Title

Pillar Integration Process: A joint display technique to integrate data in mixed methods research

Authors and affiliations

Dr Rebecca Johnson

Division of Health Sciences, Warwick Medical School, The University of Warwick, Coventry, UK, CV4 7AL

Mrs Amy Grove

Division of Health Sciences, Warwick Medical School, The University of Warwick, Coventry, UK, CV4 7AL

Professor Aileen Clarke

Division of Health Sciences, Warwick Medical School, The University of Warwick, Coventry, UK, CV4 7AL

Contact information for the corresponding author

Dr Rebecca Johnson

Room B-162, Division of Health Sciences

Warwick Medical School,

The University of Warwick

Coventry, UK, CV4 7AL

Rebecca.Johnson@warwick.ac.uk

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Abstract

Despite an emphasis on integration in mixed methods research, there remain relatively few well-articulated integration techniques for use by researchers. We developed the Pillar Integration Process, a transparent and rigorous four-stage technique for integrating and presenting qualitative and quantitative findings in a joint display. The purpose of this paper is to describe the technique and illustrate how it was developed and applied using via two examples from health sciences. The first is an evaluation of a health improvement program, the second is a mixed methods systematic review to identify interacting factors which influenced decision-making in orthopedics. Future research can provide additional evidence on the value of the PIP technique within a mixed method approach.

Keywords

Integration, mixed methods, joint display, intervention evaluation, evidence synthesis

Word count

5999 (including abstract [165] excluding, references, appendices and tables)

Interest in mixed methods research is expanding, and it has become increasingly sophisticated in research which spans different disciplines (Creswell et al., 2011). Greene (2007) suggested that strategies for integrated data analysis are a priority. (Bazeley, 2009a) discussed how data integration can help to generate insights such as the identification of subgroup characteristics, demonstrating parallels between behavioral characteristics and scaled scores, showing the pattern of relationships between different variables, and the identification of deviant cases within a study set.

Several authors have developed critical appraisal frameworks and methods of assessing the quality of mixed methods research, including Onwuegbuzie and Johnson (2006), Dellinger and Leech (2007), and Heyvaert et al. (2013), who considered integration techniques necessary to promote methodological rigor. In their best practice guidance, Creswell et al. (2011) described a methodological preference for systematic integrative procedures. These include merging, connecting and embedding described below:

- merging (e.g., joint display [also referred to as a metamatrix or matrix] using tables or figures that combine and display both quantitative and qualitative data together);
- connecting (e.g., analyzing a quantitative dataset and using the information to inform subsequent qualitative data collection); and
- embedding (e.g., a qualitative dataset of secondary priority is embedded within a larger, primary quantitative design) (Creswell, 2003; Creswell & Clark, 2007)

Despite the rapid adoption of mixed methods, Fetters and Freshwater (2015) suggested there remains an “integration challenge”, i.e., an “imperative to produce a

whole through integration that is greater than the sum of the individual qualitative and quantitative parts" (p.116). Yin (2006) provided insight into the challenge of structuring integration approaches, noting particularly that "of all the procedures, analytic integration may be the trickiest" (p.45).

Data Integration Approaches and Techniques

Creswell and Clark (2007) have described three main approaches to mixed methods research which contain six basic study designs and four common analytical techniques. Data integration is one part of a mixed methods analysis which can be conducted using a broad spectrum of approaches and techniques. These are used to blend, weave, combine and ultimately synthesize two or more types of data together. The overall approach to data integration could utilize one of the four common techniques highlighted below:

- data transformation or conversion (i.e., transforming qualitative textual data into quantitative numerical data, or vice versa);
- visual presentation of data using a matrix or joint display (i.e., to study qualitative and quantitative data from the same case in parallel);
- following a thread (a multistage technique that aims to conduct primary analysis of all aspects of a study, identifying key themes for further exploration and following those key issues across other data groups within the study); and
- triangulation/comparison of datasets (data are collected and analyzed separately and then combined at the point of interpretation, checking for agreement or disagreement between findings which examine the same phenomena) (Bazeley, 2009a, 2012; Caracelli & Greene, 1993; Creswell et al., 2011; Fetters et al.,

2013; Harden & Thomas, 2005; Miles & Huberman, 1994; O'Cathain et al., 2007, 2010; Teddlie & Tashakkori, 2009; Yin, 2006).

In this paper, we define the integration or mixing 'approach' as one that merges, connects or embeds qualitative and quantitative procedures at some point in the collection, analysis and interpretation of data. In contrast, we define a mixed method analytical integration 'technique' as a procedure to combine or integrate findings specifically within the analytical or interpretation stages of a study.

Visualizing Data Using Joint Displays

A key feature of data integration can be the visual presentation of data and the synthesis or merging itself. Leaders in the field of mixed methods have called for greater articulation of data integration methods and an increased use of joint displays to enhance the insight of findings obtained through mixed methods approaches (Bazeley, 2009b, 2012; Fetters & Freshwater, 2015; Guetterman et al., 2015; O'Cathain et al., 2008; Yin, 2006).

Miles and Huberman (1994) popularized the use of joint displays and more generally the visual presentation of data using a matrix, with other important contributions made by Happ et al. (2006) and Bazeley (2009a). The joint display technique to integrate data can be used when qualitative and quantitative data exist for the same case and can be studied together (O'Cathain et al., 2010). Cases are the units of study and can be individuals, settings, phenomena or data on the same topic or result in an evidence synthesis.

