRATIONS OF MIXED METHODS DESIGNS IN EVALUATION RESEARCH

To demonstrate the variations in structure, function, and process of mixed methods designs in evaluation, we provide examples of their use in evaluations of intervention or program effectiveness and/or implementation. Some designs are used to evaluate effectiveness or implementation alone, whereas other designs are used to conduct simultaneous evaluations of both effectiveness and implementation.

Effectiveness Studies

Often, mixed methods designs are applied in the evaluation of program effectiveness in quasi-experimental and experimental designs. For instance, Dannifer and colleagues (25) evaluated the effectiveness of a farmers market nutrition education program using focus groups and surveys. Grouped by the number of classes attended (none, one class, more than one class), a control group of market shoppers was asked about attitudes, self-efficacy, and behaviors regarding fruit and vegetable preparation and consumption ($QUAN_{dc} \rightarrow qual_{dc}$). Bivariate and regression analyses examined differences in outcomes as a function of the number of classes attended, and qualitative analysis was based on a grounded theory approach (14). By connecting the results ($QUAN_{da} \rightarrow qual_{da}$), qualitative findings were used to expand results from quantitative analysis with respect to changes in knowledge and attitudes.

In other effectiveness evaluations, quantitative methods are used to evaluate program or intervention outcomes, while mixed methods plays a secondary role in the evaluation of process. For example, Cook and colleagues (13) proposed to use a stepped-wedge randomized design to examine the effect of an alcohol health champions program. A process evaluation will explore the context, implementation, and response to the intervention using mixed methods ($quan_{dc} + qual_{dc}$) in which the two types of data are merged ($qual_{da} \rightarrow \leftarrow qual_{da}$) to provide a complementary perspective on these phenomena.

Implementation Studies

As with effectiveness studies, studies that focus solely on implementation use mixed methods to evaluate process and outcomes. Hanson and colleagues (42) describe a design for a nonexperimental study of a community-based learning collaborative (CBLC) strategy for implementing trauma-focused cognitive behavioral therapy (12) by promoting interprofessional collaboration between child welfare and child mental health service systems. Quantitative data will be used to

assess individual- and organization-level measures of interpersonal collaboration (IC), interorganizational relationships (IOR), penetration, and sustainability. Mixed quantitative/qualitative data will then be collected and analyzed sequentially for three functions: (*a*) expansion to provide further explanation of the quantitative findings related to CBLC strategies and activities (i.e., explanations of observed trends in the quantitative results; $quan_{dc} \rightarrow QUAL_{dc/da}$); (*b*) convergence to examine the extent to which interview data support the quantitative monthly online survey data (i.e., validity of the quantitative data; $QUAN_{da} \rightarrow \leftarrow qual_{da}$); and (*c*) complementarity to explore further factors related to sustainment of IC/IOR and penetration/use outcomes over the follow-up period ($QUAN_{da} + QUAL_{da}$). Taken together, the results of these analyses will inform further refinement of the CBLC model.

Hybrid Designs

Hybrid designs are intended to efficiently and simultaneously evaluate the effectiveness and implementation of an evidence-based practice (EBP). There are three types of hybrid designs (20). Type I designs are focused primarily on evaluating the effectiveness of the intervention in a real-world setting, whereas assessing implementation is secondary. Type II designs give equal priority to an evaluation of intervention effectiveness and implementation, which may involve a more detailed examination of the implementation process. Type III designs are focused primarily on the evaluation of an implementation strategy; as a secondary priority, they may evaluate intervention effectiveness, especially when intervention outcomes may be linked to implementation outcomes.

In hybrid 1 designs, quantitative methods are typically used to evaluate intervention or program effectiveness, while mixed methods designs are used to identify potential implementation barriers and facilitators (38) or to evaluate implementation outcomes such as fidelity, feasibility, and acceptability (29) or reach, adoption, implementation, and sustainability (79). For instance, Broder-Fingert and colleagues (7) plan to simultaneously evaluate effectiveness and collect data on implementation of a patient navigation intervention to improve access to services for children with autism spectrum disorders in a two-arm randomized comparative effectiveness trial. A mixed methods implementation evaluation will be structured to achieve three aims that will be carried out sequentially, with each project informing the next ($QUAL_{da/da} \rightarrow QUAL_{dc/da} \rightarrow QUAN_{dc/da}$). Data will also converge in the final analysis ($QUAL_{da} \rightarrow \leftarrow QUAN_{da}$) for the purpose of triangulation.

Mixed methods has been used in hybrid 2 designs to evaluate both processes and outcomes of program effectiveness and implementation (19, 50, 78). For instance, Hamilton and colleagues (41) studied an evidence-based quality improvement approach for implementing supported employment services at specialty mental health clinics in a site-level controlled trial at four implementation sites and four control sites. Data collected included patient surveys and semistructured interviews with clinicians and administrators before, during, and after implementation; qualitative field notes; structured baseline and follow-up interviews with patients; semistructured interviews with patients after implementation; and administrative data. Qualitative results were merged to contextualize the outcomes evaluation ($QUAN_{da/dc} + QUAL_{da/dc}$) for complementarity.

