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Conceptual models to guide integration during analysis in convergent mixed methods studies

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Abstract

Methodologists have offered general strategies for integration in mixed-methods studies through merging of quantitative and qualitative data. While these strategies provide researchers in the field general guidance on how to integrate data during mixed-methods analysis, a methodological typology detailing specific analytic frameworks has been lacking. The purpose of this article is to introduce a typology of analytical approaches for mixed-methods data integration in mixed-methods convergent studies. We distinguish three dimensions of data merging analytics: (1) the relational dimension, (2) the methodological dimension, and (3) the directional dimension. Five different frameworks for data merging relative to the methodological and directional dimension in convergent mixed-methods studies are described: (1) the explanatory unidirectional approach, (2) the exploratory unidirectional approach, (3) the simultaneous bidirectional approach, (4) the explanatory bidirectional approach, and (5) the exploratory bidirectional approach. Examples from empirical studies are used to illustrate each type. Researchers can use this typology to inform and articulate their analytical approach during the design, implementation, and reporting phases to convey clearly how an integrated approach to data merging occurred.

Keywords

Mixed methods, integration, convergent design, merging, analysis, theory

Introduction

Mixed-methods research (MMR) continues to grow in popularity as a methodology in educational, social, and health science research (Curry and Nunez-Smith, 2015; Plano Clark, 2010; Tashakkori and Teddlie, 2010). MMR is defined as an approach to research in which both quantitative and qualitative data are collected, analyzed, and integrated, thereby drawing interpretations based on the combined strengths of both sets of data (Creswell, 2015a; Creswell and Plano Clark, 2011). Since the 1980s, researchers have increasingly used MMR approaches in natural, social, and health science research (Maxwell, 2016; Stange et al., 1994; Stange and Zyzanski, 1989). Since that time, a growing number of empirical studies have been published, and there is considerably more agreement about the nomenclature for core designs than even a decade ago (Fetters, 2016).

Integration is considered by many to be the hallmark of MMR (Fetters et al., 2013; Fetters and Freshwater, 2015; O'Cathain et al., 2007). Integration is defined as an intentional process by which the researcher brings quantitative and qualitative data together in one study (Creswell, 2015a). By intentionally integrating data, the researcher can access knowledge or insights unavailable to a quantitative or qualitative study undertaken independently (Fetters and Freshwater, 2015; O'Cathain et al., 2007). Researchers can achieve MMR integration through the philosophical, research design, methods and data collection, and/or during the interpretation and reporting levels of the research.

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The objectives of this article are three-fold. First, we describe integration at the different levels and the integration challenges specifically associated with merging quantitative and qualitative data in the analysis in convergent mixed-methods studies. Second, we define three dimensions of merging analytics at the relational, methodological, and directional levels, and describe the subcategories of each. Third, we introduce a typology including novel nomenclature for mixed-methods analysis procedures relative to the methodological and directional level in convergent MMR studies. We introduce a lens heuristic that can be used to illustrate the directional levels, unidirectional and bidirectional, to illustrate variations in the typology for informing integration approaches. Through these conceptual representations and examples, mixed-methods researchers can understand different approaches in merging of quantitative and qualitative data to enhance interpretation of merged data in convergent studies.

Integration in mixed-methods research

Integration at the philosophical level

The utility of paradigms for MMR has been debated extensively by previous methodologists (Morgan, 2007; Plano Clark and Ivankova, 2016; Shannon-Baker, 2015). For purposes of this article, we use Morgan's (2007) definition of paradigm as "*systems of shared beliefs among a community of scholars*" that influence how researchers select both the questions they study and the methods that they use to study them (p. 65). The terms "quantitative" and "qualitative" are not synonymous with paradigms, but refer to different approaches to data and methods in social science (Biesta, 2010; Morgan, 2007; Shannon-Baker, 2015)

Mixing of epistemological positions. Some methodologists have questioned whether the different epistemological positions that quantitative and qualitative studies employ can be logically mixed and integrated (Biesta, 2010; Plano Clark and Ivankova, 2016). Some could argue that MMR is unattainable because it is not possible to mix methods that are based on incompatible views of the social world (Plano Clark and Ivankova, 2016; Sale et al., 2002). Others have argued that multiple, even conflicting paradigms should be used in MMR research. For example, Johnson argues for dialectical pluralism as a "metaparadigm" for integrating equally and respectfully the quantitative and qualitative paradigms such that researchers can thrive on their differences and intellectual tensions while still developing integrated wholes (Johnson, 2015). Another prominent stance is that there are single paradigms that can provide a good foundation for MMR. Mertens (2003) argues for a transformative-emancipation paradigm characterized by the intentional collaboration with minority and marginalized groups, while others discuss critical realism as philosophical basis for MMR (Maxwell and Mittapalli, 2010). A detailed review of these arguments exceeds the scope of this article, but a good overview of different paradigms in MMR is provided by Shannon-Baker (2015). Despite some strongly argued views of the incompatibility of quantitative and qualitative approaches, a robust series of proposals for integration at the philosophical level have been articulated and have become increasingly accepted.

An analysis grounded in pragmatism. In this article, we take pragmatism as our paradigmatic stance (Morgan, 2007, 2014). The rationale for a pragmatic approach in MMR research lies in its response to the traditional ontological and epistemological positions that proclaim issues of incompatible paradigms when conducting MMR research (Biesta, 2010). Pragmatism does not reject the differences between, for example, positivism and constructivism as approaches to research, but focuses on their characteristic approaches to inquiry (Morgan, 2014). Pragmatism emphasizes creating shared meaning and joint action, and this emphasis points to the underlying belief in complementarity. Hence, quantitative and qualitative approaches can be combined in order to complement the advantages and disadvantages within each approach (Shannon-Baker, 2015).

