

A WORLD OF POSSIBILITIES IN MIXED METHODS: REVIEW OF THE COMBINATIONS OF STRATEGIES USED TO INTEGRATE QUALITATIVE AND QUANTITATIVE PHASES, RESULTS AND DATA

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ABSTRACT

Mixed methods (MM) are increasingly popular. Researchers integrate qualitative (QUAL) and quantitative (QUAN) methods (e.g., research questions, data collections and analyses, and results). Several integration strategies have been proposed, but their conceptualization is usually design-driven, or fragmented, or not empirically tested. This is challenging for planning and conducting MM studies, and for training graduate students. Based on the methodological literature, we developed a conceptual framework including types of integration and practical strategies, and possible combinations. Then, we tested this framework using 93 health-related 2015 MM studies with a method-detailed description, which illustrated all types of combinations. Our work contributes to advance methodological knowledge on MM via (a) a call for better reporting health-related MM studies, and (b) a tested conceptualisation comprising 3 types of integration and 9 specific strategies, which explain current and future possibilities for combining strategies to integrate QUAL and QUAN phases, results, and data.

Key Words

Review; Mixed methods research; Research methodology; Methods; Research Proposal; Research techniques; Data reporting; Patient oriented research; Collaborative monitoring of research trends.

INTRODUCTION

Mixed methods (MM) involve combining qualitative (QUAL) and quantitative (QUAN) methods in program evaluation, primary research, and literature review (Creswell & Plano Clark, 2011; Johnson, Onwuegbuzie, & Turner, 2007; Pluye & Hong, 2014; Tashakkori & Teddlie, 2010). They are being increasingly used, specifically in health sciences. Over the years, several strategies to integrate QUAL and QUAN phases, results, and data have been proposed but rarely conceptualized and never tested in a comprehensive manner (Greene, 2008). For each MM researcher and teacher, one of the challenges is to plan, conduct, and report simply and clearly what are the applied specific MM strategies and their combinations. As a contribution for addressing this issue, the purpose of this article is to propose and test a conceptual framework of the combinations of strategies that are used in primary MM research.

In this article, to be considered MM, studies have to meet the following criteria (Creswell & Plano Clark, 2011): (a) at least one QUAL method and one QUAN method are combined; (b) each method is used rigorously in accordance to the generally accepted criteria in the area (or tradition) of research invoked (e.g., ethnography and randomized controlled trial); and (c) the combination of the methods is carried out at minimum through a MM design (defined *a priori*, or emerging) and the integration of the QUAL and QUAN phases, results, and data. The QUAL and QUAN methods can be also combined (but not necessarily) with regard to the data collection (mixed instrumentation), the literature review (mixed studies review justifying the MM research questions and design), and the MM team members' interpretations of sciences in terms of epistemology, ontology, teleology, and methodology (hereafter termed *worldview*).

Conversely, the following types of research are not considered MM in this manuscript: (a) a QUAN method with a collection and analysis of qualitative information that does not consist of *research data* because it does not refer to a QUAL research methodology and method, (b) a QUAL method with a collection and analysis of quantitative information that does not consist of research data because it does not refer to a QUAN research methodology and method, (c) a combination of QUAN methods, (d) a combination of QUAL methods, and (e) the juxtaposition of QUAL and QUAN methods (similar to two separate studies) without integration of QUAL and QUAN approaches, questions, designs, instrumentations, phases, results, and data.

Based on an overview of the methodological literature, we will first present the main elements of MM that form the basis of the conceptual framework. Then, we will propose the

framework that comprises three types of integration, nine specific strategies, and seven combinations of strategies to integrate the QUAL and QUAN phases, results, and data. We will describe how this proposal was tested using results of a collaborative monitoring of the strategies of MM analysis applied in Patient Oriented Research (POR). We will conclude by mentioning the limitations of our work and the practical implications.

Concept Boundaries

Our conceptual framework is based on three key aspects of the MM that are summarized in this section: the pluralism of worldviews, common types of designs, and the scientific rigor in data collection and analysis.

Pluralism of worldviews in MM. In 2003, Teddlie and Tashakkori affirmed the co-existence of different worldviews in MM. This pluralism is illustrated by numerous publications (Niglas, 2010). MM research team members may share a common worldview, and explicitly or tacitly agree with respect to the epistemological, ontological, teleological, and methodological foundations of their work (Gendron, 2001; Ridde & Dagenais, 2012). When a team includes MM researchers whose worldview differ, the combination of methods requires epistemological, ontological, teleological, and methodological discussions. For example, the team can seamlessly combine five common worldviews that recognize QUAL and QUAN methods such as Campbell's postpositivism, Hacking's social constructionism, pragmatism, critical realism, and critical theories (Campbell, 1988; De Waal, 2005; Hacking, 1999; Sayer, 2000; Tyson, 2014).

Common Types of MM Designs

A common classification of MM is based on two types of designs (sequential and convergent designs) and three main variants (multiphase, multilevel, and multiphase-multilevel) (Creswell & Plano Clark, 2011).

First, sequential designs use a QUAL method followed by a QUAN method (e.g., QUAN methods and results are used to statistically generalize some QUAL results), or a QUAN method followed by a QUAL method (e.g., QUAL methods and results are used to interpret some QUAN results). In any sequential design, Phase-1 results inform Phase-2. Assuming that a research project can be conceptualized as an organizational process (e.g., a collective project involving QUAL and QUAN researchers), the literature on organizations (management and project

management) provides a useful definition of such sequence (hereby defining the concept of integration in MM sequential designs). Inspired by Van de Ven (1992), a sequence consists of a developmental change in the project's orientation over time (results of a first data collection and analysis [phase-1] inform a second data collection and analysis [phase-2]), and a cognitive transition of the researchers at the time of change (from QUAL to QUAN, or from QUAN to QUAL).

Second, convergent designs combine the QUAL and QUAN methods during data collection and analysis, while the QUAL and QUAN methods are often (but not necessarily) concomitant. The literature on organizations and processes of collective decision-making (e.g., decisions made by a team of researchers using MM) provides a useful definition of convergence (hereby defining the concept of integration in MM convergent designs). Inspired by Langley, Mintzberg, Pitcher, Posada, and Saint-Macary (1995), convergence is defined as a process of progressive, successive, and constant improvements during the collection and analysis of QUAL and QUAN data (convergence of data), or the interpretations of results (convergence of results): the researchers work in a prospective, non-linear way, guided by a cognitive representation of the additional data, or databases, or analyses of data, or results to be created.

Third, the variants of these designs simply involve multiplying the phases or levels of data collection and analysis. The multiphase design includes three sequential phases (e.g., QUAL then QUAN then QUAL) or more (Lisle, 2013). The feasibility of this design can be problematic because each phase depends on the timely completion of the previous one. The multilevel design includes two levels of analysis (e.g., QUAN at the individual level and QUAL at the organizational level) or more (Dagenais, Nault-Brière, Dupont, & Dutil, 2008). This design is based on the convergence of the results of the analyses carried out at each level. In addition, Youngs and Piggot-Irvine (2011) combined the two variants and used a multiphase-multilevel design.