Hybrid 3 designs are similar to implementation-only studies described above. While quantitative methods are typically used to evaluate effectiveness, mixed methods designs are used to evaluate both process and outcomes of specific implementation strategies (23, 87). For instance, Lewis et al. (51) conducted a dynamic cluster randomized trial of a standardized versus tailored measurement-based care (MBC) implementation in a large provider of community care. Quantitative data were used to compare the effect of standardized versus tailored MBC implementation on clinician- and client-level outcomes. Quantitative measures of MBC fidelity and qualitative data on implementation barriers obtained from focus groups were simultaneously mixed in

a QUAL + QUAN structure, in which the two sets of data were connected so that the qualitative data could expand on the findings of the quantitative analyses.

PROCEDURES FOR COLLECTING QUALITATIVE DATA

Mixed methods evaluations often require timely collection and analysis of data to provide information on the intervention itself or the strategy used to successfully implement the intervention. One such method is a technique developed by anthropologists known as rapid assessment procedures. This approach is designed to provide depth on the understanding of the event and its community context, which is critical to the development and implementation of more quantitative approaches involving the use of survey questionnaires and diagnostic instruments (5, 84).

With a typically shorter turnaround time, qualitative researchers in implementation science have turned toward rapid analysis techniques in which key concepts are identified in advance to structure and focus the inquiry (33, 40). In the rapid analytic approach used by Hamilton (40), main topics (domains) are drawn from interview and focus group guides, and a template is developed to summarize transcripts (33, 49). Summaries are analyzed using matrix analysis, and key actionable findings are shared with the implementation team to guide further implementation (e.g., the variable use of implementation strategies) in real time, particularly during phased implementation research such as in a hybrid 2 study (20).

Rapid assessment procedures have been used in evaluation studies of health care organization and delivery (92). However, with few exceptions (3, 51), they have been used primarily as standalone investigations with no integration with quantitative methods (11, 37, 45, 83, 97). Ackerman and colleagues (3) used "rapid ethnography" to understand efforts to implement secure websites (patient portals) in "safety net" health care systems that provide services for low-income populations. Site visits at four California safety net health systems included interviews with clinicians and executives, informal focus groups with frontline staff, observations of patient portal sign-up procedures and clinic work, review of marketing materials and portal use data, and a brief survey. However, "researchers conducting rapid ethnographies face tensions between the breadth and depth of the data they collect and often need to depend on participants who are most accessible due to time constraints" (93, pp. 321–22).

More recently, the combination of clinical ethnography and rapid assessment procedures has been modified for use in pragmatic clinical trials (66). Known as rapid assessment procedure–informed clinical ethnography (RAPICE), the process begins with preliminary discussions with potential sites, followed by training calls and site visits, conducted by the study's principal investigator (PI) acting as a participant observer (PO). During the visit, the PO participates in and observes meetings with site staff, conducts informal or semistructured interviews to assess implementation progress, collects available documents that record procedures implemented, and completes field notes. Both site-specific logs and domain-specific logs (i.e., trial-specific activities, evidence-based intervention implementation, sustainability, and economic considerations) are maintained. Interview transcripts and field notes are subsequently reviewed by the study's mixed methods consultant (MMC) (98). A discussion ensues until both the PO and the MMC reach consensus as to the meaning and significance of the data (66). This approach is consistent with the pragmatic trial requirement for the minimization of time-intensive research methods (89) and the implementation science goal of understanding trial processes that could provide readily implementable intervention models (99).

The use of RAPICE is illustrated by Zatzick and colleagues (99) in an evaluation of the American College of Surgeons national policy requirements and best practice guidelines used to inform the integrated operation of US trauma centers. In a hybrid trial testing the delivery of high-quality

screening and intervention for post-traumatic stress disorder across US level 1 trauma centers, the study uses implementation conceptual frameworks and RAPICE methods to evaluate the uptake of the intervention model using site visit data.

PROCEDURES FOR ANALYZING QUALITATIVE DATA

Intervention and practice evaluations using mixed methods designs generally rely on semistructured interviews, focus groups, and ethnographic observations as sources of qualitative data. However, the demand for rigor in mixed methods designs has led to innovative approaches in both the kind of qualitative data collected and how these data are analyzed. One such approach, referred to as quantitizing qualitative data, transforms qualitative data into quantitative values (56). This approach must adhere to assumptions that govern the collection of qualitative as well as quantitative data simultaneously. Caution must be exercised in making certain that the application of one set of assumptions (e.g., insuring that every participant had an opportunity to answer a question when reporting a frequency or rate) does not violate another set of assumptions (i.e., samples purposively selected to insure depth of understanding). For instance, quantitative data may be used for the purposes of description but may not necessarily satisfy the requirements for the application of statistical tests to ascertain the level of significance of differences across groups. Three approaches to quantifying qualitative data are summarized below.