Guetterman et al. (2015) reviewed different types of joint displays for visualizing data integration and made several recommendations for best integrative practice,

including: label quantitative and qualitative results; be consistent with the design and the integration approach; and identify inferences or insights generated.

Problem to be Addressed

These examples of best practice and guidelines support increased quality in the design, reporting and evaluation of mixed methods studies. Researchers are encouraged to describe their integration approaches, not least to provide more consistent and greater transparency to help develop and improve mixed methods techniques (O'Cathain et al., 2010). However, there remain few mixed methods studies which systematically describe each of the components of mixed methods integration, limiting the amount of knowledge that has been gained (Fetters & Freshwater, 2015; O'Cathain et al., 2010). Existing studies do not discuss in-depth, replicable techniques for integrating different types of data.

Objective

In order to address the lack of specific, transparent, well-defined analytical techniques to support the integrated joint display approach, we define and describe the development and validation of a four-stage analytical technique for systematically integrating qualitative and quantitative findings using a joint display format, called the “Pillar Integration Process” (PIP). PIP aimed to minimize observer bias and maximize opportunities for synthesis, both visually and methodologically. We illustrate the development of this technique using two different examples from Health Sciences.

The first example originates from a multi-intervention public health improvement program that used a mixed methods evaluation framework R. E. Johnson (2013). The second example comes from a mixed methods evidence synthesis of decision-

making in orthopedic surgery (Grove et al., 2016). We sought to incorporate the recommendations of Guetterman et al. (2015) for best integrative practice into the development of this technique.

Pillar Integration Process Development Example One: City Health Improvement Program

Context: Example One

The development of PIP was underpinned by a subtle realist epistemological view (Hammersley, 1992). This view reflects the notion that we can only know reality from our own perspective of it. This is aligned with the pragmatic approach to mixing methods (R. B. Johnson & Onwuegbuzie, 2004; R. B. Johnson et al., 2007).

Methods: Example One

The Pillar Integration Process was initially developed to integrate quantitative and qualitative data collected as part of an evaluation of a City Health Improvement Program (CHIP) (example one). This was a three year (2009-2012) funded project jointly managed and delivered by a City Council and the National Health Service (NHS) in a city in England (we have anonymized the location). The program aimed to minimize the burden of poor physical and mental health, and to maximize the benefits associated with good physical and mental wellbeing, thereby improving the quality of life for residents of the City. The CHIP comprised nine projects, including over 40 short-and long-term interventions. Five CHIP interventions that specifically addressed mental wellbeing as a component were selected, including one

intervention to improve mental wellbeing in school-age young people using ‘Wellbeing Mentors’, who acted as health and wellbeing counsellors.

These five interventions were evaluated in an enhanced mixed method approach, using a sequential explanatory design (Figure 1). It included a before-and-after quantitative evaluation (analyzed using descriptive and inferential statistics) and 15 semi-structured qualitative interviews with evaluation and management staff to examine their attitudes towards, and the process of, delivering the CHIP interventions (analyzed using a thematic analysis). A joint display was used for integration because it provided adequate methodological structure without being rigid in defining criteria for use. It enabled us to focus on the issues surrounding each intervention separately (O'Cathain et al., 2010). Full details of data collection and analysis are available elsewhere (R. E. Johnson, 2013).

<Inset Figure 1 about here>

Figure 1. The individual components of the City Health Improvement Program evaluation

Initial quantitative analysis of the Wellbeing Mentors intervention revealed variation across settings. There were low rates of participation and high rates of invalid data in some schools. Initial qualitative analysis revealed problematic processes during the delivery and evaluation of the intervention that posed challenges and barriers to public health practice (R. E. Johnson et al., 2016). Gaps remained in our understanding of how the quantitative limitations identified in the evaluation might have been empirically connected to the qualitative barriers that staff described during interviews. We sought to integrate the data but found no step-by-

step instructions for creation and analysis of a joint display. It was in this context that we developed the Pillar Integration Process, both to expand our understanding of these barriers (Greene et al., 1989) and to provide a more transparent explanation of what was happening at each stage of the analytic process. Therefore, PIP was created to integrate quantitative and qualitative data that have undergone an initial separate analysis, for example quantitative results and qualitative findings that have been produced, but not yet integrated.

The Four Stages of the Pillar Integration Process

There are four stages to PIP (listing, matching, checking, and pillar-building) that are completed sequentially, after the initial quantitative and qualitative analyses have been completed separately. A blank PIP diagram is included in Figure 2 for illustrative purposes. The arrows in Figure 2 demonstrate how the joint display is completed from the outside columns first, working towards the central column as the data become integrated. Either the QUANT DATA or the QUAL CODES column can be the starting point.

<Insert figure 2 about here>

Figure 2. A generic diagrammatic representation of the Pillar Integration Process to demonstrate column headings and direction of integration

Each stage of the process is described below, illustrated with data from the CHIP Wellbeing Mentor evaluation used for PIP development.

