Methods in Psychology 5 (2021) 100080

Contents lists available at ScienceDirect

Methods in Psychology

journal homepage: www.sciencedirect.com/journal/methods-in-psychology

Visuals in joint displays to represent integration in mixed methods research: A methodological review☆

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ARTICLE INFO

Keywords:
Mixed methods
Integration
Joint displays
Visual displays
Methodological review

ABSTRACT

Joint displays provide a visual means to represent the integration of qualitative and quantitative research in addition to a framework for thinking about integration and organizing data, methods, or results. Despite increases in the use of joint displays, opportunities exist for more creative joint displays that use additional visuals to more easily communicate complex information. These additional visual features include charts, graphs, maps, and images. However, little has been written about their usage within joint displays. The purpose of this methodological article is to advocate the use of joint displays that incorporate graphs, charts, maps images, and other visuals, as appropriate and to discuss the decisions in including these features. To assist in identifying joint displays that include visuals, we conducted a systematic literature search of Google Scholar, PubMed, ERIC, and Academic Search Premier using terms for mixed methods research. After screening articles to identify joint displays that include graphs, charts, maps, images, and other visuals, we analyzed articles (n = 33) for mixed methods features and joint display features. Regarding the quantitative strand in a joint display, charts, and graphs can communicate more information than statistical numbers, such as showing distributions of data, plotting relationships among variables, and using bars of varying lengths to facilitate comparison. Maps and GIS data can similarly relate additional information for the reader, particularly when geographical or spatial area is important to the research. Furthermore, images can be a useful type of qualitative data and is especially relevant in photo-elicitation research. These visuals can be depicted in joint displays to represent integration. Visuals used in joint displays included: column or bar charts, histograms, boxplots, scatter plots, quantitative path models, maps, pictures, and qualitative visual models. We also include four exemplars of joint displays that use visuals. Researchers can use these types of joint displays for integration in psychological intervention research, for theory development in psychology, and for instrument development in educational psychology. We conclude with recommendations for including visuals and suggestions to optimize integration from a mixed methods perspective.

Joint displays are a visual means for representing integration in mixed methods research (Guetterman et al., 2015b). Perhaps equally important, joint displays provide a framework for integration, breaking down the cognitive process of merging, comparing, relating, and linking qualitative and quantitative data or results (Guetterman and Moss Breen, 2021) to assist in identifying meta-inferences. Our experience suggests that the use of joint displays in mixed methods research has increased substantially over the past five years in content-related journals, and their use has become common in methodological journals, such as the Journal of Mixed Methods Research and the International Journal of Multiple Research Approaches. The most common type of joint display is a side-by-side display that juxtaposes qualitative results with related quantitative results and resulting meta-inferences. However, researchers have been innovating on these types of displays by incorporating visuals, such as graphs, charts, figures, and other images. Visuals can help the reader to process and sort through information in a new way, also consistent with dual coding theories in education. In other words, a reader can read narrative prose about integrated results and also see a visual depiction, which may enhance understanding. Several authors (LeCompte and Schensul, 1999; Parmentier-Cajaiba and

☆ [1]the studies included in the review are marked with an asterisk.

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https://doi.org/10.1016/j.metip.2021.100080
Received 29 June 2021; Received in revised form 5 October 2021; Accepted 18 October 2021
Available online 1 November 2021

Cajaiba-Santana, 2020; Ravasi, 2017; Verdinelli and Scagnoli, 2013), primarily working in qualitative research, have noted the benefits of visual displays for research. First, visuals support communication of research findings by helping researchers synthesize and present information more systematically and efficiently. Second, visuals can help support analytic thinking since the more detailed articulation of elements to be analyzed can help researchers make sense of the data and even sometimes develop new theories. Therefore, the purpose of this methodological article is to advocate the use of joint displays that incorporate graphs, charts, maps images, and other visuals, as appropriate and to discuss the decisions in including these features. To understand their use and inform our recommendations, we conducted a scoping review by systematically searching the literature and analyzing joint displays that include additional visuals. Researchers in psychology may find visuals in joint displays helpful for achieving integration, such as clinical or counseling intervention research, theory development in psychology, and assessment instrument development in educational psychology.