Concept Mapping

The technique of concept mapping (91), where qualitative data elicited from focus groups are quantitized, is an example of convergence through transformation (2, 74). Concept mapping is a structured conceptualization process and a participatory qualitative research method that yields a conceptual framework for how a group views a particular topic. Similar to other methods, such as the nominal group technique (26) and the Delphi method (26), concept mapping uses inductive and structured small-group data collection processes to qualitatively generate different ideas or constructs and then quantitize these data for quantitative analysis. In the case of concept mapping, the qualitative data are used to produce illustrative cluster maps depicting relationships of ideas in the form of clusters.

Concept mapping involves six steps: preparation, generation, structuring, representation, interpretation, and utilization. In the preparation stage, focal areas are identified and criteria for participant selection/recruitment are determined. In the generation stage, participants address the focal question and generate a list of items to be used in subsequent data collection and analysis. In the structuring stage, participants independently organize the list of items generated by sorting the items into piles on the basis of perceived similarity. Each item is then rated in terms of its importance or usefulness to the focal question. In the representation stage, data are entered into specialized concept-mapping computer software (Concept Systems), which provides quantitative summaries and visual representations or concept maps based on multidimensional scaling and hierarchical cluster analysis. In the interpretation stage, participants collectively process and qualitatively analyze the concept maps, assessing and discussing the cluster domains, evaluating items that form each cluster, and discussing the content of each cluster. This approach leads to a reduction in the number of clusters. Finally, in the utilization stage, findings are discussed to determine how best they inform the original focal question.

Waltz and colleagues (94) illustrate the use of concept mapping in a study to validate the compilation of discrete implementation strategies identified in the Expert Recommendations for Implementing Change (ERIC) study. Hierarchical cluster analysis supported organizing the 73 strategies into 9 categories (see **Figure 1** below).

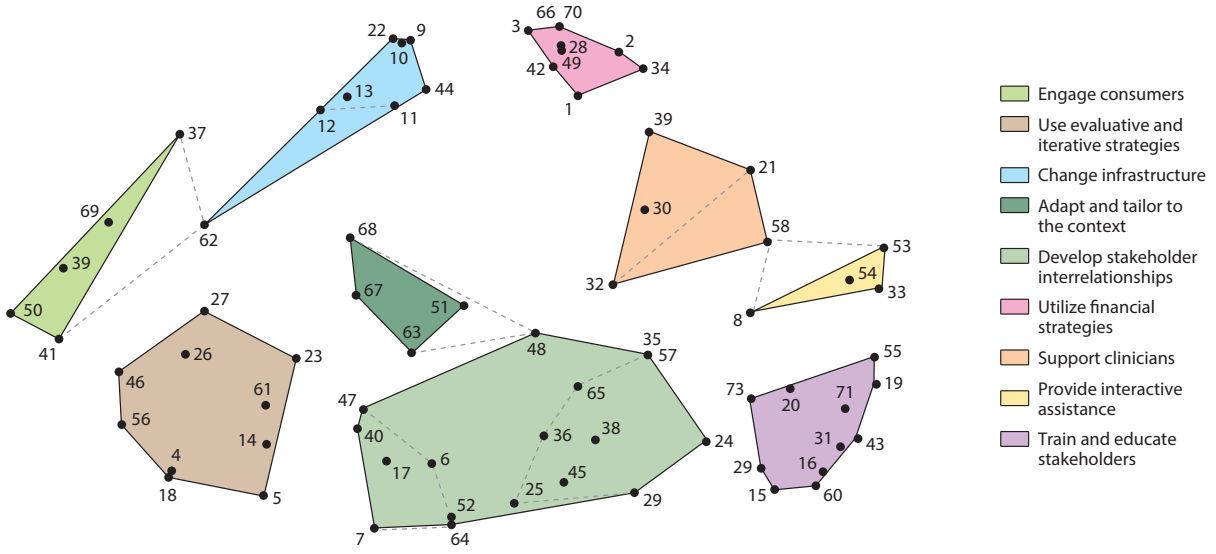

Figure 1

Illustration of the graphic output of concept mapping. Point and cluster map of all 73 strategies identified in the Expert Recommendations for Implementing Change (ERIC) process. The map reflects the product of an expert panel ($n = 32$) sorting 73 discrete strategies into groupings by similarity, each strategy being depicted by a black dot. Spatial distances reflect how frequently the strategies were sorted together as similar. Gray dashed lines within the "develop stakeholder interrelationships" cluster indicate how two separate clusters were merged into one large cluster owing to conceptual similarity among their items. Gray dashed lines extending between other clusters archive the reassignment of strategies from their original cluster to a neighboring cluster to which there was a better conceptual fit (i.e., strategies 48, 58, and 62). Figure adapted from Waltz et al. (94).