Stage 1 Listing. Raw data (e.g., percentages, selected quotations) and coded or grouped data (e.g., abstracted into a category, transformed into text, themes) that the researchers consider important for inclusion in the integration are 'listed' in the joint display, either in the QUANT DATA and QUANT CATEGORIES columns, or in the QUAL CODES and QUAL CATEGORIES columns. Listing can be comprehensive (including all codes and data identified in a prior quantitative or qualitative analysis) or selective (including only particular codes, data or emerging themes from an earlier analysis that warrant further investigation), depending on the focus and purpose of the integration for which PIP is being used. Therefore, either column can be the starting point and there is flexibility in the variety of data that can be included in these outside columns. By the end of this stage, two of the five columns should be completed, on one side of the PIP template.

In example one, the quantitative evaluation limitations were listed in the 'QUANT DATA' column (e.g., loss to follow up, miscoded data, invalid recording, outcome effect size). These quantitative data were then transformed, abstracted, and listed in the 'QUANT CATEGORIES' column. Table 1 shows excerpts from the listing stage of the Wellbeing Mentors intervention, which focused on problematic aspects of the intervention delivery and evaluation.

<Insert table 1 about here>

Table 1. An example of stage 1 of PIP, using data from a Wellbeing Mentor intervention

Stage 2 Matching. Once the relevant data have been listed in the QUANT or QUAL columns, a matching process proceeds on the opposite side of the joint

display. If the researcher has first listed quantitative data in the QUANT DATA column, then matching a list of qualitative data in the QUAL CODES column is needed, or vice versa. During the matching stage, the researcher matches the opposite column data reflecting content that relates to the initial listed data, horizontally aligning similar data, and refining and organizing categories that had been generated in the two 'categories' columns. Each list is organized and compared across rows of the joint display so that the qualitative items reflect patterns, parallels, similarities or any other relational quality with the quantitative items. This process may produce quantitative or qualitative items that do not appear to have a matching counterpart. Where no match is found, this column can be labeled 'not identified' or left blank, so the researcher can visually identify gaps in the matched data. By the end of stage two, the QUANT DATA, QUANT CATEGORIES, QUAL CODES and QUAL CATEGORIES columns should be completed.

During the development of PIP in example one, in the QUAL CODES column, we matched the qualitative data (reflecting information, context, setting and any other content) to the QUANT DATA and QUANT CATEGORIES columns. We identified codes and then selected quotations that reflected and/or related to our QUANT DATA. We listed them in the QUAL CODES column. For example, interview quotations about school autonomy were matched with quantitative data illustrating heterogeneity between schools. Some qualitative data were left unmatched at the end of this process. We reflected and reorganized the unmatched qualitative data to match quantitative data, where appropriate. If no match was found, this cell was labeled 'not identified'. This allowed us to identify clearly any gaps in the relationship between the two datasets.

Stage 3 Checking. Once the data are matched and the researcher is satisfied with the accuracy of the match, the data are checked for quality purposes. All data in the four completed outside columns need to be cross-checked for completeness to ensure the rows are appropriately matched. Any identified gaps should be double-checked and verified to ensure that no raw data could provide an appropriate match. These gaps are important because they aid the identification or confirmation of emerging patterns, and of equal importance, a lack of pattern for some listed elements. This improves the quality of the integration. The checking stage acts as a point in the process to step back and reflect on the emerging pattern or lack of pattern, and consequently refine and modify the nature of the lists and how they match across the four columns. By the end of this stage, the researcher should have checked that all relevant data and codes are categorized and have appropriate matches.

In example one, gaps and patterns in the data were checked for quality. Any gaps were cross-checked with raw data for completeness to ensure the rows were appropriately matched.

Stage 4 Pillar Building. In stage 4 the PILLAR is built in the final central column. To build the PILLAR, the researcher compares and contrasts the findings that have developed from the listing, matching and checking stages, and conceptualizes the insights identified from connecting and integrating the qualitative and quantitative columns. The researcher builds inferences about what patterns, insights or themes have emerged and the possible explanations. They locate these themes in the PILLAR column. The PILLAR holds the integrated themes from each row. When all the themes in the PILLAR column are viewed together, the researcher

can begin to weave together a meaningful narrative from the integration of quantitative and qualitative data.

In the development of PIP, we synthesized the evidence presented on both 'sides' of our investigation into the PILLAR, and showed barriers to implementing and evaluating the Wellbeing Mentors intervention. The PILLAR was the product of the visual and conceptual integration of our understanding. Viewing the PILLAR and the contributing data together helped clarify the connections between rows in the joint display (Table 2).

<Insert table 2 about here>

Table 2. An example of stage 4 of PIP, using data from a Wellbeing Mentor intervention

Results: Example One. What the Pillar Integration Process Added to the CHIP Evaluation

In example one, PIP enabled us to determine the crossover between empirical evaluation limitations and barriers, and interviewee responses relating to the impact of the barriers on intervention delivery and evaluation. Initial quantitative findings revealed limitations in the collection of evaluation data, while the 'matched' qualitative data enhanced our understanding of the mechanisms that were operating within that context: school autonomy, hierarchy, varying beliefs and approaches on how student wellbeing should be addressed, and how the roles of the Mentors themselves were described.

In our example, the main issue that emerged was variation across settings. While on the surface this variation appeared to reflect simple issues of fidelity and

adherence to the evaluation protocol, the process of building the PILLAR helped reveal that these empirical limitations may have originated from the beliefs and approaches of staff members and leadership which differed between schools. Our recommendations for practice were greatly changed in light of this knowledge. While adherence to a protocol can simply be suggested for future practice, implementing those changes in a context where the beliefs of school leadership and the role and ethos of the Wellbeing Mentors are not aligned may result in the delivery of a sub-optimal intervention. Because we identified this issue using PIP, we could instead recommend that future intervention delivery ensure that the settings in which the intervention is delivered have a 'wellbeing ethos' aligned with that of the Wellbeing Mentor intervention.