1. Defining visuals in joint displays

A mixed methods joint display is a visual means of facilitating or representing the integration of qualitative and quantitative research (Guetterman et al., 2015b). This intentionally broad definition is inclusive of the integration of results, methods, or data in any combination. However, researchers sometimes include additional visual features. For our purposes, we define the use of *visuals* in joint displays as those that include the addition of graphs, charts, maps, images, figures, diagrams, visual models, or any other graphical feature. Ideally, these additional visuals support integration, understanding, and interpretation.

2. Relevant literature on joint displays

In qualitative analysis, Miles and Huberman (1994) advocated for visual displays, such as meta-matrices to combine information for cross-case comparison and analysis. Later, mixed methods scholars began to discuss the use of a matrix for integrative analysis (Happ et al., 2006; O'Cathain et al., 2010). The term joint display seems to originate from correspondence analysis which is a quantitative method in which researchers use a visuals to show the relationship between categorical variables in a contingency table (Greenacre, 2007). For example, they may depict relationships between people and events (Faust, 2005) to look for patterns or clusters on two dimensions. Extending the concept to mixed methods research, joint displays are a way to show the mixing between qualitative and quantitative research. The first reference we have found to the term "joint display" in mixed methods research appears in a white paper from Kuckartz (2010), which details the use of software to examine qualitative data by quantitative characteristics.

Building on the foundational ideas of joint displays, an increasing number of mixed methods researchers have come to use visual displays for depicting research designs in procedural diagrams and for depicting integration (Plano Clark and Sanders, 2015). Joint displays have been applied to mixed methods research since at least 2006 with publications such as Wittink et al. (2006) that presented a statistical profile of thematically different types of older adults. The statistics-by-themes type of joint display related qualitative thematic types to a statistical profile of demographic and baseline mental health for those individuals. Other joint display uses around the same time included side-by-side joint displays that juxtaposed related qualitative and quantitative results next to one another in order to make comparisons and merge the two. This merging of results is helpful for identifying meta-inferences, which are new insights from integrative analysis (Tashakkori et al., 2020).

With increased interest in joint displays, researchers began systematically examining their usage to identify features and exemplar approaches (Guetterman et al., 2015b; Plano Clark and Sanders, 2015). Although joint displays were still emerging as a best practice at the time, patterns in their usage became evident with distinct types of joint displays that seem to fit best for certain types of integration and mixed methods designs (Guetterman et al., 2015a). Major types of joint displays include the following:

- **Side-by-side joint displays**: represent merging by arraying qualitative and quantitative results next to each other, organized by research questions, results, or a theoretical model. Facilitates comparison.
- **Statistics-by-themes or themes-by-statistics joint displays**: array statistical results by qualitative themes with one as rows and the other as columns, similar to a crosstabulation. Facilitates relating qualitative and quantitative results to look for patterns.
- **Interview questions joint displays**: link the results of a quantitative strand of research to specific interview or focus group questions to further explain results.
- **Participant selection joint displays**: link the results of a quantitative strand of research to a specific purposeful qualitative sample of participants that will best elaborate or explain the quantitative results.
- **Instrument development joint displays**: link the results of a qualitative strand of research to build specific scales, variables, and items that will appear on a quantitative instrument such as a survey or questionnaire.

Since identifying types of joint displays, scholars have developed techniques that leverage joint displays for mixed methods analysis. Pillar integration is a process for integrating qualitative and quantitative results and identifying meta-inferences in joint displays (Johnson et al., 2019). The Pillar integration process consists of four stages: 1) listing data, codes, and categories for inclusion in the joint display; 2) matching qualitative and quantitative data, codes, or categories identified in listing; 3) checking the matching to ensure it is complete and valid; and 4) pillar building to integrate the qualitative and quantitative data by identifying meta-inferences, which the authors term metathemes (Johnson et al., 2019). Broader conceptualizations that leverage joint displays for analysis focus on the process of developing any type of joint display as helping with the cognitive task of integration. For example, joint display analysis is a strategy for integration through which the development of joint displays is iterative and the process of considering what to include, and perhaps, returning to qualitative or quantitative data and results facilitates integration and identifying metainferences (Fetters and Guetterman, 2021).