In MM designs (sequential, convergent, multiphase, multilevel, or multiphase-multilevel), the QUAL designs most commonly combined with a QUAN design are descriptive or interpretative qualitative research, exploratory case studies, ethnography, grounded theory, phenomenology, and life stories or biographies (Schwandt, 2007). The QUAN designs most commonly combined with a QUAL design are descriptive surveys (e.g., prevalence or incidence studies), non-randomized studies (e.g., analytical survey, or cohort, or case-comparison, or quasi-

experiment), and randomized controlled trials (Porta, 2008). Special mention can be made for case study and grounded theory that are usually QUAL, but may be QUAN or MM. The MM case studies incorporate QUAL and QUAN methods (multiple sources of evidence) to explain one or more cases (Yin, 2006). The MM grounded theory integrates QUAL and QUAN data to develop a theory (Johnson, McGowan, & Turner, 2010).

Rigor in MM Data Collection and Analysis

In accordance with these designs, any combination of QUAL and QUAN data collection techniques is possible in MM. MM researchers use all forms of experimental, observational, or simulated data collection. Nevertheless, traditional data collection techniques are most commonly used. The structured questionnaire tends to predominate in QUAN techniques, and the open or semi-structured interview tends to dominate in QUAL techniques (Bryman, 2006). The following QUAL and QUAN data collection techniques deserve special mention as they constitute a source of students' recurring questions in MM courses, and were important for selecting MM studies to test our conceptual framework.

The structured questionnaire combines closed questions (validated or derived from standard measurement) and open-ended questions. These open-ended questions can be seen as QUAL or QUAN methods depending on how they are designed and used. Answers to open-ended questions yield QUAL data when they are obtained through a rigorous QUAL methodology and research process (explicit, transparent, and reproducible) that produces plausible QUAL results (credible, contextual, confirmable, and transferable). Researchers know the participants and interact with them (by reformulating responses or stimulating the development of responses) to learn more about the context and to better understand the meaning of the data such as interviewees' words, non-verbal language, and context.

In contrast, a written response in an optional comment box to an open question that is asked at the end of an anonymous online self-administered questionnaire cannot be considered QUAL data. In epidemiological surveys, words obtained in this way traditionally provide some illustrations to discuss QUAN results. These words are information, but cannot constitute QUAL data because they were not obtained through a rigorous QUAL methodology and QUAL research process, and thus cannot produce trustworthy QUAL results. Researchers cannot know who wrote these words and why (anonymity); they cannot interact with those who have written and

those who have not written; they cannot know more about the context and better understand the meaning of the written words, or the reasons why nothing was written.

These concept boundaries are based on previous work on the critical appraisal of the methodological quality of MM. We combined a literature review with a pilot study including workshops and consultations with experts (Pace et al., 2012; Pluye, Gagnon, Griffiths, & Johnson-Lafleur, 2009), and developed a tool for critically appraising studies using QUAL, QUAN, and MM methods: the Mixed Methods Appraisal Tool (MMAT; Pluye et al., 2011). The MMAT uses different criteria for different methods. Thus, it allows researchers to evaluate the methodological quality of (a) the QUAL components of the MM based on criteria used for appraising QUAL methods, (b) the QUAN components of the MM based on criteria used in epidemiology for appraising QUAN methods, and (c) the quality of the specific MM components based on aforementioned definition-related criteria (justification of the MM design, the integration of QUAL and QUAN methods, and the added value and limitations of this integration). The MMAT is free and available on the internet (mixedmethodsappraisaltoolpublic.pbworks.com). It comes with a manual that makes it easy to use. Recent work has validated and tested the reliability of MMAT, and showed that this tool is efficient (Souto et al., 2015). The MMAT constitutes a popular proof-of-concept (more than 20,000 website visits and 500 citations in Google Scholar between 2013 and 2017), and is being improved using further validation research.

Overview of the Methodological Literature

In 2010, a 13-dimension general review of MM analyses was published (Onwuegbuzie & Combs, 2010), including the temporal sequence, the priority given to a particular analysis, the orientation (case- or variable-oriented analysis), the interdependence of analyses, the links between the analyses and the other aspects of designs (e.g., worldviews), and the generalizability (statistical or theoretical) of the results. Apart from this review, methodological articles and books propose single strategies (each strategy being presented as a necessary and sufficient process to obtain results), and publications are usually prescriptive (not tested empirically) and limited to few combinations (e.g., one-design and one-strategy combination).

We have analyzed the most cited methodological publications, and grouped strategies into three main categories of specific strategies: those that (a) connect the QUAL and QUAN phases, (b) compare the results of QUAL and QUAN, and (c) assimilate the QUAL and QUAN data. In the next section (conceptual framework), we will define each of these categories successively. These categories have been defined using harmonization principles (International Standards Organization [ISO], 2009; Roche, 2012), refer to the three common types of integration of QUAL and QUAN methods (phase connection, results comparison, and data assimilation), and integrate previous terminology (Bazeley, 2009; Greene, 2007; Teddlie & Tashakkori, 2009), as follows:

- (1) The phase connection is called *sequential development* (Bazeley, 2009), *correlation and comparison* (Greene, 2007), or *sequential mixed analysis* (Teddlie & Tashakkori, 2009).
- (2) The comparison of results is called *triangulation and expansion* (Bazeley, 2009), *joint inferential analysis* (Greene, 2007), or *parallel analysis* (Teddlie & Tashakkori, 2009).
- (3) The assimilation of the data is called *transformation* (Bazeley, 2009), *transformation and consolidation* (Greene, 2007), or *mixed analysis by conversion* (Teddlie & Tashakkori, 2009).

Furthermore, we have been guided by categories proposed by Creswell and colleagues, but did not limit each category to a MM design. In contrast, Creswell and colleagues (Creswell & Plano Clark, 2011; Guetterman, Fetter, & Creswell, 2015) appear to limit QUAL and QUAN phase connection to sequential designs, and QUAL and QUAN results comparison to convergent designs.

Three Types of Integration in MM

Greene (2007) and Teddlie and Tashakkori (2003, 2009, 2010) suggested three principles of MM (complementarity, dialectic tension, and unification) that justify three types of integration: phase connection, results comparison, and data assimilation. These three types are not mutually exclusive (i.e., they can be combined) and not hierarchically ordered; for example, phase connection does not refer to a higher (or lower) degree of integration compared to results comparison or assimilation of data.