In this example, integrating the quantitative evaluation data and the qualitative interview excerpts aided the identification of important contextual mechanisms at work. The process of comparing and contrasting the columns and visually centering the PILLAR concepts allowed for greater cohesion where context, intervention components and evaluation results could be harmonized in a methodologically rigorous and replicable way.

Pillar Integration Process Example Two: Mixed Methods Evidence Synthesis

In order to test the external validity of the Pillar Integration Process, we applied it in a different context to integrate data unrelated to the original PIP development datasets. In this second example, PIP was used to integrate the findings of a mixed methods review of the barriers and facilitators to decision-making by orthopedic surgeons (Grove et al., 2016). This example was selected for pragmatic reasons, as the data

were currently available to the research team, and also to demonstrate that the PIP can be used to integrate and synthesize secondary as well as primary data.

Context: Example Two

Previous research has highlighted variation in surgical practice across and within geographical areas (Ferlie et al., 1999; Glover, 2008; Wennberg, 2002) and within surgical specialties (Moritz et al., 1997; Pope, 2002) and sub-specialties (Birkmeyer et al., 1998; Dunn et al., 2005). These studies highlighted that rates of surgical intervention did not align with rates of disease. There are many reasons for performing surgery and these did not always directly link to the clinical needs of the patient (McPherson, 2008). We aimed to systematically review and summarize all types of published literature on methods, practices, barriers and facilitators to evidence use in decision-making within orthopedic surgery, in particular aiming to understand potentially unjustified variation.

Methods: Example Two

We conducted a mixed methods systematic review by combining a supplementary search technique alongside the more traditional method of systematic searching (Chalmers & Glasziou, 2009; Papaioannou et al., 2012). We used the references of the papers we found to identify further clusters of publications based on relevant theory and concepts, such as 'evidence based orthopedics', in order to obtain key papers in the field. Full details of the study aims, search strategy, inclusion and exclusion criteria, and analysis are available elsewhere (Grove et al., 2016).

Included studies were heterogeneous in terms of methods, phenomena examined, and outcomes measured (which included clinical outcomes, process of

care and patient outcomes, and factors that influence treatment decisions and rates of surgery). Hence, meta-analysis of the quantitative data was not feasible. In example two, the Pillar Integration Process was used to integrate and synthesize all of the qualitative and quantitative studies that were identified in the systematic review.

Stage 1 Listing. We listed all the factors in the joint display that were reported to influence decision-making from the included papers, with each row representing one included study. We reported the quantitative data findings in text format, using the terms or phrases from the individual papers. This enabled us to represent the findings as codes instead of reporting the raw data in numeric form. An excerpt is presented in Table 3 as an example of this stage.

<Insert table 3 about here>

Table 3. Excerpt of the Pillar Integration Process stage 1 listing process for a mixed methods evidence synthesis

We then grouped the factor codes into broader conceptual categories iteratively. This ensured that the ‘QUANT CATEGORIES’ column represented categories of factors (e.g., ‘patient characteristics’), which helped to avoid repetition. Citation numbers were then listed in ‘QUANT DATA’ column to show which paper generated each factor. In our example we completed the ‘QUANT DATA’ first, then repeated the listing process for the qualitative data, however this could be performed in the opposite direction.

Stage 2 Matching. In example two, we decided to match the qualitative studies to the quantitative studies first. Therefore, we matched factors and 'sources of evidence' from the qualitative column to those already present in the quantitative column. Where no previous factor existed we added further factors to the 'QUANT CATEGORIES' column to produce a group of qualitative factors not yet matched to quantitative factors.

Stage 3 Checking. We ensured the validity of matches by checking qualitative studies for references to factors identified from quantitative studies, and vice versa. We checked for empty cells where no match had been made between 'QUANT CATEGORIES' and 'QUAL CATEGORIES'. We cross-checked the original study data to see if there should be a match (e.g. assessing whether categories should be collapsed or were really standalone categories). The checking stage helps to maintain a high quality standard of integration.

Stage 4 Pillar Building. We inspected the completed factor columns ('QUANT CATEGORIES' and 'QUAL CATEGORIES') to allow us to integrate both sets of data into a group of core findings represented in the central 'pillar' (PILLAR BUILDING THEMES column). Table 4 provides an excerpt of the completed joint display at this stage of the integration. Synthesizing the mix of study methods in this way enabled us to compare and contrast the data sets and incorporate the data in a meaningful and transparent way. It allowed us to move beyond the individual studies, and the two separate data types, to develop meta themes which represented all the data in a complete narrative.

<Insert table 4 about here>

Table 4. Excerpt of the Pillar Integration Process stage 4: pillar building in a mixed methods evidence synthesis

Results: Example Two. What PIP Added to the Orthopedic Surgery Systematic Review

In our second example, the Pillar Integration Process enabled us to systematically combine findings from qualitative and quantitative studies to identify the barriers and facilitators for decision-making in orthopedic surgery. Eight themes were generated from the PIP which covered factors such as the surgeon or health care professional, the source and type of evidence need, patient factors, or issues related to the health system. Detailed results of the themes and the complete PIP can be found elsewhere (Grove et al., 2016).