Integration at the design level

Integration at the *design* level can occur through core (also known as basic) designs that include explanatory sequential, exploratory sequential, and convergent designs (Creswell, 2015a; Fetters et al., 2013). An explanatory sequential design begins with collecting and analyzing quantitative data, and these findings then inform the follow-up qualitative phase. The exploratory sequential design begins with collecting and analyzing qualitative data that then builds to the subsequent quantitative phase (Fetters et al., 2013). In a convergent design, the quantitative and qualitative data are collected and analyzed during a similar timeframe and the data compared (Fetters et al., 2013). In addition to these core designs, there are additional advanced designs or so-called "complex" designs (Nastasi and Hitchcock, 2016), multistage applications, intervention, case study, participatory, and instrument/app development build upon the three core designs, but have an overarching purpose, for example, interventional MMR design used in trials, or transformative design used to promote social justice (Creswell, 2015a; Fetters et al., 2013).

Integration at the methods level

The scope of general procedures for linking quantitative and qualitative data at the *methods* level has been classified as *connecting* (linking through sampling), *building* (findings from one strand inform development of data collection tools or procedures for the other strand), *hypothesis generating and testing* (using one type of data to generate hypothesis and another type of data to test that hypothesis), *matching* (reflecting the intent to have themes/constructs match on a domain

by domain basis), *diffracting* (using cuts of data to understand a phenomenon), *embedding* (the addition of qualitative data into a multistage study at multiple points), and *merging* (the two databases are brought together for analysis and for comparison) (Fetters et al., 2013; Uprichard and Dawney, 2016). Five of these approaches occur during data collection, while merging remains the most obtuse as it refers to the analytical process, and diffraction may refer to multiple levels.

Integration at the interpretation and reporting level

Integration at the *interpretation and reporting* level can be either through narrative, data transformation, joint displays, and visualization, for example, using Geographic Information System (GIS) mapping (Fielding and Cisneros-Puebla, 2009; Jones, 2015), or a combination there of (Fetters et al., 2013). For example, Beck et al. (2009) describe the quantitative and qualitative findings in the discussion, thereby integrating data through a narrative. Tarn et al. (2013) illustrate transformation of data in their intervention study where qualitative data were transformed into quantitative data and then merged with quantitative survey results in a combined analysis. Panda et al. (2015) illustrate the use of joint display as a way to bring data together through visual means in a convergent study. Jones (2015) illustrates the use of visualization through GIS mapping in seed distribution programming.

A more detailed view of merging data in a convergent MMR study

Merging of quantitative and qualitative data during the analysis continues to be an active area of discussion and development, but has proven to be difficult in practice (Bryman, 2006, 2007; Ostlund et al., 2011). Merging typically occurs in the analysis phase in convergent MMR studies, and this can be challenging due to the inherent difficulty of comparing results from different forms of data. Current discussions about merging remain general, and use descriptive non-directive language such as "the data are brought together to enhance greater understanding" (Creswell and Plano Clark, 2011; Curry and Nunez-Smith, 2015).

Approaches for integrating quantitative and qualitative data have been addressed in the literature (Bazeley, 2012; Castro et al., 2010; Onwuegbuzie et al., 2009; Plano Clark et al., 2010). These authors suggest practical techniques relative to integrating data generally during the methods, but explication of a typology for approaches to merging quantitative and qualitative data during the actual analysis remains obtuse.

Articulating the intent of merging during design of a convergent MMR study

During the design of a convergent mixed-methods study, investigators may have various degrees of clarity of intent relative to merging. The first pattern, a "blind faith" approach, describes the situation when the researchers have an intent, sometimes more vague than not, that merging the two types of data will produce new insights about the phenomena of their research. The second pattern, the "matching" approach, involves intentionally designing data collection instruments to have related items such that both instruments will elucidate data about the same phenomena/variables. Concretely, this involves matching qualitative questions with scales of quantitative instruments (Creswell, 2015a, 2015b; Fetters et al., 2013). The third pattern, the "data diffraction" approach, alludes to the design (and often inevitability) of the quantitative and qualitative data collection instruments to obtain different aspects of a central phenomenon. The intent is to obtain different "cuts of data" that will reveal information about different aspects of a phenomenon of interest (Uprichard and Dawney, 2016).

Techniques for merging qualitative and quantitative data

The existing literature does offer *techniques* for merging quantitative and qualitative data for analysis (Bazeley, 2012; Creswell, 2015a; Fetters et al., 2013). These can include (1) comparing the quantitative and qualitative findings after separate analyses of the quantitative and qualitative data collected (Fetters et al., 2013); (2) analyzing on a construct-by-construct basis by linking related quantitative scales and qualitative themes (Fetters et al., 2013); (3) following a thread based on a finding during the analysis of one type of data that leads to looking for related information in the other type of data (O'Cathain et al., 2010); (4) analysis through construction of joint display that juxtaposes quantitative and qualitative findings side-by-side, and then draws meta-inferences from both sources of data (Guetterman et al., 2015); (5) data transformation of one type of data into the other type of data (e.g. qualitative to quantitative data transformation followed by merging of the transformed quantitative data with the other collected quantitative data, or quantitative to qualitative transformation followed by merging of the transformed qualitative data with the other collected qualitative data) (Fetters et al., 2013); (6) data correlation (as an iteration of qualitative to quantitative transformation) involves the process of correlating or cross-classifying the data types, for example, converting qualitative data into "variables" and correlating with quantitative data through point-biserial correlation and cross-tabulation tables (Johnson and Christensen, 2014); (7) data consolidation when quantitative and qualitative data are brought together to form new consolidated codes, variables, or datasets (Johnson and Christensen, 2014); and (8) use of GIS mapping to bring together for analysis spatial information with local quantitative or qualitative findings (Fielding and Cisneros-Puebla, 2009). These techniques focus on the practical approach to merging, while paying little attention to the analytical frame.