Connection of phases. The complementarity principle is derived from the literature suggesting that the worldviews associated with the QUAL methods are different and separate

from those associated with the QUAN methods. Thus, methods for collecting and analyzing QUAL and QUAN data must be kept separated. QUAL and QUAN methods and results are presented separately in the MM publications, and the complementarity of the QUAL and QUAN results is described. Integration (cognitive transition) occurs during the connection between two phases (e.g., between a QUAL and a QUAN phase).

Comparison of results. The principle of dialectical tension comes from the literature suggesting that the worldviews associated with QUAL and QUAN methods are different and interdependent (their juxtaposition generating creative tensions leading to discovery and innovation). Thus, the QUAL and QUAN data collection and analysis methods are separated, or interconnected, and the results are interconnected using a comparison process. The similarities, differences and contradictions between QUAL and QUAN results are explained (guided by a cognitive representation of the results to be created). For instance, discrepancies between the QUAN and QUAL results are mentioned and discussed in the MM publications.

Assimilation of data. The third principle, unification, focuses on a worldview (or an approach such as participatory research) associated with the QUAL and QUAN methods. It corresponds to two streams of thought: on the one hand, MM can address research questions and mobilize theories that unify the use of QUAL and QUAN methods (independently of the worldviews); on the other hand, several worldviews directly allow the integration of QUAL and QUAN methods in MM (unification on a shared worldview). This principle justifies the assimilation of the data (guided by a cognitive representation of the results to be created). The QUAL and QUAN data can be transformed into a single QUAL (themes) or QUAN (variables) form, or merged on a case-by-case basis.

Conceptual Framework

In accordance with a typology of theories (Gregor, 2006), our conceptual framework refers to a *theory for explaining*: it states what are the MM analysis strategies (concepts), and how they are used (resource, process, and product) and combined (relationships between concepts). This conceptualization is summarized in Table 1 and Figure 1. It suggests that any study using MM may combine several strategies. Inspired by social constructionism (Hacking, 1999), each strategy produces a *mixed kind* using a *looping effect* between QUAL and QUAN phases, results, or data. In other words, each strategy is defined by a resource (an input in the

process of managing the research project using MM), a MM process (looping effect between QUAL and QUAN evidence), and a MM product (mixed kind of evidence). Any combination of strategies multiplies looping effects and mixed kinds. This conception is innovative because it incorporates all the strategies mentioned in the methodological literature, and all possible combinations of strategies.

In our conceptual framework, MM analysis strategies "consist of analytical techniques applied to QUAL and QUAN data" (standard procedures used in statistics and qualitative research), techniques for integrating phases, and outcomes and QUAL and QUAN data "at a single point in the research process or at multiple points" (Creswell & Plano Clark, 2011, p. 212). The latter are grouped into MM-specific strategies that are presented below in the form of proposals. For each type of integration, the specific strategies correspond to the basic strategies commonly described in the methodological literature. In evaluation, four basic strategies are usually described: typology and taxonomy development, extreme case analysis, data transformation, and data consolidation and fusion (Caracelli & Greene, 1993). In the health sciences, the basic strategies usually described are the comparison of results (triangulation), the following a thread, the merging of QUAL and QUAN data for each case (meta-matrix), and the transformation of QUAL data into QUAN (quantifying) or QUAN into QUAL data (qualifying) (O'Cathain, Murphy, & Nicholl, 2010; Sandelowski, 2000).

Integration 1: Connection of Phases

Strategy 1a. Connecting a QUAL phase to a QUAN phase. In this strategy, the resource consists of the QUAL results of Phase 1 (Creswell & Plano Clark, 2011). The process is the connection of the QUAL results with the Phase 2 QUAN data collection and analysis—for example, researchers use Phase 1 QUAL results to construct the Phase 2 QUAN questionnaire. The MM product consists of a QUAN data collection-analysis informed (or structured) by QUAL results. This strategy can achieve the following objectives (among others): (a) develop a typology (Phase 1 QUAL) and a taxonomy (Phase 2 QUAN); (b) create an instrument (Phase 1 QUAL) and use it for measurement (Phase 2 QUAN); (c) validate an instrument (QUAL validation of content, then QUAN validation of constructs; or ecological validation mixing QUAL content validation (e.g., exploring the representativeness of questions) and QUAN content validation (e.g., measuring the relevance of questions); (d) design an intervention (Phase

1 QUAL) and assess its effectiveness (Phase 2 QUAN); and (e) develop a conceptual framework (or theoretical model) for prediction including testable proposals (Phase 1 QUAL) and test them (Phase 2 QUAN).

Strategy 1b. Connecting a QUAN phase to a QUAL phase. The resource consists of the QUAN results of Phase 1 (Creswell & Plano Clark, 2011). The process is the connection of the QUAN results with the QUAL Phase 2 data collection and analysis—for example, researchers use Phase 1 QUAN results to identify key informant categories for the QUAL Phase 2. The MM product consists of a QUAL data collection-analysis informed (or structured) by QUAN results. This strategy can achieve the following objectives (among others): (a) validate an instrument (the QUAL data collection-analysis can yield explanations of QUAN results); (b) explain QUAN results using QUAL results obtained with a purposeful sample of key informants (sampling guided by QUAN results), for example, to better understand the differences between groups (such as the differences between intervention and control groups); and (c) help explain extreme cases.

1c. Specific strategy derived from 1a and 1b: Following a thread between QUAL and QUAN phases. The following thread strategy has been proposed by O'Cathain et al. (2010). The resource consists of the results of a QUAL or a QUAN phase. The process consists of connecting the results of this phase (e.g., QUAL) with the collection and analysis of the data of the other phase (e.g., QUAN) via the identification of a QUAL theme (or a QUAN key variable) and the new in-depth analysis of data related to this theme (or variable) in an iterative manner (back and forth between QUAL and QUAN phases). The MM product consists of QUAL or QUAN data analysis informed by QUAN or QUAL results, respectively.

Integration 2: Comparison of Results

Strategy 2a. Comparison of results obtained separately. In this strategy, the resource consists of the QUAL and QUAN results obtained through separate data collection and analysis (Creswell & Plano Clark, 2011). The process is a comparison by researchers of the similarities and differences between QUAL and QUAN results—for example, researchers can juxtapose these results in a table where each row corresponds to a main QUAL theme and the corresponding QUAN variable(s) (or vice-versa). The MM product consists of the researchers' interpretation or decision. Typically, a comparison table has four columns: sub-heading (Column

1), QUAL results (Column 2), QUAN results (Column 3), and interpretation or decision (Column 4).

Strategy 2b. Comparison of results obtained in an interdependent manner. The resource consists of the QUAL and QUAN results obtained from interdependent data collection and analysis (Creswell & Plano Clark, 2011). As in the previous strategy, the process is a researcher's comparison of similarities and differences between QUAN and QUAL results. The MM product consists of an interpretation or decision that explicitly takes account these interdependencies—for example, when a QUAN variable is derived directly from a QUAL theme (or QUAL participants recruited from the sample of QUAN participants). Where there is interdependence, researchers expect principally to present similarities—for example, a corroboration of the QUAL results with the QUAN results (or vice versa). Several assumptions can be made to explain differences if any (each difference might pose a threat to the internal validity of the QUAN results, or the credibility of the QUAL results).