The PIP highlighted that sometimes the factors which influenced decision-making were out of the control of the individual surgeon treating the patient, and aided identification of all the interacting issues and contexts that should be considered. This conceptual and contextual understanding was crucial when developing appropriate strategies in the context of orthopedic surgery. To overcome the issues that drive inappropriate decision-making in orthopedics, a multifaceted solution functioning at various levels within healthcare organizations would be required. For example, a single level intervention targeting individual surgeons to use clinical guidelines in practice may not be as successful as anticipated. Nor may an organization-wide training program to improve the use of evidence-based medicine

in practice. We were able to communicate this in-depth knowledge conceptually and visually using PIP.

The application of the PIP in example two permitted us to treat the various data types equally and group the categories based on the conceptual and contextual ideas, rather than the quantity of each factor reported or the research method used. The Pillar Integration Process as a technique allowed us to systematically present the data from the included studies into a joint display. This enables the visualization of the analysis process and the traceability of the core barriers and facilitators (themes) to their original articles. Visualization helped to overcome the problem of ensuring transparency in this mixed methods systematic review, as it gave the narrative synthesis a well-defined and rigorous framework that could be followed and clearly understood.

Discussion

The key focus for the development of Pillar Integration Process was to achieve a systematic and replicable technique to integrate data in the analysis phase of mixed methods research, for which there has been a reported demand (Fetters & Freshwater, 2015). We have described, step by step, the four stages of the PIP – a novel joint display technique to integrate quantitative and qualitative data. The novelty of the Pillar Integration Process originates from the systematic and replicable processes, which enable researchers to simultaneously convey both the process and the findings of their mixed methods integration. Therefore allowing for transparency in the integration processes. PIP provides support for the external validity of integration in mixed methods analysis and can be used in a range of mixed methods study designs.

The Pillar Integration Process was developed in a mixed methods primary study (example one), where it illuminated the underlying factors contributing to delivery and evaluation challenges, which might otherwise be seen as normal and persistent problems. It was validated using a second example. In the systematic review, it highlighted conceptual meta-issues, for example the mixed definition of evidence, and discerned various factors that influence decision-making in practice.

PIP Requirements

The Pillar Integration Process requires knowledge of both quantitative and qualitative techniques of data collection and analysis. PIP is characterized by an ability to work methodically to code, transform and condense the two data sources into categories, and then into pillar themes. The resources required for this technique are no more or less than other integration techniques available.

A researcher who is relatively inexperienced at data integration may use this technique and rely on the four stage procedure we have described here. An experienced researcher with knowledge of data integration, can use the Pillar Integration Process with a team to undertake collaborative data integration. The strengths and limitations of mixed methods team working would apply to PIP (O'Cathain et al., 2010).

Comparisons with Other Integration Methods

Comparing the similarities and differences of the Pillar Integration Process with other analytical techniques can help to contextualize PIP. Table 5 displays four common techniques of analytic integration and highlights the similarities and differences

between the PIP and traditional integration methods. The final column in Table 5 references seminal works and exemplars from each technique.

<Inset Table 5 about here>

Table 5. Comparison of the Pillar Integration Process with other analytical integration techniques

PIP and joint display. The Pillar Integration Process is a type of joint display rather than a stand alone approach to mixed methods analysis. It was adapted and developed from traditional mixed methods matrix and joint display techniques to integrate data, and it uses a table format for display (Creswell, 2003; Miles & Huberman, 1994; O'Cathain et al., 2010). PIP is flexible in its ability to be used with most basic mixed methods study designs and mixing approaches. Depending on the nature and use of the data collected it is particularly suited to the convergent, embedded, transformative or multiphase designs (Creswell & Clark, 2007). Joint displays and matrices traditionally display study findings in the right hand column, and do not always specify the stages of conducting or developing the analysis within the matrix (Bazeley, 2006; Castro et al., 2010; Guetterman et al., 2015; Happ et al., 2006; Miles & Huberman, 1994; O'Cathain et al., 2010; Wendler, 2001). While these traditional techniques are easy to follow, they may not clearly convey the actual processes of the integrator.

PIP differs as it centralizes the results of comparison and synthesis of the data in the pillar, balancing the qualitative and quantitative data visually and technically. PIP also specifies the process of analysis in a replicable way, with pre-defined structured

stages, in addition to presenting the findings, supporting the reader to understand the process and the findings and showing the trustworthiness of the method. Transforming qualitative into quantitative data and vice versa may be required at the listing or matching stages of PIP, although PIP is broader than transformation, since there are further stages of integration before interpretation can take place (Bazeley, 2009a; Griffiths et al., 2015; Onwuegbuzie & Teddlie, 2003; Teddlie & Tashakkori, 2009). The Pillar Integration Process promotes both the flexibility of developing the joint display alongside rigor of pre-defined structured stages, supporting the comprehension and trustworthiness of the method for the reader.

PIP and comparing/validating/triangulation. The Pillar Integration Process is similar to the comparing technique, in that it allows for the clear identification of instances of divergence or dissonance in the matching phase, through a systematic method (Greene, 2007; Teddlie & Tashakkori, 2009). It differs in that it may or may not be used to compare findings from two distinct methods with the purpose of verification or validation. However, PIP focuses more on exploring or expanding findings and generating new insights (Graham, 2005; Moran-Ellis et al., 2006; Ruffin et al., 2009; Sandelowski, 1995). PIP allows for the identification of absence of data, which may be as important as the presence of findings.