Qualitative Comparative Analysis

Another procedure for quantitizing qualitative data that has gained increasing attention in recent years is qualitative comparative analysis (QCA). Developed in the 1980s (75), QCA was designed to study the complexities often observed in social sciences research by examining the nature of relationships. QCA can be used with qualitative data, quantitative data, or a combination of the two and is particularly helpful in conducting studies that may have a small to medium sample size, but it can also be used with large sample sizes (76).

Similar to the constant comparative method used in grounded theory (35) and thematic analysis (53) in which the analyst compares and contrasts incidents or codes to create categories or themes to generate a theory, QCA uses a qualitative approach in that it entails an iterative process and dialogue with the data. Findings in QCA, however, are based on quantitative analyses—specifically, a Boolean algebra technique that allows for a reductionist approach interpreted in set-theoretic terms. The underlying purpose in using this method is to identify one or multiple configurations that are sufficient to produce an outcome (see **Table 1**) with enough consistency to illustrate that the same pathway will continue to produce the outcome and a coverage score indicating the percentage of cases where a given configuration is applicable. Pathways are interpreted using logical ANDs, logical ORs, and the presence or absence of a condition. Configuration 3, below, for example, would be interpreted as follows: The presence of conditions A and B when combined with either E or D, but only in the absence of C, is sufficient to produce outcome X.

On the bases of the type of data being used, the context of what is being studied, and what is already known about a particular area of interest, a researcher will begin by selecting one of two

Table 1 An illustration of equifinality (multiple coexisting pathways) demonstrating the use of logical operators[a]

Original conditions associated with outcome (X)	Causal pathways sufficient for outcome (X) identified through qualitative comparative analysis
A, B, C, D, E → X	1) A * C * E → X 2) A * B + D → X 3) A * B * E + D * ∼C → X

[a]The three common logical operators used in QCA are symbolically defined as follows: *, logical AND (set intersection); +, logical OR (set union); ∼, negation (absence of a condition).

commonly used analyses, crisp-set (csQCA) or fuzzy-set (fsQCA). In csQCA, conditions and the outcome are dichotomized, meaning that a given case's membership to a condition or outcome is either fully in or fully out (76). Alternatively, membership on a fuzzy-set can fall into three, four, six-point, or continuous value set, enabling the researcher to qualitatively assess the degree of membership most appropriate for a case on any given condition.

Procedures for conducting a QCA are illustrated in **Figure 2** below. Prior to beginning formal analyses, several steps, including determining outcomes and conditions, identifying cases, and calibrating membership scores, inform the development of a data matrix. QCA relies heavily on substantive knowledge, and decisions made throughout the analytics process are guided by a theoretical framework rather than by inferential statistics (76). In the first step, researchers assign weights to constructs on the basis of previous knowledge and theory, rather than basing thresholds on means or medians. The number of conditions is carefully selected; having as many conditions as cases will result in uniqueness and failure to detect configurations (55). Once conditions have been defined and operationalized, each case can be dichotomized for membership. In crisp-set analysis, cases are classified as having full nonmembership [0] or full membership [1] in the given outcome by using a qualitative approach (indirect calibration) or a quantitative approach with log odds (direct calibration) (76).

Once a data matrix has been created, formal csQCA can commence using fs/QCA software, R suite, or other statistical packages for configurational comparative methods (a comprehensive list can be found on **http://www.compasss.org/software.htm**). Analyses should begin with determining whether all conditions originally hypothesized to influence the outcome are, indeed, necessary (81). Using a Boolean algebra algorithm, a truth table is then designed to provide a reduced number of configurations. A truth table may show contradictions (consistency score = 0.3–0.7), indicating that it is not clear whether this configuration is consistent with the outcome (76). Several techniques can be used to resolve such contradictions (77), many of which entail revisiting the operationalization and/or selection of conditions or reviewing cases for fit.

Once all contradictions are resolved and assigned full nonmembership or full membership on the given outcome, sufficiency analyses can be conducted. Initial sufficiency analysis is usually based on the presence of an outcome. The Quine-McCluskey algorithm produces a logical combination or multiple combinations of conditions that are sufficient for the outcome to occur. Three separate solutions are given: parsimonious, intermediate, and complex. The intermediate solution is typically selected for the purposes of interpretation (76). One interest of interpreting findings is to explicitly state that this combination will almost always produce the given outcome. The extent to which a set of conditions produces a specific outcome is referred to as consistency. While a perfect score of 1 indicates that this causal pathway will always be consistent with the outcome, a score ≥0.8 is a strong measure of fit (76, 77). Complementary to consistency is coverage, or identifying the degree to which all cases were explained by a given causal pathway. While there is