Strategy 2c. Specific strategy derived from 2a and 2b: Divergence of QUAL and QUAN results. With regard to this specific strategy, researchers compare the QUAL and QUAN results by focusing on discrepancies (contradictions, discordances, or dissonances). As before, the process is a comparison by the researchers of QUAL and QUAN results. The MM product is an interpretation or decision for each discrepancy. In the MM literature, we have found examples that illustrate two main strategies that researchers use to deal with discrepancies between QUAL and QUAN results: reconciliation or initiation of a new research project (Pluye, Grad, Levine, & Nicolau, 2009).

Integration 3: Assimilation of Data

Strategy 3a. Transformation of QUAL data into QUAN data (quantitizing). In this strategy, the resource consists of all or part of the QUAL and QUAN data. The process is the transformation or conversion of QUAL data into QUAN data so that the former can be analyzed with QUAN data. For instance, researchers use the traditional technique of quantitative content analysis (Neuendorf, 2002): they transform key qualitative themes into a small number of variables, and the corresponding QUAL data into numerical values, using a grid and a validated and reliability tested coding manual. The MM product consists of QUAN data (combining QUAN data and QUAL data transformed into QUAN data) that can be analyzed using statistics

(frequentist or Bayesian) or Boolean algebra. The rigor of this strategy is based on the validity and the inter-rater reliability of the quantitative content analysis (the grid and the coding manual being the measurement instrument). Several scholars criticize this strategy on the pretext that it would "reduce" the QUAL data, although nothing prevents all QUAL data from being analyzed in a QUAL manner in parallel. The transformation of QUAL data into QUAN data simply yields added value in terms of analysis and results. For example, Fenenga and colleagues transformed the QUAL data collected at the health system level into QUAN data, which were included in statistical multilevel analyzes alongside QUAN data collected at the organizational and individual (health professional) levels (Fenenga et al, 2015).

Strategy 3b. Transformation of QUAN data into QUAL data (qualitizing). The resource consists of all or part of the QUAN data from epidemiological or statistical research, and QUAL data. The process is the transformation or conversion of the QUAN data into QUAL data so that the former can be analyzed with the QUAL data. Researchers use interpretive (e.g., thematic or constant comparison) analysis and transform statistical results into a narrative (e.g., organized by theme or concept) (Sandelowski, 2000). The MM product consists of QUAL data (combining QUAL data and QUAN data transformed into QUAL data) that can be analyzed in a narrative manner. As in the previous strategy, there is nothing to prevent all QUAN data from being analyzed statistically in parallel, and the QUAN data transformation into QUAL data provides added value in terms of analysis and results. For example, Reichwein and colleagues transformed QUAN data collected at the national level into QUAL narrative data, which were included with QUAL data to describe two ideal-typical persons and target prevention programs (Reichwein et al, 2015).

Strategy 3c. Merging QUAL and QUAN data. In this last specific strategy, the resource consists of cases (e.g., specific organizations) and case-related QUAL and QUAN data (O'Cathain et al., 2010). The process is the merger of QUAL and QUAN data on a case-by-case basis (intra-case analysis) to allow for inter-case analysis. The MM product consists of a new set of data that can be analyzed statistically (e.g., case description and hypothesis testing) and in a narrative manner (e.g., case histories). The rigor of this strategy is based on a clear definition of cases, and the collection of QUAL and QUAN data for each case. For example, clinicians assessed the relevance, cognitive impact, and use of information found in specialized medical resources using a validated questionnaire (longitudinal QUAN study); the cases were defined as

information searches where clinical information was used for a specific patient; for each case, clinicians were interviewed and described the effects of using this information on patient health (multiple QUAL case study); the QUAN and QUAL data were merged into clinical vignettes (each vignette describing a case), and these vignettes were used to construct a MM *meta-matrix*, which led to an estimate of the proportion of patients for whom clinicians associated information use with health benefits (Pluye, Grad, Johnson-Lafleur, et al., 2013; Pluye, Grad, Repchinsky, et al., 2013).

Combinations of Strategies

Therefore, we propose a conceptual framework that comprises these three types of integration and nine specific strategies, and seven combinations of strategies, for integrating QUAL and QUAN phases, results, and data in MM research. A combination is defined by one or more elements of a set, hereafter one or more than one type of integration (1, 2 and 3), whereas each type corresponds to three practical specific strategies (connection of phases [1a, 1b and 1c], comparison of results [2a or 2b or 2c], and assimilation of data [3a, 3b and 3c]). The originality and innovation of this framework is to propose a set of possible relationships among types of integration (three solo combinations: type 1, or 2, or 3; three duo combinations: type 1 and 2, or 1 and 3, or 2 and 3; and one combination trio: type 1 and 2 and 3) and corresponding combinations of strategies to plan, conduct, and report MM research (Table 1 and Figure 1).

METHODOLOGY AND METHODS

To test this conceptualization and identify emerging (unexpected) strategies, we used an original system for collaborative monitoring of research trends. This system is called eSRAP (Box 1) (Tang, Pluye, & Bouthillier, 2015); eSRAP enables the collaboration of community members in Patient Oriented Research (POR) to evaluate and share research studies in a way that is tailored to the needs of users.

The authors of this chapter have contributed to the development of the eSRAP prototype, which was specifically designed to facilitate the monitoring of advanced MM developments as soon as the corresponding publications appear in bibliographic databases. At the time this manuscript is written, five researchers (teachers and alumni of MM courses offered by the

Department of Family Medicine at McGill University since 2008) use eSRAP to monitor and analyze MM strategies to integrate QUAL and QUAN phases, results, and data.

Using eSRAP, we selected articles that describe in detail the MM strategies used in POR. Our eligibility criteria were the following: empirical study (including collection and analysis of data obtained from observation, experimentation, or simulation) using MM in POR, and published in 2015. Our source of information was the Scopus bibliographic database (searched up to January 30, 2017). We used the following query: "TITLE (mixed PRE/5 method*) AND SUBJAREA (MEDI OR SOCI)". This allowed us to identify records (authors, journal, year, title and summary) related to the MM with a high precision/specificity (low recall/sensitivity), which was deemed appropriate to obtain a manageable set of records and a large sample of MM studies.

For each record, at least two authors participated in the coding process and discussed disagreements between coders (PP & EGB, or PP and NK). Relevant records and corresponding full-text articles were selected using a coding manual. The three main codes (eligibility criteria) were: report of an empirical POR study, using MM, and including a detailed description of the methods. The code MM was based on the aforementioned definition. The POR code involved use of the Canadian Institutes of Health Research (CIHR) definition where POR refers to a continuum of research that engages patients as partners, focuses on patient priorities, and improves health services and patient health. The POR is usually multidisciplinary and conducted in partnership with all stakeholders. In POR, the concept *patient* refers to the general population, including people facing a social or health problem and their family caregivers.