When using the PIP, it is essential to be rigorous in validating the work at the checking stage, and useful frameworks exist to support checking within mixed methods (Creswell et al., 2011; Dellinger & Leech, 2007; Pluye et al., 2009) and qualitative research (Lincoln & Guba, 1985).

PIP and following a thread*.* PIP has some similarities with following a thread, as both techniques scrutinize themes across data types. The repetition within the listing and matching stages of PIP reflects the following a thread technique whereby key emerging issues are searched for, identified, and examined across other components of study data. However, following a thread does not specify particular steps as it focuses more heavily on early identification of common themes to be explored across multiple components of a study or dataset (Adamson et al., 2009; Moran-Ellis et al., 2006; O'Cathain et al., 2010). This is not the same in the Pillar Integration Process as the four stages of PIP are a distinguishing component, and central to the procedure and to the integration of findings.

PIP and transformation. Finally, transformation is necessary in the Pillar Integration Process in order to formulate the central pillar. Transformation and PIP differ in that transformation is a technique itself and a researcher may move directly form transformation into the interpretation of quantified or qualitized data. When using PIP however, there are two further stages of integration (matching and checking) that are required before the final pillar building stage and interpretation can take place.

In summary, there is a paucity of analytical integration description within mixed methods literature. To the authors' knowledge, few other techniques provide a step-by-step process for integrating data at this level of detail. This is something we specifically set out to generate through operationalizing the Pillar Integration Process.

Limitations

There are some limitations to this work. In developing PIP, it was tailored to a specific study (example one), which could have missed important issues in its generalizability. More complete and empirical process information therefore may have revealed more conclusive or different findings. However, we aimed to address this concern by verifying the use of the PIP in another study with many differences from the first, including study design (systematic review rather than primary study), setting (NHS rather than schools), sample (orthopedic surgeons rather than school staff), and topic (decision-making rather than health improvement program). Further use of PIP should help to consolidate its role and value in increasing methodological transparency, rigor and trustworthiness of reporting.

The Pillar Integration Process requires knowledge of two approaches to data collection and analysis and an understanding of the epistemology of subtle realism (Hammersley, 1992). As with any mixed methods study, PIP is characterized by an ability to work methodically to code, transform and condense two data sources into categories, and then into pillar themes.

Implications for Research

The methodological rigor of the PIP technique means that it could be used in other mixed methods research and practice contexts. The Pillar Integration Process is flexible enough to be used in different study designs (Creswell & Clark, 2007). PIP is likely to be most suitable for use in mixing purposes of comparison/triangulation, complementarity, and expansion, though it can be used in studies with a purpose of development or initiation (Greene et al., 1989). Further use of PIP in different settings is welcomed as it is likely to be no more or less resource intensive than

other integration techniques. The time requirement to use the PIP would be largely determined by the volume and intricacy of the datasets and research questions under investigation.

How the Study Adds to the Mixed Methods Literature

The existing mixed methods literature emphasizes the importance of integration; however, relatively few well-articulated integration techniques are available for use by mixed methods researchers that provide a technical step-by-step process for integrating data at this level of detail. While Happ et al. (2006) and Wendler (2001) offer descriptive examples of analytical integration and data merging, this is not a predominate activity in mixed methods reporting. Previous literature reviews focus more on overall methodological integration (Zhang & Creswell, 2013) or the integration of empirical and theoretical approaches (Ostlund et al., 2011) rather than on specific techniques to merge and synthesize data, reflecting a semantic issue within wider mixed methods reporting rather than an omission on the part of the reviewers. Teddlie and Tashakkori (2009) also provide comprehensive presentation of overall analytical approaches and suggest that data are integrated to form meta-inferences. They describe “conclusions generated through an integration of the inferences that were obtained from both strands of the study” (p.266); however, they do not describe in detail how these data can be integrated.

The examples above demonstrate the nuances that exist within the description and discussion of integration techniques in the mixed methods literature. A range of approaches and techniques are available that can be used to conduct and analyze mixed methods studies. The Pillar Integration Process is one type of joint display technique that adds to this literature. It illustrates how analytical data can be

integrated and enables transparency and rigor during data integration and interpretation, and clarity in the presentation of study results. Through the publication of integration techniques, in addition to criteria for quality assessment in mixed methods research, greater overall methodological transparency can be achieved.

Conclusion

The Pillar Integration Process is a four stage technique that can be used to integrate qualitative and quantitative data using a joint display format. This paper has defined and described the Pillar Integration Process and demonstrated its application using two examples. Existing mixed methods literature emphasizes the importance of integration but relatively few well articulated integration techniques are available. The PIP aims to fill the gap in existing literature by enabling transparency and rigor during data integration and interpretation, and clarity in the presentation of study results.