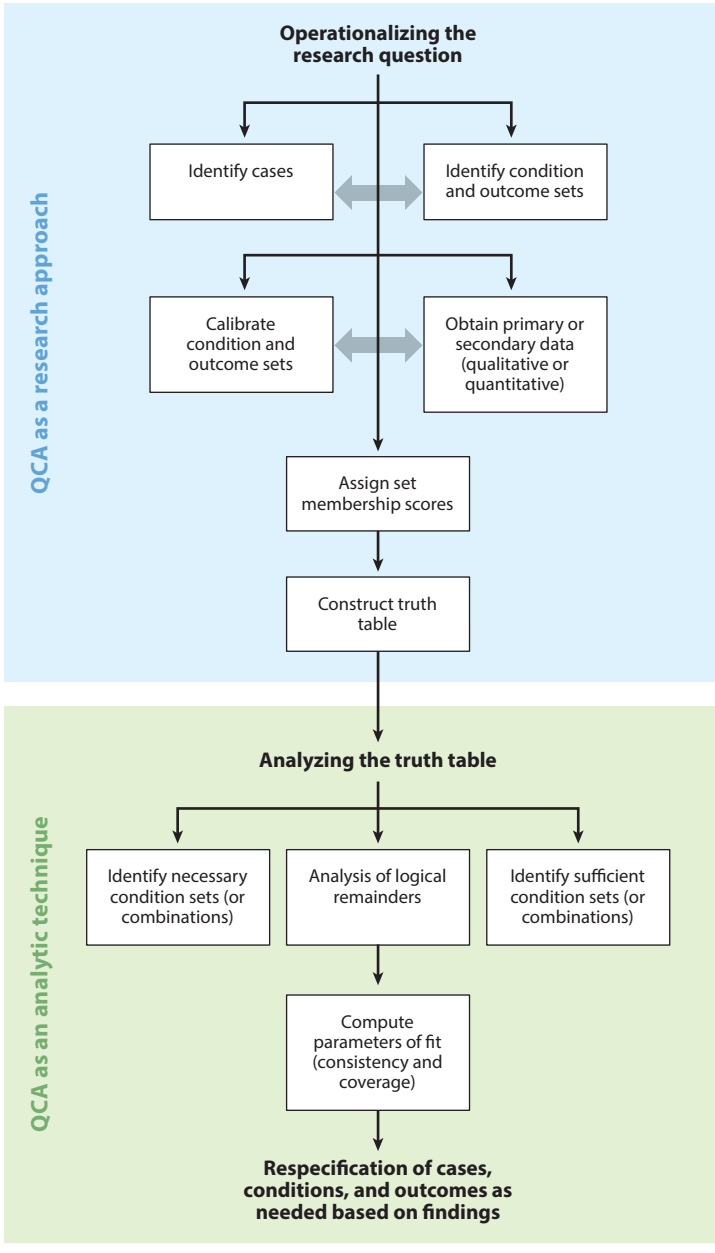

Figure 2

Qualitative comparative analysis (QCA) as an approach (*top*) and as an analytic technique (*bottom*). Figure adapted from Kane et al. (45) with permission.

often a trade-off between these two measures of fit, without high consistency, it is not meaningful to have high coverage (76).

QCA has increasingly been used in health services research to evaluate program effectiveness and implementation where outcomes are dependent on interconnected structures and practices

(15, 28, 31, 46–48, 90, 92). For instance, Kane and colleagues (47) used QCA to examine the elements of organizational capacity to support program implementation that resulted in successful completion of public health program objectives in a public health initiative serving 50 communities. The QCA used case study and quantitative data collected from 22 awardee programs to evaluate the Communities Putting Prevention to Work program. The results revealed two combinations for combining most work plan objectives: (*a*) having experience implementing public health improvements in combination with having a history of collaboration with partners; and (*b*) not having experience implementing public health improvements in combination with having leadership support.

Implementation Frameworks

A third approach to quantitizing qualitative information used in evaluation research has been the coding and scaling of responses to interviews guided by existing implementation frameworks. These techniques call for assigning a numeric value to qualitative responses to questions pertaining to a set of variables believed to be predictive of successful implementation outcomes and then comparing the quantitative values across implementation domains, different implementation sites, or different stakeholder groups involved in implementation (24, 95).

In an illustration of this approach, Damschroder & Lowery (22) embedded the constructs of the Consolidated Framework for Implementation Research (CFIR) (21) in semistructured interviews conducted to describe factors that explained the wide variation in implementation of MOVE!, a weight-management program disseminated nationally to Veterans Affairs (VA) medical centers. Interview transcripts were coded and used to develop a case memo for each facility. Numerical ratings were then assigned to each construct to reflect their valence and their magnitude or strength. This process is illustrated in **Figure 3**. The numerical ratings ranged from −2 (construct is mentioned by two or more interviewees as a negative influence in the organization, an impeding influence on work processes, and/or an impeding influence in implementation efforts) to +2 (construct is mentioned by two or more interviewees as a positive influence in the organization, an impeding influence on work processes, and/or an impeding influence in implementation efforts). Of the 31 constructs assessed, 10 strongly distinguished between facilities with low versus high MOVE! implementation effectiveness; 2 constructs exhibited a weak pattern in distinguishing between low versus high effectiveness; 16 constructs were mixed across facilities; and 2 had insufficient data to assess.