For each relevant record, the full-text article was retrieved and coded by at least two authors (PP & EGB, or PP and NK). Only studies with a detailed description of the application of MM were included. The '*Good Reporting of A Mixed Methods Study*' (GRAMMS) recommendations were used to define this eligibility criterion (O'Cathain, 2010). Minimally, the three main components of MM (QUAL methods, QUAN methods, and the integration of QUAL and QUAN methods) had to be described in at least one paragraph each. Studies were included when these paragraphs (together) described at least (a) the MM objective and design; (b) the QUAL and QUAN sampling, data collection, and analysis; and (c) the integration of QUAL and QUAN phases, results, and data (the *abc* of the GRAMMS recommendations). The three other GRAMMS recommendations were used to describe the included studies: (d) a justification for

using MM, (e) a description of the value added of the integration of the QUAL and QUAN methods, and (f) a description of the limitations of this integration.

For each included study, at least two authors (PP & EGB, or PP and NK) assigned the type of design (sequential, convergent, multiphase, multilevel, or multiphase-multilevel) and the type(s) of integration and applied strategy (connection of phases [1a, 1b and 1c], comparison of results [2a or 2b or 2c], assimilation of data [3a, 3b and 3c], and ‘other’ emerging/unexpected strategy). The results are presented in the following section.

RESULTS

Of 704 documents entitled "Mixed Methods" and published in 2015, 333 reported a POR-related work (Figure 2). Of these, 257 (77.2%) met the definition of MM. Seventy-six (22.8%) did not meet this definition for the following reasons: 34 (10.2%) reported quantitative data collection or analysis (QUAN only) and qualitative information (e.g., information based on comments provided at the end of the self-administered anonymous structured QUAN questionnaire) that were not considered *research data* because they did not refer to a QUAL methodology and method; 23 (6.9%) reported qualitative data collection or analysis (QUAL only) and quantitative information (e.g., information describing participants) that were not seen as research data because they did not refer to a QUAN methodology and method; two (0.6%) reported a juxtaposition of separate QUAL and QUAN methods without integration (similar to two separate studies); and 17 (5.1%) were excluded for various reasons (integrated literature review, methodological work, or confusing text).

Among the 257 (77.2%) documents that involved the reporting of a POR empirical study and met the definition of MM, only 93 (27.9%) provided a detailed description of the three main MM components (the abc of GRAMMS recommendations). The other documents ($n = 164$; 49.3%) barely mentioned the MM design and methods in one sentence, or described them succinctly in one paragraph, or described only the QUAL and QUAN components (not the MM component).

The following results focus on the 93 articles that reported a POR study with a detailed description of MM. In this sub-sample, 52 (55.9%) studies used a convergent design, 35 (37.6%) a sequential design, four (4.3%) a multiphase design, one (1.1%) a multilevel design, and one

(1.1%) combined convergent and sequential designs (results of a phase-1 convergent QUAL/QUAN design informed a QUAN Phase 2). Of these 93 articles, only nine (9.7%) satisfied the three other GRAMMS recommendations (d,e,f), 29 (31.2%) met two, 34 (36.5%) one, and 21 (22.6%) none. Table 2 (distribution of combinations per type of design) and Figure 3 (Venn diagram) present the multiple combinations of MM strategies observed across these 93 studies. All combinations were observed (1; 2; 3; 1 and 2; 1 and 3; 2 and 3; 1 and 2 and 3). No emerging (unexpected) strategy or combination was observed.

DISCUSSION

These results show that MM studies can combine several strategies, and support the proposed conceptual framework. Based on the MM literature, the framework comprises three types of integration (connection of phases, comparison of results, and assimilation of data), nine specific strategies (three for each type of integration), and seven combinations of strategies to integrate QUAL and QUAN phases, results, and data in MM. These combinations offer multiple new possibilities for planning, conducting, and reporting MM research. Although our conceptualization and the eSRAP monitoring system allowed us to identify emerging strategies, we did not detect any yet.

Our results focus on POR, and future research can test whether this conceptual framework is equally applicable for the social sciences. It would also be interesting to check whether this framework is applicable for MM applied in the areas of literature review and program evaluation. We monitored only a sample of studies using MM in POR published in 2015, and did not aim to provide an exhaustive description of MM in this area. Although these results are limited with respect to completeness, they show that eSRAP offers the advantage to a growing community of MM researchers to keep up-to-date on MM trends by sharing the burden of selecting detailed studies. Another limitation of our work stems from the lack of assessment of the methodological quality of the included studies. We retained only the documents that provided a detailed description of the QUAL, QUAN, and MM aspects without consideration of the conceptual and methodological quality.

Future research will be able to clarify this using the MMAT for instance, and examine the association between the quality of the reporting (description of the methods) and the methodological quality in MM. The quality of the reporting is mainly associated to the written

information about the study design, data collection, and analysis (Huwiler-Müntener, Jüni, Junker, & Egger, 2002). Reporting refers to key concepts of scientific quality such as transparency and completeness (Simera et al., 2010). Stated otherwise, research articles are deemed to provide clear and detailed sufficient information to allow readers to understand a study (Simera et al., 2010). It is often argued that the quality of reporting and methodological quality are related because a poorly reported study can hardly be critically appraised (Carroll, Booth, & Lloyd-Jones, 2012).

In addition, our results suggest that almost one out of five POR studies ($n = 59$; 17.7%) entitled “mixed methods” do not meet the basic definition criteria of MM, and correspond to studies using QUAL methods, or QUAN methods, or QUAL and QUAN methods without integration. This proportion can be interpreted as a sign of the recognition of MM and an illustration of the extremes of the continuum between QUAL and QUAN methods (Figure 4). It suggests that MM is attractive to POR researchers and publishers (positive publication bias). This, nevertheless, suggests that journals still published studies entitled “Mixed Methods” that were not completely seen as MM by the international MM community: in 2015, MM researchers agreed that MM integrate rigorous QUAL and QUAN methods (Creswell & Plano Clark, 2011; Johnson et al., 2007; Plano Clark & Ivankova, 2016).

In turn, this might suggest that “Instructions to Authors” may systematically include specific recommendations to motivate researchers to describe MM analysis strategies and combinations, and general recommendations for reporting MM such as GRAMMS (O’Cathain, Murphy, & Nicholl, 2008), which are available through the Equator Network (the international clearinghouse of reporting guidelines: www.equator-network.org). Like any scientific work, MM must be explicit, transparent, and reproducible. Specifically, better describing MM will be useful to help students understand the methods and strategies used to integrate QUAL and QUAN phases, results, and data. Indeed, our results suggest that the proportion of the poor quality of reporting MM is substantial. Eight years after the publication of the six GRAMMS recommendations, approximately two thirds of MM studies in POR ($n = 163$; 63.4%) are not even reported according to the ‘abc’ of GRAMMS (no descriptions of the QUAL, QUAN, and MM aspects). Almost all ($n = 248$; 96.5%) MM studies in POR do not apply all six GRAMMS recommendations (abcdef). There seems to be a need for active promotion of good reporting practices among POR researchers and editors via the *Mixed Methods International Research*

Association (MMIRA) and affiliated organizations such as ‘*Méthodes mixtes francophonie*’ (MMF).