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TABLE 1. An Example of Stage 1 of PIP, Using Data From a Wellbeing Mentor Intervention

Case: Wellbeing Mentor Intervention				
QUANT data	QUANT categories	Pillar building themes	QUAL categories	QUAL codes
				
Response rate (%) School 1: 85 School 2: 35 School 3: 35 School 4: 60	Heterogeneity between schools in number of returns and completeness of returns			

School 5: 100 School 6: 85 School 7: 60 School 8: 20	(response rate range from 20% - 100%)
23% of participants were aged 11 or 12 and were excluded from the analysis	Evaluation fidelity: Didn't follow flow chart of exclusion criteria
3/8 schools (37.5%) completed academic	Incomplete data collection

achievement outcome requests.	
1/8 schools (12.5%) completed requests for attendance records.	Referral systems varied between schools
Moderate effect size for the increase in Wellbeing outcome scores between baseline and follow up (0.52).	Increase in Wellbeing over time among students who undertook Wellbeing Mentorship

TABLE 2. An Example of Stage 4 of PIP, Using Data From a Wellbeing Mentor Intervention

Case: Wellbeing Mentor Intervention				
QUANT data	QUANT categories	Pillar building themes	QUAL categories*	QUAL codes
→	→		←	←
Response rate (%) School 1: 85 School 2: 35 School 3: 35	Heterogeneity between schools in number of returns and completeness of returns (response rate range from 20% - 100%)	Compatibility of setting, staff and intervention	Compatibility of context (school) and program required flexibility to account for school autonomy	*"Schools are very autonomous, err, and that's often very difficult for partners who aren't in education to understand. Err, you can't tell them what to do. So, err, there there was variation."*

School 4: 60 School 5: 100 School 6: 85 School 7: 60 School 8: 20	Compatibility of ethos underpinning actions	Compatibility of wellbeing ethos behind intervention and medical ethos behind some leadership The beliefs of teachers, beliefs of school leaders can affect how the intervention was implemented. Role of school Role of teacher	"*Some people will still say 'I don't care about their their health side, their mental health side. I just want them to achieve academically'."* *"So, it's not particularly in the interest of the school to invest the time trying to help more on that universal small group approach because going straight to the doctor gets you straight onto the next stage."*

			Role of external support staff	
23% of participants were aged 11 or 12 and were excluded from the analysis	Evaluation fidelity: Didn't follow flow chart of exclusion criteria	Hierarchy, positioning, approaches to leadership	When Mentors were not adequately supported, they struggled to manage their workloads appropriately	*"The mentors themselves didn't have the authority. They are seen as auxiliary support staff. So in terms of the pecking order, the hierarchical place of them in the schools… I don't know if teachers were receptive to what they were saying. Erm, they needed the support of a line manager. Err, a senior teacher who would actually back it up*."
3/8 schools (37.5%) completed academic	Partial data collected on academic achievement and was different for each	Hierarchy, positioning,	Context and autonomy between	

achievement outcome requests.	school: e.g. class attendance, key stage scores, and SIMS behavior points were all used	approaches to leadership	schools, staff and Mentors	
1/8 schools (12.5%) completed requests for attendance records.	Setting variation		Setting variation Schools utilized mentors in a way that worked best for them.	
Moderate effect size for the increase in Wellbeing outcome scores between baseline and follow up (0.52).	Increase in Wellbeing over time among students who undertook Wellbeing Mentorship	Intervention ethos and ethos of school/key staff	Referral system may be influenced by teacher-mentor relationship, beliefs of teachers, beliefs of school	"The more senior *members of staff, erm, more experienced members of staff, were coming saying I don't know how the wellbeing mentor handles that child because we can't get them to behave, we can't get*

	them to learn and yet they can. And
Role of school	*in the end they were giving advice to*
Role of teacher	*the teachers about the best way to*
Role of external	*handle the children and the best way*
support staff	*to get the best rewards out of them."*

TABLE 3. Excerpt of the Pillar Integration Process Stage 1: Listing Process for a Mixed Methods Evidence Synthesis

Case: Mixed method systematic review

QUANT data →	QUANT categories →	Pillar building themes	← QUAL categories	← QUAL codes
Bhandari et al., 2005	1) Management preference by patient age 2) Patient medical condition (i.e. activity) 3) Superiority of treatment opinion (mortality, QoL, function, infection rates, pain)			
Borkhoff et al., 2008	1) Patient characteristics in general 2) Patient sex			
Canty 2013	1) Habit 2) Learned in practice 3) Clinical/ treatment 4) Believes it is evidence based 5) Practical reason (messy)			

TABLE 4. Excerpt of the Pillar Integration Process Stage 4: Pillar Building in a Mixed Methods Evidence Synthesis

Case: Mixed method systematic review				
QUANT data →	QUANT categories →	Pillar building themes	← QUAL categories	← QUAL codes
3	Believe decision is evidence based	Formal codified knowledge	"You can always find a paper to support your idea"	7
5	Practice by guideline present		"Orthopedic journals hold the most powerful position"	7
17	There is more agreement when more evidence exists		"There is complexity of surgeon appraisal of patients, various explicit things come into the judgement"	8
19	Independent peer reviewed papers are preferred			
22,24	Guidelines			

5	Supervisor prevented use of evidence	Socialization and association with colleagues	“Orthopedics is a learnt craft”	7
9	What my mentor taught me		“There is a professional community with distinct norms that are resilient, embedded and retain control”	7
9	It burns fewer bridges with colleagues		“Negotiating relationships with other professionals and maintaining professional networks”	8
9,12	Do what others are doing			
19	From meeting and conferences with colleagues		“Clinicians play a role as experts they are assigned and adopt the roles”	10

TABLE 5. Comparison of the Pillar Integration Process With Other Analytical Integration Techniques