Outcomes of merging

The existing literature also presents outcomes of merging data. An outcome of the comparisons of the two different strands, that is, the quantitative and qualitative, on a topic is the ability to see whether the databases converge, complement, conflict, or diverge (Creswell, 2015b). Note should be made that the intention of data collection procedures during the design phase, and the outcomes after the actual data collection and analysis may not always be congruent. That is, a researcher who matches data collection to similar domains on both the quantitative and qualitative data collection tools may well produce data that converge, complement, conflict, or diverge. Across all domains of the study, there can be two or more of these outcomes for each domain within the same study.

The mixed-methods methodology "field test"

For mixed-methods researchers, the "rubber hits the road" when field work actually ensues, and it is during this time when cracks, potholes, and omissions in current methodological thinking often become apparent. In working on the integration of survey data and interview data in two different convergent MMR studies—one investigating quality of life in patients undergoing diagnostic evaluations for cancer (Moseholm et al., 2016), and another project on gatekeeper training for suicide prevention in an ethnic minority population (Teo et al., 2016)—we felt keenly that current descriptions in the literature fell short for describing the analytical framing and procedures we were using. Despite the deceivingly simple notion that the data are "brought together and compared," different possibilities for merging surfaced. This prompted our exploration of a typology of analytical frameworks for and examples of data merging during integration. This approach focuses on merging at the analytical level, thereby extending the practical techniques previously described in the literature (Creswell, 2015a; Fetters et al., 2013).

Three dimensions of data merging analytics

We contend that there are three key dimensions of data merging analytics in an integrated MMR analysis, the relational, the methodological, and directional. Below, we discuss these three dimensions (Table 1).

Relational dimension of merging

The *relational* dimension of data merging can be defined as how researchers conducting mixed-methods studies allow the data collection and analytics of the quantitative and qualitative strands to interface. The relational dimension can be characterized under two categories, either "separative" or "iterative." In the separative approach, the quantitative and qualitative data analyses are conducted independent of each other until the final merging of the two strands. For example, McAuley et al. (2006) utilized a separate approach where the quantitative and qualitative data were collected and analyzed separately and then integrated through themes in the discussion of the results. This may be especially common in large teams where there is a qualitative analysis team, and a biostatistics team. In the *iterative* approach, "the data talk to each other" during the analysis and data collection. For example, Crabtree et al. (2005) utilized an iterative approach in MMR case studies research when qualitative findings were used early on to develop and refine quantitative instruments. Rather than allowing two products to emerge separately for comparison, for example, the quantitative results and the qualitative results, and then compared, the iterative approach involves cross-talk during the data collection *and* analytics.

Table 1. Three dimensions of data merging analytics.

Relational dimension
Separative
Iterative
Methodological dimension
Qualitatively driven
Quantitatively driven
Equivalently driven
Directional dimension
Unidirectional
Bidirectional

Methodological dimension of merging

The methodological dimension of data merging can be defined as how the quantitative and qualitative strands are weighted relative to merging analytics. There are three categories of the methodological dimension of data merging analytics. Johnson et al. (2007) describe MMR as being "qualitatively driven," "quantitatively driven," and "equal-status." They depict qualitatively driven MMR as QUAL + quan to emphasize that the qualitative strand predominates, and define it thus:

> Qualitative dominant mixed methods research is the type of mixed research in which one relies on a qualitative, constructivist-poststructuralist-critical view of the research process, while concurrently recognizing that the addition of quantitative data and approaches are likely to benefit most research projects. (Johnson et al., 2007: 124)

They depict quantitatively driven MMR as QUAN + qual to emphasize when the quantitative strand predominates, and define it as follows:

> Quantitative dominant mixed methods research is the type of mixed research in which one relies on a quantitative, postpositivist

> view of the research process, while concurrently recognizing that the addition of qualitative data and approaches are likely to benefit most research projects. (Johnson et al., 2007: 124)

They do not define the "Equal Status" approach directly in their original 2007 article (Johnson et al., 2007), but Johnson (2015: 4) later elaborates on equal-status as "interactive mixed research" where the researcher or research team attempts to listen to qualitative- and quantitative-related epistemologies or insights to produce a superior whole. To provide greater consistency and clarity, we propose the term *equivalently driven mixed-methods research*.

Directional dimension of merging

The directional dimension of merging can be defined as whether the merging analytics occur using a one-way "unidirectional" approach, or whether the merging analytics occur using a "two-way" bidirectional approach.

Unidirectional approaches. In the unidirectional approaches, the lens of the completed analysis of one type of data frames the merging of the two types of data. As the merging can go from the quantitative strand to the qualitative strand or from the qualitative strand to the quantitative strand, two unidirectional approaches emerge (Figures 1 and 2).

Bidirectional approaches. In bidirectional approaches, the hallmark is using the analytics of both the quantitative and qualitative strands to frame merging. These frameworks have a "two-way" lens such that the analyses of both types of data can be considered in the framing. This can be achieved simultaneously or iteratively. With the simultaneous approach, the researcher uses results from the quantitative and qualitative strands to look at each other and structure the merged findings based on both (Figure 3). As the merging can go from the quantitative strand to the qualitative strand and back to the quantitative strand (Figure 4) or from the qualitative strand to the quantitative strand and back to the qualitative strand (Figure 5). Hence, there are three bidirectional approaches.

Typology and nomenclature for mixed methods analytic procedures when merging data in convergent mixed-methods research

For consistency with the existing and predominant language of MMR, the terminology introduced in the typology leverages language used for MMR study designs. This was a deliberate choice as the typology logically extends concepts that already exist in the MMR literature (Fetters and Molina-Azorin, 2017).