Finally, our results are based on an innovative collaborative system for monitoring research trends (eSRAP) that was used for MM, and can be used for any other topic. Specifically, eSRAP is adaptable to the individual needs of evaluators, researchers, and teachers (each user of eSRAP can create and use custom tags to identify studies of interest), and allows them to share the burden of monitoring the literature. For example, each member of the eSRAP MM community can benefit from the prospective work of all members at any time. For teachers of MM, eSRAP allows in a few clicks before each course to retain recent studies as pedagogical material for the students using ‘filters’. The eSRAP system provides a quick way to find recent articles illustrating each strategy in detail, and is used by MM teachers at McGill University for the annual FMED 672 'Applied Mixed Methods in Health Research' 3-credit graduate course.

CONCLUSION

This manuscript assumes the pluralism of MM in terms of worldviews, and the collaboration of MM research team members who must reconcile their worldviews when they are different, and vouch for the methodological rigor of QUAL, QUAN, and MM aspects of their work. This manuscript contributes to advance methodological knowledge on MM via a conceptualisation comprising three types of integration and nine specific strategies, which explain multiple current and future new possibilities for combining strategies to integrate QUAL and QUAN phases, results, and data. In addition, this manuscript contributes to knowledge on MM in terms of definition and practice. It defines the concepts of sequence and convergence using the literature on project management, and it guides students and researchers for planning, conducting, and reporting MM studies. For any researcher or editor, our results show the importance of simply and clearly reporting all QUAL, QUAN, and MM aspects of research studies, including the specific MM strategies used and their combinations.

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Table 1. Nine MM Strategies for Integrating QUAL and QUAN Phases, Results, or Data

3 TYPES OF INTEGRATION & 9 SPECIFIC STRATEGIES	DEFINITIONS
TYPE 1: Connection of phases	Connection of the QUAL and QUAN phases
1a. Phase QUAL to phase QUAN	Connect the results of a QUAL phase-1 with the collection and analysis of a QUAN phase-2 [1]
1b. Phase QUAN to phase QUAL	Connect the results of a QUAN phase-1 with the collection and analysis of a QUAL phase-2 [1]
1c. Special case of 1a and 1b : Following a thread	Analyze the QUAL (or QUAN) data and identify the main themes (or variables) that require further study; Choose a theme (or variable) and re-analyze through the QUAN (or QUAL) components [2]
TYPE 2: Comparison of results	Compare the results of QUAL and QUAN components
2a. QUAL and QUAN results obtained separately	Compare similarities and differences between QUAL and QUAN results obtained from separate data collection and analysis [1]
2b. QUAL and QUAN results obtained in an interdependent manner	Compare similarities and differences between QUAL and QUAN results obtained from interdependent data collection and analysis [1]
2c. Special case of 2a and 2b : Divergence of QUAL and QUAN results	Interpret differences (contradictions, discordances or dissonances) between QUAL and QUAN results [3]
TYPE 3: Assimilation of data	Assimilate QUAL and QUAN data
3a. QUAL data in QUAN data	Assimilate QUAL and QUAN data by transforming QUAL data into QUAN data [1]
3b. QUAN data in QUAL data	Assimilate QUAL and QUAN data by transforming QUAN data into QUAL data [1]
3c. Merging of QUAL and QUAN data	Assimilate QUAL and QUAN data by merging them for each case in an additional database [1].

TYPE 4: Emerging strategies	To be discovered by monitoring trends in MM with eSRAP
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References: [1] (Creswell & Plano Clark, 2011); [2] (O'Cathain et al., 2010); [3] (Pluye, Grad, et al., 2009).

Table 2. Distribution of Studies According to Common Types of MM Design and Seven Combinations of MM Strategies (n = 93)

3 TYPES OF INTEGRATION 9 TYPES OF STRATEGIES	COMBINATIONS OF STRATEGIES (ACCORDING TO THE TYPE OF MM DESIGN) (n =number of studies illustrating each combination)				
	Sequential	Convergent	Multiphase	Multilevel	Other*
1. CONNECTION OF PHASE					
1a. Phase QUAL to phase QUAN	1a (n=3)	na	1a (n=1)		
1b. Phase QUAN to phase QUAL	1b (n=10)	na	1b (n=1)		
1c. Special case : Following a thread		1c & 2a (n=1)	1a & 1b & 1c & 2b (n=1)		1c & 2b (n=1)
2. COMPARISON OF RESULTS					
2a. QUAL and QUAN results obtained in a separate manner	na	2a (n=13)			
2b. QUAL and QUAN results obtained in an interdependent manner	1a & 2b (n=5) 1b & 2b (n=11)	2b (n=26)	1a & 2b (n=1)		
2c. Special case: Divergence	1a & 2b & 2c (n=2) 1b & 2b & 2c (n=1)	2a & 2c (n=3) 2b & 2c (n=2)			
3. ASSIMILATION OF DATA					
3a. QUAL data in QUAN data	1a & 3a (n=1)	2b & 3a (n=2) 3a (n=2)		3a (n=1)	
3b. QUAN data in QUAL data		3b (n=1)			
3c. Merging of QUAL and QUAN data	1a & 2b & 3c (n=1) 1b & 3c (n=1)	2b & 3c (n=1) 2b & 3b & 3c (n=1)			
4. EMERGING STRATEGIES					

• None found yet					
OBSERVED COMBINATIONS OF TYPES OF INTEGRATION	4 (n=35)	5 (n=52)	2 (n=4)	1 (n=1)	1 (n=1)
• Number of solo combinations	1 (n=13)	2 (n=47)	1 (n=2)	1 (n=1)	
• Number of duo combinations	2 (n=21)	2 (n=5)	1 (n=2)		1 (n=1)
• Number of trio combinations	1 (n=1)				

*Other design: Variant of a sequential design where results of a Phase 1 convergent design (QUAL+QUAN) informed a Phase 2 QUAN.

Note: The logo '&' (meaning 'and') allows to represent the combinations with several strategies.

Figure 1. Seven combinations of MM strategies for integrating QUAL and QUAN phases, results, or data.