Analytical Technique	Description	Similarities to PIP	Differences from PIP	Origins and Exemplars
Metamatrix/ joint display	A metamatrix can be used to combine and display textual and numerical data together in one visual display. Also referred to as a joint display.	PIP falls within the category of a matrix and is similarly flexible in its ability to be used with most basic mixed methods study designs and mixing approaches. Both PIP and a matrix use tables made up of rows and columns to	Matrix traditionally culminates findings at the final column of the matrix (reading left to right). The matrix does not always specify stages of conducting or developing the analysis within the matrix. A matrix could be a representation of the combined findings only, or it	Miles & Huberman, (1994); Happ et al., (2006); O'Cathain et al., (2010); Guetterman et al., (2015); Wendler, (2001).

		organize and aid understanding of data.	could be the process and the presentation, whereas PIP is the latter.	
Following a thread	A multistage technique. First conduct primary analysis of all aspects within a study in order to identify any themes or issues that could be explored further. After a key issue from one study aspect is identified, it is followed across the other aspects/data groups within the study and from there the thread is created.	Both useful where a question can be further investigated or scrutinized across all components of the study data.	Central focus is on the narrowing down of a particular issue to explore across the data; this could be a chosen approach to use PIP but is not the central focus. Following a thread does not specify particular steps whereas the four stages of PIP are a distinguishing component.	Moran-Ellis et al., (2006); O'Cathain et al., (2010); Adamson et al., (2009).

Comparing/ validity check/ triangulation	Data are collected and analyzed separately and data are combined at the point of interpretation, checking for agreement or disagreement between findings looking at the same phenomena.	Comparing and PIP can help identify differences between datasets and findings.	Comparing is usually used for comparing two distinct methods of data collection that focus on the same phenomena for the purposes of validation. PIP may focus more on exploring or expanding on findings and generating new insights.	Sandelowski, (1995); Moran-Ellis et al., (2006); Williamson, (2005); Ruffin, et al., (2009).
Transformation/ conversion	Transforming one single set of data into another type e.g. textual or numerical. Quantitizing: Transforming qualitative data into quantitative, numerical data.	PIP will often require data transformation in the early stages of developing the PIP matrix to enable comparison and	Transformation is a stand-alone technique and may move directly on to interpretation after data are transformed. Transformation can be one component of PIP and	Teddlie & Tashakkori, (2009); Bazeley, (2009b); Onwuegbuzie & Teddlie (2003); Griffiths, et al., (2015).

Qualitizing: Transforming quantitative data into qualitative, textual data e.g. codes and categories	analysis between datasets.	further exploration and analysis of the data will occur in addition to transformation.

FIGURE 1. The Individual Components of the City Health Improvement Program Evaluation

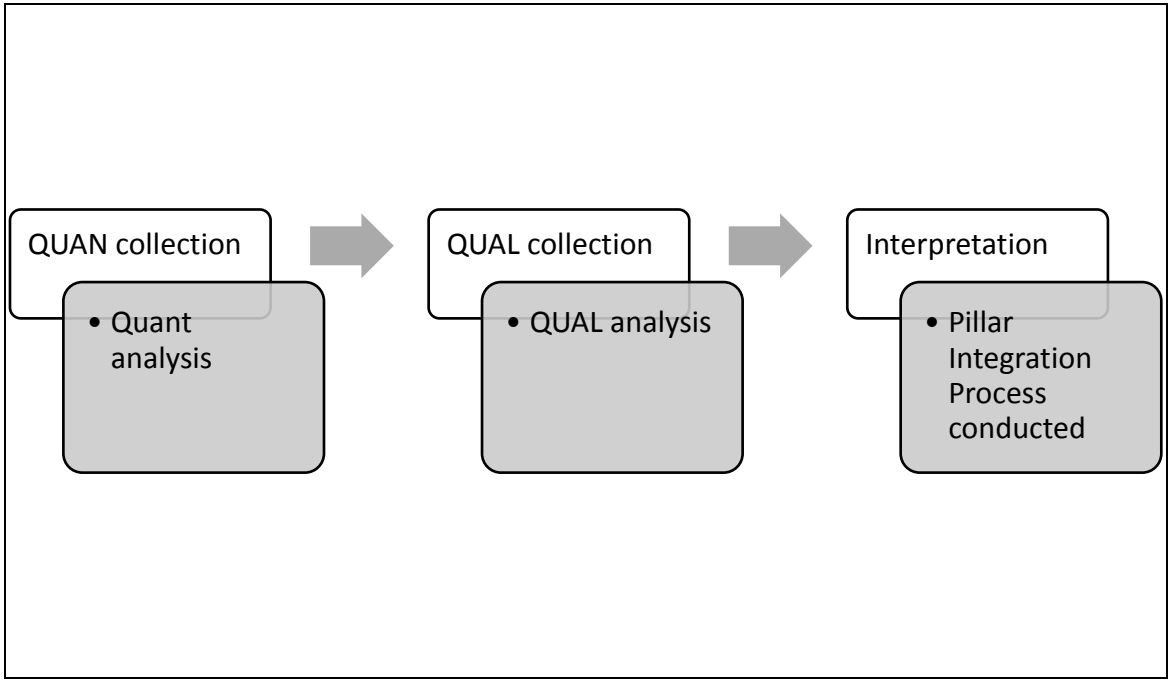

FIGURE 2. A Generic Diagrammatic Representation of the Pillar Integration Process to Demonstrate Column Headings and Direction of Integration