In the absence of quantification of the qualitative data in these three analytical approaches, a thematic content analysis approach (44) might have been used to analyze the data obtained from the small-group concept-mapping brainstorming sessions or the interviews or focus groups that are part of the QCA. A qualitative framework approach (34) might have been used to analyze the data obtained from the interviews using the CFIR template. The analysis would be inductive for data collected for the concept-mapping exercise, inductive-deductive for data collected for the QCA exercise, and deductive for the data collected for the framework exercise. With the quantification, these data are used largely to describe a framework (concept mapping) that could be used to generate hypotheses (implementation framework) or to test hypotheses (qualitative comparative analysis).

PROCEDURES FOR MEASURING EVALUATION OUTCOMES

In addition to their use to evaluate intervention effectiveness and implementation, mixed methods designs have increasingly been employed to develop innovative measurement tools. Three such recent efforts are described below.

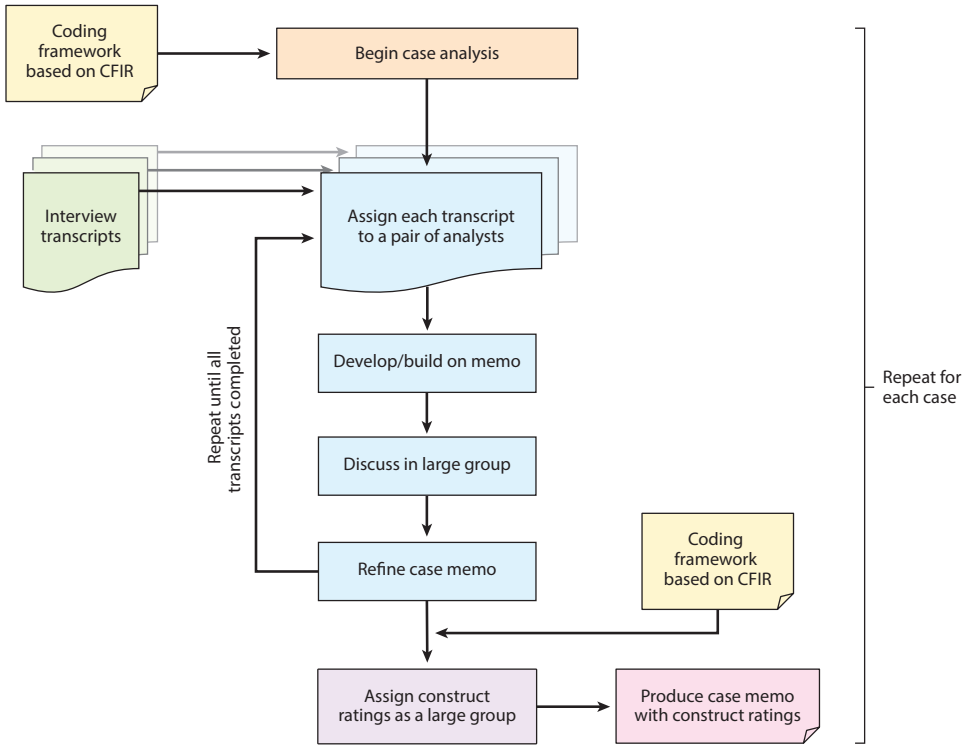

Figure 3

Team-based workflow for case analysis. Abbreviation: CFIR, Consolidated Framework for Implementation Research. Figure adapted from Damschroder & Lowery (22).

Stages of Implementation Completion

The stages of implementation completion (SIC) is an eight-stage assessment tool (9) developed as part of a large-scale randomized implementation trial that contrasted two methods of implementing Treatment Foster Care Oregon [TFCO (formerly Multidimensional Treatment Foster Care)] (10), an EBP for youth with serious behavioral problems in the juvenile justice and child welfare systems. The eight stages range from engagement (stage 1) with the developers/purveyors in the implementation process to achievement of competency in program delivery (stage 8). The SIC was developed to measure a community or organization's progress and milestones toward successful implementation of the TFCO model regardless of the implementation strategy utilized. Within each of the eight stages, specific activities are operationalized and completion of activities is monitored, along with the length of time taken to complete these activities.

In an effort to examine the utility and validity of the SIC, Palinkas and colleagues (64) examined influences on the decisions of administrators of youth-serving organizations to initiate and proceed with implementation of three EBPs: multisystemic therapy (43), multidimensional family therapy (52), and TFCO. Guided by the SIC framework, semistructured interviews were conducted with 19 agency chief executive officers and program directors of 15 youth-serving organizations. Agency leaders' self-assessments of implementation feasibility and desirability in the stages that occurred prior to (preimplementation), during (implementation), and after (sustainment) phases were found to be influenced by several characteristics of the intervention, inner setting, and outer setting that were unique to a phase in some instances and found to operate

in more than one phase in other instances. Findings supported the validity of using the SIC to measure implementation of EBPs other than TFCO in a variety of practice settings, identified opportunities for using agency leader models to develop strategies to facilitate implementation of EBPs, and supported using the SIC as a standardized framework for guiding agency leader self-assessments of implementation.