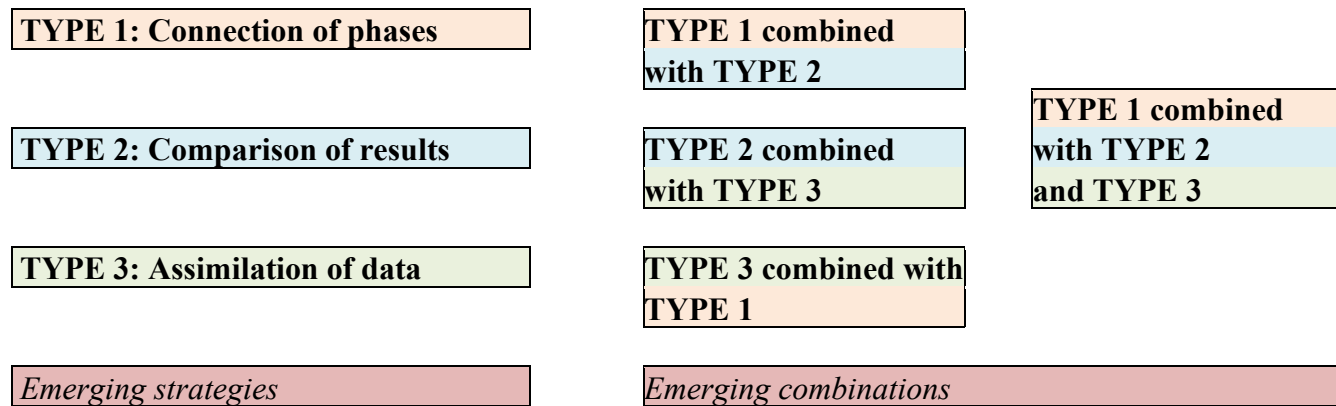
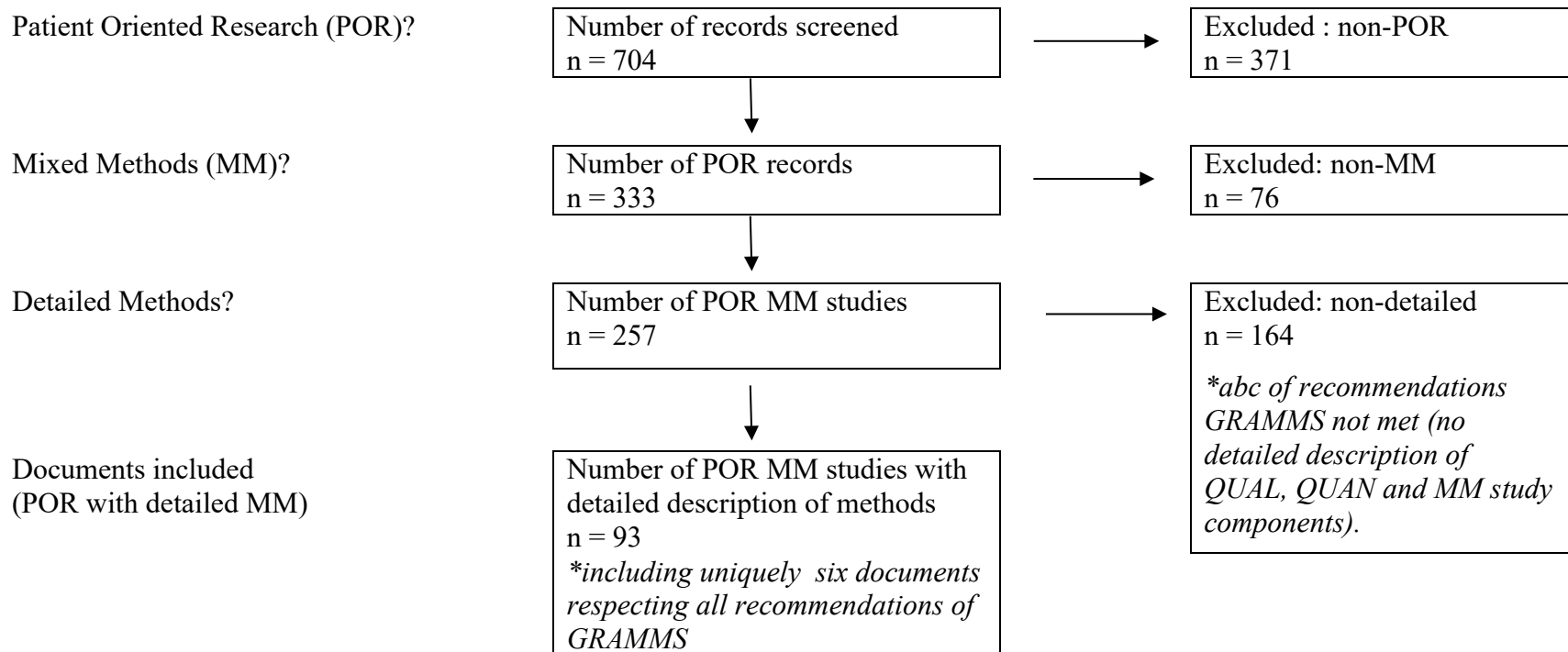
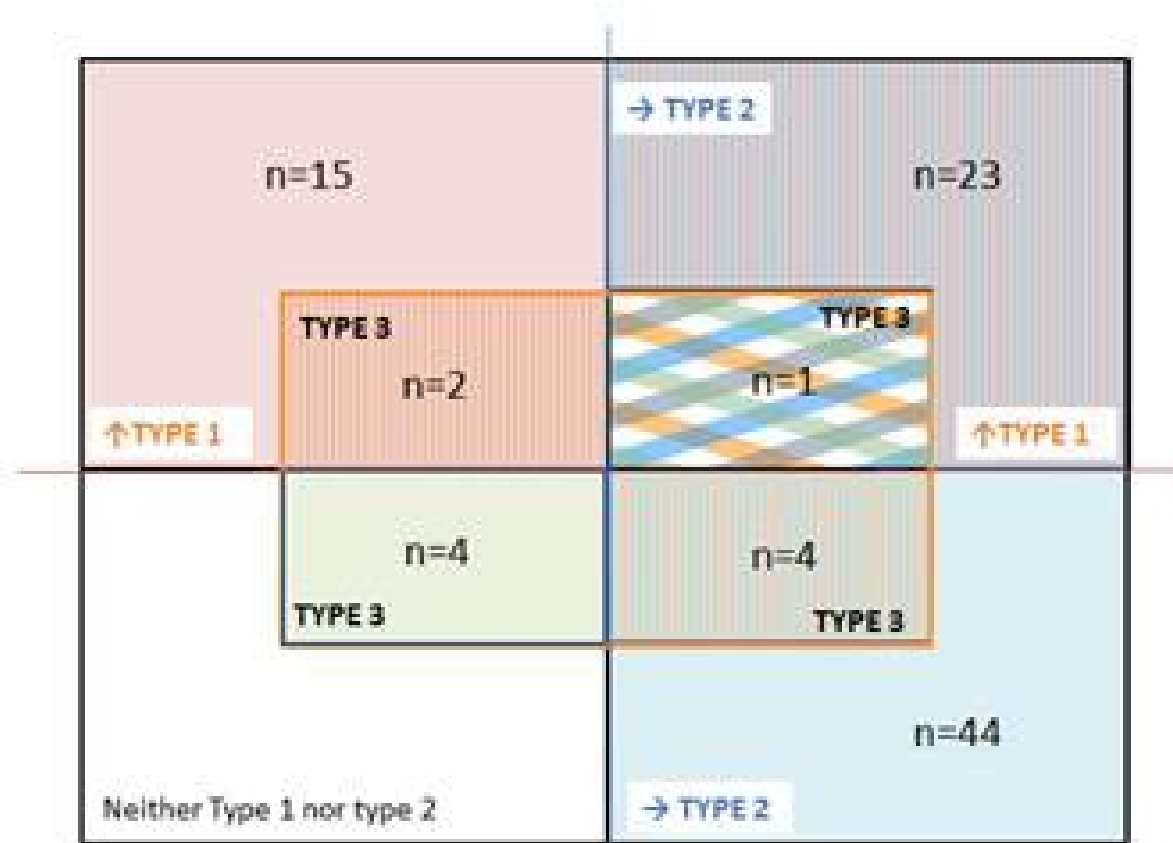