Based on the above-presented dimensions of data merging, a typology can thus be developed for data merging analytics (Table 2). As the relational element speaks to the presence or lack of iterative merging during data collection and analysis, and the proposed typology speaks to the data merging analytics only, our typology incorporates elements from the methodological and directional dimensions. The

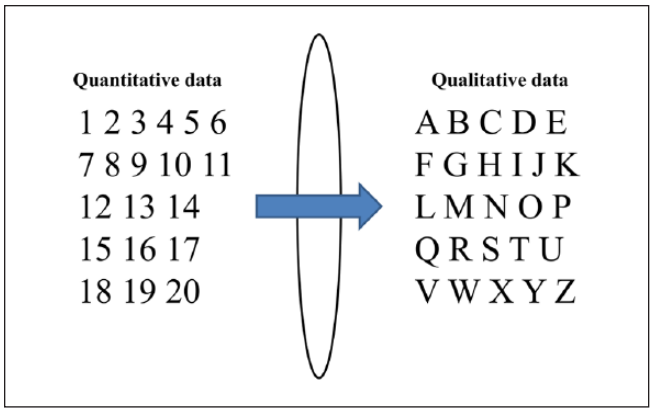

Figure 1. Explanatory unidirectional framework for convergent design integration.

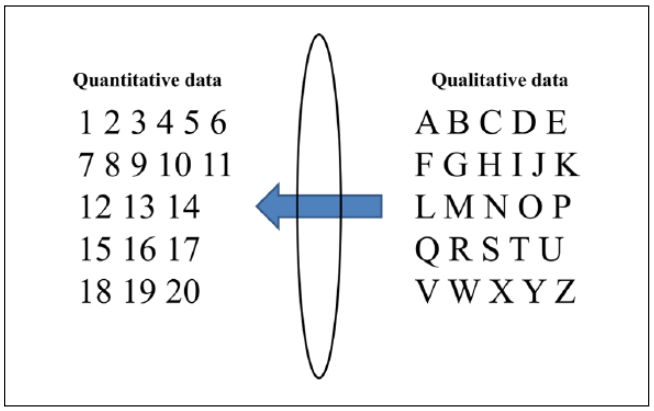

Figure 2. Exploratory unidirectional framework for convergent design integration.

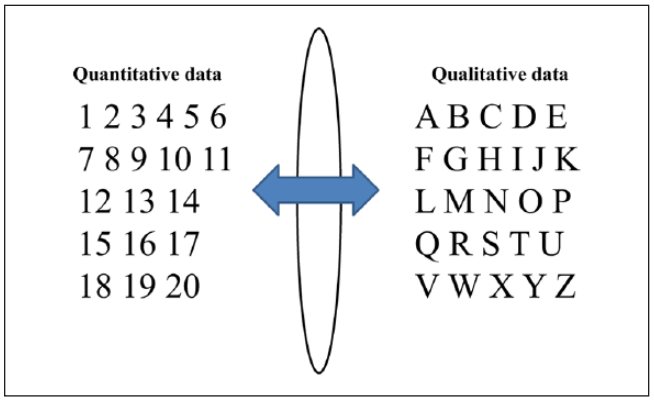

Figure 3. Simultaneous bidirectional framework for convergent design integration.

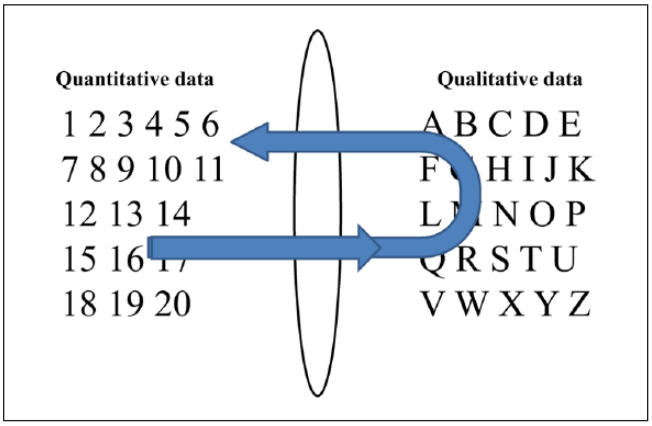

Figure 4. Explanatory bidirectional framework for convergent design integration.

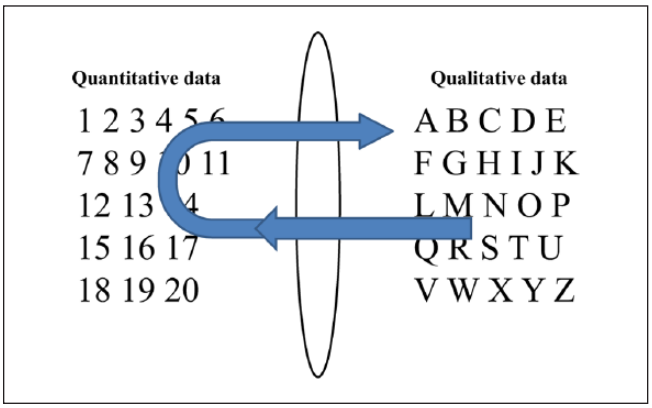

Figure 5. Exploratory bidirectional framework for convergent design integration.

proposed typology focuses on the methodological frame of integration, for example, merging analytics, and is therefore not linked to the other "levels" of integration, for example, the philosophical, design, or methods.

Below we present the typology of the five different MMR analytical approaches, both uni- and bidirectional, for framing the integration through merging of quantitative and qualitative data in a convergent design (Figures 1 to 5).