Sustainment Measurement System

The development of the sustainment measurement system (SMS) to measure sustainment of prevention programs and initiatives is another illustration of the use of mixed methods to develop evaluation tools. Palinkas and colleagues (69, 70) interviewed 45 representatives of 10 grantees and 9 program officers within 4 SAMHSA (Substance Abuse and Mental Health Services Administration) prevention programs to identify key domains of sustainability indicators (i.e., dependent variables) and requirements or predictors (i.e., independent variables). The conceptualization of "sustainability" was captured using three approaches: semistructured interviews to identify experiences with implementation and sustainability barriers and facilitators; a free list exercise to identify how participants conceptualized sustainability, program elements they wished to sustain, and requirements to sustain such elements; and a checklist of CFIR constructs assessing how important each item was to sustainment. Interviews were analyzed using a grounded theory approach (14), while free lists and CFIR items were quantitized; the former consisted of rank-ordered weights applied to frequencies of listed items and the latter used a numeric scale ranging from 0 (not important) to 2 (very important) (69). Four sustainability elements were identified by all three data sets (ongoing coalitions, collaborations, networks, and partnerships; infrastructure and capacity to support sustainability; community need for program; and ongoing evaluation of performance and outcomes), and eleven elements were identified by two of three data sets (availability of funding, consistency with organizational culture, evidence of positive outcomes, development of a plan for implementation and sustainment, presence of a champion, institutionalization and integration of program, institutional support and commitment, community buy-in and support, program continuity, supportive leadership, and opportunities for staff training).

RE-AIM QuEST

Another innovation in the assessment of implementation outcomes is the RE-AIM qualitative evaluation for systematic translation (RE-AIM QuEST), a mixed methods framework developed by Forman and colleagues (32). The RE-AIM (reach, efficacy/effectiveness, adoption, implementation, and maintenance) framework is often used to monitor the success of intervention effectiveness, dissemination, and implementation in real-life settings (36) and has been used to guide several mixed methods implementation studies (6, 50, 54, 79, 82, 85). The RE-AIM QuEST framework represents an attempt to provide guidelines for the systematic application of quantitative and qualitative data for summative evaluations of each of the five dimensions. These guidelines may also be used in conducting formative evaluations to help guide the process of implementation by identifying and addressing barriers in real time.

Forman and colleagues (32) applied this framework for both real-time and retrospective evaluation in a pragmatic cluster randomized controlled trial of the Adherence and Intensification of Medications (AIM) program. Researchers found that the QuEST framework expanded RE-AIM in three fundamental ways: (*a*) allows investigators to understand whether reach, adoption, and implementation varied across and within sites; (*b*) expands retrospective evaluation of effectiveness by examining why the intervention worked or failed to work and explains which components of the intervention or the implementation context may have been barriers; and (*c*) explicates whether

and in which ways the intervention was maintained. This information permitted researchers to improve implementation during the intervention and inform the design of future interventions.

PROCEDURES FOR PARTICIPANT SAMPLING

Purposeful sampling is widely used in qualitative research for the identification of information-rich cases related to the phenomenon of interest (17, 71). While criterion sampling is used most commonly in implementation research (68), combining sampling strategies may be more appropriate for the aims of implementation research and more consistent with recent developments in quantitative methods (8, 27). Palinkas and colleagues (68) reviewed the principles and practice of purposeful sampling in implementation research, summarized types and categories of purposeful sampling strategies and provided the following recommendations: (*a*) Use of a single-stage strategy for purposeful sampling for qualitative portions of a mixed methods implementation study should adhere to the same general principles that govern all forms of sampling, qualitative or quantitative; (*b*) a multistage strategy for purposeful sampling should begin first with a broader view with an emphasis on variation or dispersion and move to a narrow view with an emphasis on similarity or central tendencies; (*c*) selection of a single or multistage purposeful sampling strategy should be based, in part, on how it relates to the probability sample, for the purpose of answering either the same question (in which case, a strategy emphasizing variation and dispersion is preferred) or related questions (in which case, a strategy emphasizing similarity and central tendencies is preferred); (*d*) all sampling procedures, whether purposeful or probability, are designed to capture elements of both similarity (i.e., centrality) and differences (i.e., dispersion); and (*e*) although quantitative data can be generated from a purposeful sampling strategy and qualitative data can be generated from a probability sampling strategy, each set of data is suited to a specific objective and each must adhere to a specific set of assumptions and requirements.