Figure 2. Diagram of flux.



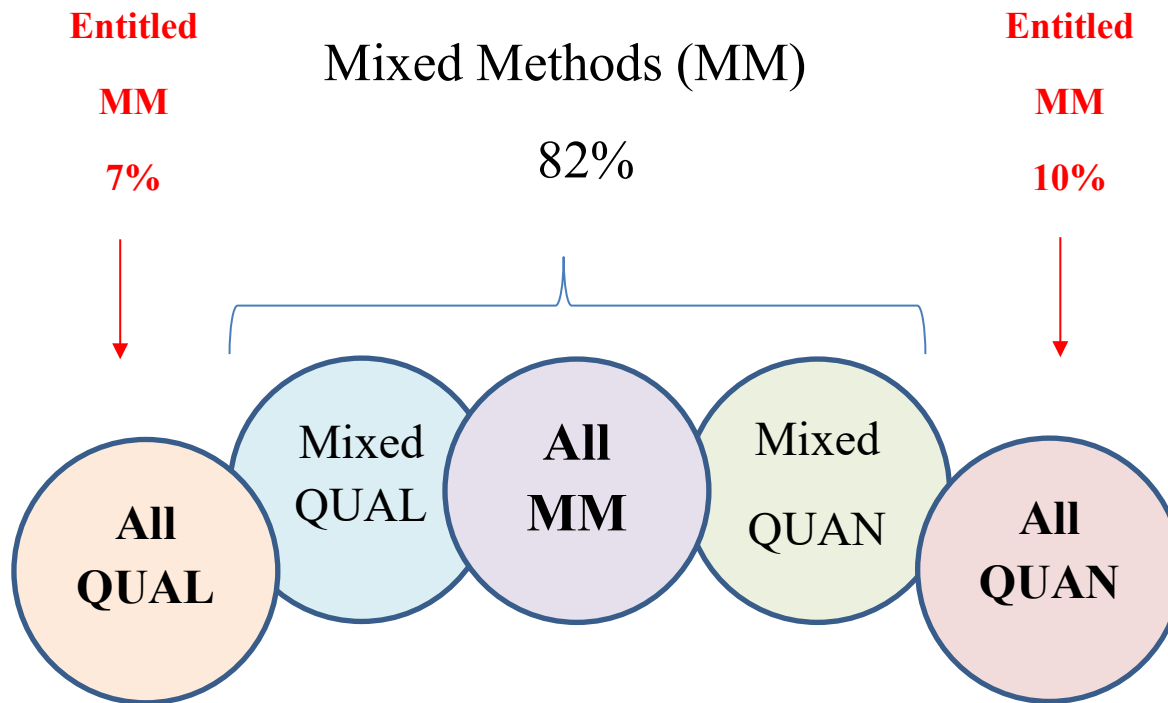
*Reporting a MM study includes providing a detailed description of QUAL, QUAN, and MM components according to the *abc* of GRAMMS recommendations: (a) justification and MM design; (b) sampling, collection, and analysis of QUAL and QUAN data; (c) the integration of QUAL and QUAN phases, results, and data. The three other GRAMMS recommendations are: (d) a justification for using MM; (e) a description of the value added by integrating methods; and (f) a description of the limitations of such integration.

Figure 3. Venn diagram: Logical relations between combinations of types of integration



Type 1: connection of phases; Type 2: Comparison of results; Type 3: Assimilation of data

Figure 4. QUAL or QUAN studies entitled “mixed methods” (but not meeting MM criteria).



Other entitled MM: separate QUAL and QUAN studies without integration (1%)

Adapted from (R. Johnson et al., 2007)

BOX 1. eSRAP: Monitoring trends in Patient Oriented Research

eSRAP is a user-centered research trend monitoring (RTM) system that enables the collaboration of Patient Oriented Research (POR) community members to analyze and understand the environment and emerging trends in their research areas with the goal of keeping up to date. Specifically, eSRAP enables the monitoring and filtering of cutting-edge developments as soon as they appear in bibliographic databases.

RTM uses the principles of competitive intelligence and environmental scanning to update users with the latest knowledge in a rapid, consistent, and structured way. RTM can complement systematic literature reviews and replace traditional alert mechanisms. On the one hand, systematic reviews are comprehensive and produce valuable recommendations, but are costly and inherently post hoc, and not continuously updated. On the other hand, traditional alert systems (e.g., RSS) merely provide a non-classified and often irrelevant titles and abstracts.

RTM provides a selection of relevant quality documents and analytical insights by and for user communities. RTM capitalizes on and leverages a large and fast growing body of scientific knowledge and projects with few resources (resource commitment decreases when the number of active community members increases). RTM focuses on the newest protocols and publications and is forward-looking by nature.

Each eSRAP component can be adapted to fulfill the needs of POR communities. The monitoring strategy is determined with subject/domain experts (e.g., POR community leaders). A structured approach to disseminate and organize new knowledge is validated and operationalized. Analyzes can be automated (with algorithms), semi-automated, or manual. Alerts can be created for the dissemination of new knowledge and findings to community members. The POR community can use this structured and continuously-updated knowledge repository to generate insights for training, protocols and publications in traditional and social media.

eSRAP is funded by the Quebec SPOR SUPPORT Unit (<http://unitesoutiensrapqc.ca>) and designed by academic and industry experts in competitive intelligence and Science & Technology monitoring.

Reference : Tang D, Pluye P & Bouthillier F (2015). eSRAP: A research trend monitoring system enabling the collaboration of members of Patient Oriented Research (POR) communities for rating records and sharing research results and protocols in a user customized way.

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