To demonstrate the five possible combinations of data merging analytics beyond the conceptual level, there needs to be empirical evidence for the five data merging analytical procedures. Table 2 provides each framework and a relevant study to illustrate how researchers have used the different approaches in merging of quantitative and qualitative data in actual convergent studies. These articles were found through searches in *Journal of Mixed Methods Research*, *Quality & Quantity*, *Field Methods*, and Google Scholar using the following search words: "convergent OR concurrent" AND "mixed methods." The search focused on the ways in which researchers framed the merging of quantitative and qualitative data in their analysis. The methodological approach used in the analysis was identified by the authors of this article based on the methods, priority of quantitative and qualitative strands, and/or presentation and discussion of the results. Examples for each of the five merging analytical procedures are provided below.

Nomenclature for unidirectional approaches

In both unidirectional approaches, the lens of the completed analysis of one type of data frames the merging of the two types of data. Thus, there is a sequential approach to the analysis. The literature provides language for sequential MMR designs. This language can be readily extended to merging analyses.

Explanatory unidirectional framework for data merging analytics

When an initial quantitative strand is conducted and followed by a qualitative study to explain the findings, the design is called an explanatory mixed-methods design. When the lens of the strand of the quantitative analytics frames the merged analysis, it is called a unidirectional *explanatory unidirectional framework* (Figure 1). Thus, at the analytical level, a quantitatively structured analysis is complemented by the qualitative data to provide a more comprehensive understanding of the phenomena of interest.

Explanatory unidirectional framework examples. Two studies illustrate the explanatory unidirectional approach. Maiorana et al. (2012) illustrate this approach in their study about trust and acceptability of sharing HIV-related patient data. Quantitative survey data with HIV patients and qualitative interview data with medical staff were merged for comparison, using the qualitative findings to provide a more in-depth understanding of the quantitative drivers and barriers of sharing HIV-related patient data (Maiorana et al., 2012). The quantitative data framed the analysis and the qualitative data were used to elaborate and explain the quantitative findings. Kennett et al. (2008) used a convergent MMR design to understand how learned resourcefulness empowers individuals with chronic pain. Using survey data to divide participants into categories of high and low resourcefulness, the researchers used qualitative data to explain contrasting experiences across categories. The quantitative categories framed the merging of the two datasets and the qualitative data were used to enhance understanding of the complexities underlying the pain-coping process (Kennett et al., 2008).

Exploratory unidirectional framework for data merging analytics

When an initial qualitative strand is used to explore a topic that is then followed by a quantitative strand, the design is called an exploratory sequential mixed-methods design. This

Table 2. Typology of data integration via merging for convergent mixed-methods integration.

Typology	Explanatory unidirectional	Exploratory unidirectional	Simultaneous bidirectional	Explanatory bidirectional	Exploratory bidirectional
Definition	Quantitatively framed approach, enhanced with qualitative findings for the final interpretation	Qualitatively framed approach, enhanced with quantitative findings for the final interpretation	Simultaneous quantitatively and qualitatively framed approach drive final the interpretation	Initial quantitatively framed approach is followed by a qualitatively framed approach before reaching the final interpretation	Initial qualitatively framed approach followed by a quantitatively framed approach before reaching the final interpretation
Examples					
Authors	Kennett et al. (2008)	Myers et al. (2012)	Andrew et al. (2011)	Teo et al. (2016)	Moseholm et al. (2016)
Title	Learned resourcefullness and the long-term benefits of a chronic pain management program	Perceptions regarding the ease of use and usefulness of health information exchange systems among medical providers, case managers and non-clinical staff members working in HIV care and community settings	Beyond the ceiling effect: Using a mixed methods approach to measure patient satisfaction	Brief gatekeeper training for suicide prevention in an ethnic minority population	Health-related quality of life in patients undergoing diagnostic evaluations for cancer: A mixed methods study
Integration	Merging	Merging	Merging	Merging	Connecting, Merging
Description	Categorized survey data framing the analysis is enhanced by qualitative experiences across the categories.	Key differences identified in the qualitative data framed analysis and were enhanced by quantitative survey data.	Matrix comparing quantitative survey categories with qualitative themes extracted from interviews.	Quantitative domains were used as codes to search the qualitative data. Subsequent emerging themes from the qualitative text were enhanced by corroborative data from the quantitative dataset.	Initial qualitative themes frames the analysis followed by quantitative categories framing the analysis.

language can be adapted to merging analytics. When the lens of the strand of the qualitative analytics frames the merged analysis, it is an *exploratory unidirectional framework* (Figure 2). Thus, at the analytical level a qualitatively structured analysis is complemented by the quantitative data to provide a more thorough understanding of the phenomena of interest.

Exploratory unidirectional framework examples. A study exploring how knowledge and cognitive function contribute to self-care in patients with heart failure illustrates the exploratory unidirectional approach (Dickson et al., 2011). Qualitative interview data were used to create a frame for the next steps in the analysis where the quantitative survey results were used to enhance understanding by exploring misconceptions and lack of understanding in those with inadequate self-care (Dickson et al., 2011). Myers et al. (2012) conducted in-depth qualitative interviews and quantitative web-based surveys with medical providers in a study examining how HIV patients' care teams perceived the usefulness and ease of application of newly implemented health information exchange systems. From the qualitative data, the researchers discovered key differences in perceptions and actual use of health information exchange systems across occupational groups. The researchers then used these results to guide the analysis of the quantitative survey data, stratifying by occupational group. Merging of the two datasets was thus framed by the qualitative data analysis, and the final results offer insights into the use and potential benefits of health information exchange systems (Myers et al., 2012).

Nomenclature for bidirectional approaches

The bidirectional approach refers to an integration tactic using a "two-way" lens that allows framing with both a quantitative and qualitative lens. This can be achieved simultaneously or iteratively. This yields three possible frameworks based on the methodological and directional dimensions of an analysis.

The temporality in the bidirectional lenses is dependent on how the analysis is initially framed, and not necessarily on the weighting of the quantitative and qualitative components.