CHALLENGES OF INTEGRATING QUANTITATIVE AND QUALITATIVE METHODS

Conducting integrated mixed methods research poses several challenges, from design to analysis and dissemination. Given the many methodological configurations possible, as described above, careful thought about optimal design should occur early in the process in order to have the potential to integrate methods when deemed appropriate to answer the research question(s). Considerations must include resources (e.g., time, funding, expertise; see Reference 58), as integrated mixed methods studies tend to be complex and nonlinear. After launching an integrated mixed methods study, the team needs to consistently evaluate the extent to which the mixed methods intentions are being realized, as the tendency in this type of study is to work (e.g., collect data) in parallel, even through analysis, only then to find that the sources of data are not reconcilable and the potential of the mixed methods design is not reached. This lack of integration may result in separate publications with quantitative and qualitative results rather than integrated mixed methods papers. Several sets of guidelines and critiques are available to facilitate high-quality integrated mixed methods products (e.g., 18, 60, 61).

Another consideration of integrating the two sets of methods lies in assessing the advantages and disadvantages of doing so with respect to data collection. Of course, there are trade-offs involved with each method introduced here. For instance, rapid assessment procedures enable more time-efficient data collection but require more coordination of multiple data collectors to insure consistency and reliability. Rapid assessment procedure–informed clinical ethnography also enables time-efficient field observation and review procedures that constitute ideal nimble mixed methods approaches for the pragmatic trial, along with minimizing participant burden, allowing

for real-time workflow observations, more opportunities to conduct repeated measures of qualitative data through multiple site visits, and greater transparency in the integration of investigator and study participant perspectives on the phenomena of interest. However, it discourages the use of semistructured interviews or focus groups that may allow for the collection of data that would provide greater depth of understanding. Concept mapping offers a structured approach to data collection designed to facilitate quantification and visualization of salient themes or constructs at the expense of a semistructured approach that may provide greater depth of understanding of the phenomenon of interest. Collection of qualitative data on implementation and sustainment processes and outcomes can be used to validate, complement, and expand as well as develop quantitative measures such as the SIC, SMS, and RE-AIM but can potentially involve additional time and personnel for minimal benefit. The advantages and disadvantages of each method must be weighed when deciding whether to use them for evaluation.

Finally, consideration must be given to identifying opportunities for the appropriate use of the innovative methods introduced in this article. **Table 2** outlines the range of mixed methods

Table 2 Opportunities for use of innovative methods in mixed methods evaluations based on function, focus and design

Methods	Mixed methods function	Focus	Design
Collecting QUAL data			
RAP	Convergence Complementarity Expansion Development	Process Outcomes	Effectiveness/implementation
RAPICE	Convergence Complementarity Expansion Development	Process Outcomes	Effectiveness/implementation
Analyzing (Quantitizing) QUAL data			
Concept mapping	Development	Predictors	Effectiveness/implementation
Qualitative comparative analysis	Development	Predictors Outcomes	Effectiveness/implementation
Implementation frameworks	Expansion	Predictors	Implementation
Measuring Evaluation Outcomes			
States of implementation completion	Development Convergence Complementarity Expansion	Outcomes Process	Implementation
Sustainment measurement system	Development Convergence Complementarity Expansion	Outcomes Process	Implementation
RE-AIM QuEST	Convergence Complementarity Expansion	Outcomes	Effectiveness/implementation
Sampling	Sampling	Predictors Process Outcomes	Effectiveness/implementation

Abbreviations: QUAL, qualitative data; RAP, rapid assessment procedures; RAPICE, rapid assessment procedure–informed clinical ethnography; RE-AIM, reach, efficacy/effectiveness, adoption, implementation, and maintenance; RE-AIM QuEST, RE-AIM qualitative evaluation for systematic translation.

functions, research foci, and study design for each innovative method. For example, rapid assessment procedures could be used to achieve four different functions (convergence, complementarity, expansion, and development) and to assess both process and outcomes in effectiveness and implementation studies. However, we anticipate that these methods can and should be applied in ways we have yet to imagine. Similarly, new innovative methods will inevitably be created to accommodate the functions, foci, and design of mixed methods evaluations.

CONCLUSION

As the discipline of evaluation research evolves, the methods used by evaluation researchers must evolve as well. Evaluations are performed to achieve a better understanding of policy, program, or practice effectiveness and implementation. They assess not just the outcomes associated with these activities, but the process and the context in which they occur. Mixed methods designs are central to this evolution (16, 57, 96). As they facilitate innovations in research and advances in the understanding gained from that research, so must they also change, adapt, and evolve. Options for determining suitability of particular designs are becoming increasingly sophisticated and integrated. This review summarizes only a fraction of the innovations currently under way. With each new application of mixed methods in evaluation research, the need for further change, adaptation, and evolution becomes apparent. The key to the future of mixed methods research will be to continue building on what has been learned and to replicate designs that produce the most robust outcomes.

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