Simultaneous bidirectional framework for data merging analytics

The *simultaneous bidirectional framework* involves a simultaneous quantitative and qualitative frame for merging. Simultaneous is a key idea in this process as it reflects an active back and forth, interactive consideration of both the

emerging quantitative and qualitative findings (Figure 3). Thus, both the quantitative and qualitative results frame the merging of the data.

Simultaneous bidirectional framework examples. An illustration of simultaneous bidirectional lens can be seen in a convergent MMR study of food safety knowledge in Hispanic families (Stenger et al., 2014). Quantitative survey data and qualitative interview data were collected and analyzed separately, and then merged for interpretation. Using overarching dimensions, qualitative themes were compared with survey results to assess concordance. The results were combined in a joint display, where the frame of the analysis was the overarching themes (Stenger et al., 2014). Also, Andrew et al. (2011) examined patient satisfaction with nursing care in a neurosurgical critical care unit. In a joint display, the researchers presented a matrix describing quantitative survey results of high, medium, and low patient satisfaction scores with examples of positive, negative, and "yes, but" comments from qualitative interviews with patients. The quantitative and qualitative data had equal weight during the integration, which enabled researchers to move beyond the ceiling effect of quantitative measures of patient satisfaction and to gain a more meaningful explanation of patient satisfaction (Andrew et al., 2011).

Explanatory bidirectional framework for data merging analytics

Merging analytics that include a bidirectional component, first framed by the quantitative strand, then further considered by the qualitative strand, is an *explanatory bidirectional framework*. It is an iterative approach with an initial quantitatively framed analysis that is followed by a qualitatively framed analysis before reaching a final interpretation (Figure 4).

Explanatory bidirectional framework examples. The explanatory bidirectional framework is illustrated in a study looking at a film intervention compared to lecture format control for increasing suicide prevention among Japanese people. The authors used a convergent MMR design simultaneously collecting survey data and open text data in self-administered survey format (Teo et al., 2016). The instruments addressed awareness, self-efficacy, gatekeeper behavior, and social norms, while three open-ended questions elicited the qualitative data. For the analysis, three domains of focus in the quantitative strand were used as a priori codes to search the qualitative data. Subsequent to this analysis, the authors examined the emerging themes from the qualitative text to look for corroborative data from the quantitative dataset.

Exploratory bidirectional framework for data merging analytics

Merging analytics that include a bidirectional component, first framed by the qualitative strand, then further considered by the lens of the quantitative strand, is an *exploratory bidirectional framework*. It is an iterative approach with an initial qualitatively framed analysis that is followed by a quantitatively framed analysis before reaching a final interpretation by reconsidering the qualitative data (Figure 5).

Exploratory bidirectional framework examples. The exploratory bidirectional framework is illustrated in an ongoing study looking at quality of life in patients undergoing diagnostic evaluations for cancer, where survey data and semi-structured interviews with patients were completed within the same timeframe. An initial analysis is framed by themes of high, intermediate, and poor quality of life as expressed by the patients in qualitative interviews. Quantitative data are then used to elaborate these results. Subsequently, quantitative categories of high, intermediate, and poor quality of life in relation to survey scores are being compared to corroborating themes in the qualitative interview data to achieve a final interpretation.

Discussion

The full value of convergent MMR designs may be realized only if researchers apply effective merging strategies in their practice (Plano Clark et al., 2010). This article provides a typology and rhetoric for methodologically framing the integration through merging in convergent MMR studies. While existing terminology of "exploratory sequential" and "explanatory sequential" relates to MMR designs (Creswell, 2015a; Fetters et al., 2013), the terminology of merging analytical procedures relates to the methodological frame of the analysis. We believe that the similarity in language is a strength as it builds on concepts that already exist in the MMR literature.

The conceptual framework was developed while working with integration through merging in empirical MMR studies. We searched the literature to find examples of how researchers have used different merging approaches to enhance interpretation of the integrated quantitative and qualitative data in actual convergent studies. It was relatively easy to find studies using either an explanatory or exploratory unidirectional framework. We also found studies using a simultaneous bidirectional framework. We were less successful in identifying studies using either the explanatory bidirectional or exploratory bidirectional framework. We suspect this is at least partly attributable to the practice of authors truncating discussion in the methods and instead allocating words to the results or discussion section due to word count restrictions.

Very few studies we identified were explicit about the drivers of the analysis (Maiorana et al., 2012; Myers et al., 2012), making it difficult not only to systematically search and review the MMR literature but also to identify the analytical framework used in the integration of quantitative and qualitative data. Several reviews have found that most MMR papers lack clarity in whether the reported results stem from

quantitative or qualitative findings, and papers are even less clear when discussing their results and the basis of their conclusions (O'Cathain et al., 2008; Ostlund et al., 2011). We suspect the lack of description may also be driven in part due to the lack of a rubric and recognition of variation in integration approaches. The introduced typology can be used to fill this function.

The topic of merging analytical procedures in convergent studies raises several questions. First, while there are five possible approaches, we cannot comment whether one is superior to the other. For example, is it preferable to have a simultaneously bidirectional approach to the merging of data or is a bidirectional approach the most rigorous method as it requires the researcher to be clear about the underlying analytical frame guiding the analysis at specific time points? We suspect that the answer is study specific. There might also be situations where a unidirectional framework is appropriate, for example, in a survey where the qualitative data stem from one or two open-ended questions. Although the choice of which framework to use relates to the aim of the study, the design, and the weighing of the quantitative and qualitative data, some recommendations may be made. The unidirectional approach may be suitable in convergent studies where there is a clear emphasis on either the quantitative or qualitative strand. The simultaneous bidirectional approach may be suitable in studies using matching, thereby a priori identifying the domains used to frame the analysis. It is more difficult to make recommendations for when to use the explanatory and exploratory bidirectional frameworks, as this will be largely dependent on the study aim, rationale for merging, and the different types of data.

Second, there is the question of bias and/or preconceptions, which relates to the underlying predominant approach. Quantitative researchers typically attempt to eliminate or control for bias. In contrast, qualitative researchers actively seek to use their preconceptions to understand qualitative findings. Sale et al. (2002) argue that the distinction of the underlying methodology in MMR research is crucial, and thus, researchers must be clear, when merging two datasets, if the driver is a quantitative frame (to control for bias) or a qualitative frame (to use previous knowledge actively when analyzing the data). In our opinion, the approach to bias/preconception should follow the underlying predominant approach.

Being explicit about which analytical procedure frames the analysis can contribute to researchers' understanding of approaches available for merging the quantitative and qualitative components of a convergent MMR study; still, this result does not imply the priority of one dataset over the other. Instead of talking about priority of either the quantitative or qualitative strands in a MMR study, Creswell (2015b) argues that a clearer approach is to focus on the intent of the MMR integration. Being clear on the intent entails clarity of the merging analytical framework used in the integration.

Conclusion

Here, we have introduced a typology for methodologically framing integration in convergent MMR studies, where the aim is to merge quantitative and qualitative data. We have reviewed three dimensions of data merging analytics: (1) the relational dimension, (2) the methodological dimension, and (3) the directional dimension. For the methodological and directional dimensions, we introduce five different frameworks for merging analytical procedures in convergent mixed-methods studies. We illustrate the typology and provide examples showing how researchers have and can use the different approaches in their analyses to enhance interpretation of merged data. Introducing the idea of a uni- or bidirectional approach to integration in MMR research provides a conceptual framework and rhetoric for researchers to be explicit about the analytic strategy for merging quantitative and qualitative data in their MMR studies.

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References

Andrew S, Salamonson Y, Everett B, et al. (2011) Beyond the ceiling effect: Using a mixed methods approach to measure patient satisfaction. *International Journal of Multiple Research Approaches* 5(1): 52–63.

Bazeley P (2012) Integrative analysis strategies for mixed data sources. *American Behavioral Scientist* 56(6): 814–828.

Beck SL, Towsley GL, Caserta MS, et al. (2009) Symptom experiences and quality of life of rural and urban older adult cancer survivors. *Cancer Nursing* 32(5): 359–369.

Biesta G (2010) Pragmatism and the philosophical foundations of mixed methods research. In: Tashakkori A and Teddlie C (eds) *SAGE Handbook of Mixed Methods in Social & Behavioral Research*. Thousand Oaks, CA: SAGE, pp. 95–117.

Bryman A (2006) Integrating quantitative and qualitative research: How is it done? *Qualitative Research* 6(1): 97–113.

Bryman A (2007) Barriers to integrating quantitative and qualitative research. *Journal of Mixed Methods Research* 1(1): 8–22.

Castro FG, Kellison JG, Boyd SJ, et al. (2010) A methodology for conducting integrative mixed methods research and data analyses. *Journal of Mixed Methods Research* 4(4): 342–360.

Crabtree BF, Miller WL, Tallia AF, et al. (2005) Delivery of clinical preventive services in family medicine offices. *Annals of Family Medicine* 3(5): 430–435.

Creswell JW (2015a) *A Concise Introduction to Mixed Methods Research*. Thousand Oaks, CA: SAGE.

Creswell JW (2015b) Revisiting mixed methods and advanced scientific practices. In: Hesse-Biber SN and Johnson RB (eds) *The Oxford Handbook of Multimethod and Mixed Methods Research Inquiry*. Oxford: Oxford University Press, pp. 57–71.

Creswell JW and Plano Clark VL (2011) *Designing and Conducting Mixed Methods Research*. Thousand Oaks, CA: SAGE.

Curry L and Nunez-Smith M (2015) *Mixed Methods in Health Sciences Research: A Practical Primer*. Thousand Oaks, CA: SAGE.

Dickson VV, Lee CS and Riegel B (2011) How do cognitive function and knowledge affect heart failure self-care? *Journal of Mixed Methods Research* 5(2): 167–189.

Fetters MD (2016) "Haven't we always been doing mixed methods research? *Journal of Mixed Methods Research* 10(1): 3–11.

Fetters MD and Freshwater D (2015) The 1 + 1 = 3 integration challenge. *Journal of Mixed Methods Research* 9(2): 115–117.

Fetters MD and Molina-Azorin J (2017) The journal of mixed methods research starts a new decade. *Journal of Mixed Methods Research* 11(1): 3–10.

Fetters MD, Curry LA and Creswell JW (2013) Achieving integration in mixed methods designs-principles and practices. *Health Services Research* 48(6 Pt 2): 2134–2156.

Fielding N and Cisneros-Puebla C (2009) CAQDAS-GIS convergence: Toward a new integrated mixed method research practice? *Journal of Mixed Methods Research* 3(4): 349–370.

Guetterman TC, Fetters MD and Creswell JW (2015) Integrating quantitative and qualitative results in health science mixed methods research through joint displays. *Annals of Family Medicine* 13(6): 554–561.

Johnson B and Christensen L (2014) Data analysis in qualitative and mixed research. In: Johnson B and Christensen L (eds) *Educational Research, Quantitative, Qualitative, and Mixed Approaches*. Thousand Oaks, CA: SAGE, pp. 613–614.

Johnson RB (2015) Dialectical pluralism: A metaparadigm whose time has come. *Journal of Mixed Methods Research* 9(4): 1–18.

Johnson RB, Onwuegbuzie AJ and Turner LA (2007) Toward a definition of mixed methods research. *Journal of Mixed Methods Research* 1(2): 112–133.

Jones K (2015) Using a theory of practice to clarify epistemological challenges in mixed methods research: An example of theorizing, modeling, and mapping changing west African seed systems. *Journal of Mixed Methods Research*. Epub ahead of print 16 November. DOI: 10.1177/1558689815614960.

Kennett DJ, O'Hagan FT and Cezer D (2008) Learned resourcefulness and the long-term benefits of a chronic pain management program. *Journal of Mixed Methods Research* 2(4): 317–339.

McAuley C, McCurry N, Knapp M, et al. (2006) Young families under stress: Assessing maternal and child well-being using a mixed-methods approach. *Child & Family Social Work* 11(1): 43–54.

Maiorana A, Steward WT, Koester KA, et al. (2012) Trust, confidentiality, and the acceptability of sharing HIV-related patient data: Lessons learned from a mixed methods study about health information exchanges. *Implementation Science* 7: 34–47.

Maxwell JA (2016) Expanding the history and range of mixed methods research. *Journal of Mixed Methods Research* 10(1): 12–27.

Maxwell JA and Mittapalli K (2010) Realism as a stance for mixed methods research. In: Tashakkori A and Teddlie C (eds) *SAGE Handbook of Mixed Methods in Social and Behavioral Research*. Thousand Oaks, CA: SAGE, pp. 145–167.

Mertens DM (2003) Mixed methods and the politics of human research: The transformative-emancipatory perspective. In: Tashakkori A and Teddlie C (eds) *SAGE Handbook of Mixed Methods Social & Behavioral Research*. Thousand Oaks, CA: SAGE, pp. 135–164.

Morgan DL (2007) Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of Mixed Methods Research* 1(1): 48–76.

Morgan DL (2014) Pragmatism as a paradigm for social research. *Qualitative Inquiry* 20(8): 1045–1053.

Moseholm E, Rydahl-Hansen S, Lindhardt BO, et al. (2016) Health-related quality of life in patients with serious non-specific symptoms undergoing evaluation for possible cancer and their experience during the process: A mixed methods study. *Quality of Life Research* 26: 993–1006.

Myers JJ, Koester KA, Chakravarty D, et al. (2012) Perceptions regarding the ease of use and usefulness of health information exchange systems among medical providers, case managers and non-clinical staff members working in HIV care and community settings. *International Journal of Medical Informatics* 81(10): e21–29.

Nastasi BK and Hitchcock JH. *Mixed Methods Research and Culture-Specific Interventions-Program Design and Evaluation*. Thousand Oaks, CA: SAGE.

O'Cathain A, Murphy E and Nicholl J (2007) Integration and publications as indicators of "yield" from mixed methods studies. *Journal of Mixed Methods Research* 1(2): 147–163.

O'Cathain A, Murphy E and Nicholl J (2008) The quality of mixed methods studies in health services research. *Journal of Health Services Research & Policy* 13(2): 92–98.

O'Cathain A, Murphy E and Nicholl J (2010) Three techniques for integrating data in mixed methods studies. *BMJ* 341: c4587.

Onwuegbuzie AJ, Slate JR, Leech NL, et al. (2009) Mixed data analysis: Advanced integration techniques. *International Journal of Multiple Research Approaches* 3(1): 13–33.

Ostlund U, Kidd L, Wengstrom Y, et al. (2011) Combining qualitative and quantitative research within mixed method research designs: A methodological review. *International Journal of Nursing Studies* 48(3): 369–383.

Panda S, Das RS, Maruf SKA, et al. (2015) Exploring stigma in low HIV prevalence settings in rural West Bengal, India: Identification of intervention considerations. *Journal of Mixed Methods Research* 9: 362–385.

Plano Clark VL (2010) The adoption and practice of mixed methods: US trends in federally funded health-related research. *Qualitative Inquiry* 16(6): 428–440.

Plano Clark VL and Ivankova NV (2016) *Mixed Methods Research: A Guide to the Field*. Thousand Oaks, CA: SAGE.

Plano Clark VL, Garrett AL and Leslie-Pelecky D (2010) Applying three strategies for integrating quantitative and qualitative databases in a mixed methods study of a nontraditional graduate education program. *Field Methods* 22(2): 154–174.

Sale J, Lohfeld L and Brazil K (2002) Revisiting the quantitative-qualitative debate: Implications for mixed-methods research. *Quality & Quantity* 36(1): 43–53.

Shannon-Baker P (2015) Making paradigms meaningful in mixed methods research. *Journal of Mixed Methods Research* 10(4): 319–334.

Stange KC and Zyzanski SJ (1989) Integrating qualitative and quantitative research methods. *Family Medicine* 21(6): 448–451.

Stange KC, Miller WL, Crabtree BF, et al. (1994) Multimethod research: Approaches for integrating qualitative and quantitative methods. *Journal of General Internal Medicine* 9(5): 278–282.

Stenger KM, Ritter-Gooder PK, Perry C, et al. (2014) A mixed methods study of food safety knowledge, practices and beliefs in Hispanic families with young children. *Appetite* 83: 194–201.

Tarn DM, Paterniti DA, Orosz DK, et al. (2013) Intervention to enhance communication about newly prescribed medications. *Annals of Family Medicine* 11(1): 28–36.

Tashakkori A and Teddlie C (2010) *SAGE Handbook of Mixed Methods in Social & Behavioral Research*. Thousand Oaks, CA: SAGE.

Teo AR, Andrea SB, Sakakibara R, et al. (2016) Brief gatekeeper training for suicide prevention in an ethnic minority population: A controlled intervention. *BMC Psychiatry* 16: 211.

Uprichard E and Dawney L (2016) Data diffraction. *Journal of Mixed Methods Research*. Epub ahead of print 1 October. DOI: 10.1177/1558689816674650.

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