While joint displays often appear in the form of a table or matrix, scholars have been developing creative joint displays that use visuals, such as graphs, models, images or figures. Readers and audiences can often process data visualizations more easily, when effectively created (Evergreen, 2016). According to several authors in the mixed methods field (Creamer, 2018; O'Cathain, 2009), visual displays can improve the transparency of the integration process and outcomes by clearly representing the relationships between the quantitative and qualitative findings, and between those findings and the study results and conclusions. Despite the potential benefits of visual joint displays in representing the integration of quantitative and qualitative data and findings, there has been little discussion in the literature on concretely how to efficiently develop and use displays of this type in mixed methods empirical articles. Therefore, given the proliferation of joint displays that include such visuals, there is a need to categorize these types of innovative joint displays and provide recommendations. Our goal is to encourage the continued use of joint displays and to advocate for ongoing innovation in this important method of integrating and presenting integrated results.

3. Method

3.1. Design

A systematic methodological review was carried out to examine the application and reporting of visual joint displays in mixed methods research and to discuss the authors' decisions to include this type of display. The purpose of a mixed methods research systematic methodological review is to identify "trends across a defined set of empirical MMR articles related to a discipline, topic, or issue using studies that are identified in a systematic way, typically by using specific key words in specific databases, possibly restricted to a date range" (Howell Smith and Shanahan Bazis, 2020, p. 3). To achieve that purpose, researchers conduct a systematic search, screen articles for inclusion, extract the content of the included articles and code the mixed methods features across the entire pool of articles.

3.2. Search strategy

A systematic literature search was performed to identify relevant publications describing the use of visual joint displays in mixed methods research. The following databases were searched from the time of inception to February 2, 2021: Ovid MEDLINE(R) (including Epub Ahead of Print; In-Process & Other Non-Indexed Citations; Daily and Versions(R)), Elsevier Embase (including Embase Classic), Elsevier Scopus, Web of Science Core Collection (SCI-EXPANDED; SSCI; A&HCI; CPCI–S; CPCI-SSH; BKCI–S; BKCI-SSH; ESCI; CCR-EXPANDED), EBSCOhost CINAHL Complete, EBSCOhost PsycInfo. These databases were selected because they provide access to an extensive number of journals that publish empirical research in psychology and other related disciplines. Each search utilized controlled vocabulary whenever possible in combination with keywords in appropriate search fields. Database limits to the search were not applied. The original search strategies were developed in Medline and were translated as appropriate to the other databases using the Systematic Review Accelerator Polyglot tool (Clark et al., 2020). This tool allows researchers to transform an Ovid Medline or PubMed search query into a form using the appropriate syntax to be run in other databases. References were deduplicated using a modified version of the Bramer Method (Bramer et al., 2016). This method, designed to be used in the EndNote software reference manager, includes steps that allow for a faster and more reliable process of keeping unique citations and avoiding the accidental exclusion of false duplicates. The queries used to perform the database search are shown in Table 1, and the full search information appears in Supplementary Material 1. To complement the database search, publications identified by the authors during the preparation of this review were downloaded, along with all the publications found in SCOPUS that cited the article on joint displays by Guetterman et al. (2015b).

3.3. Inclusion and exclusion criteria

Inclusion and exclusion criteria are described in Table 2. We included publications of any type that reported empirical studies conforming to a broad definition of mixed methods research (i.e., journal articles, dissertations, book chapters that showed evidence of integration of quantitative and qualitative approaches or data at any stage) and that also used a visual joint display to integrate data or findings. In this systematic methodological review, visual joint displays were defined as tables or figures including any type of additional visual (e.g., graphs, charts, maps, images) that researchers use to represent integration of quantitative and qualitative data or findings in any phase of a mixed methods study. Publications that made use of displays described using terms other than "joint displays" were also included (e.g., "integrated matrix", "integrated table", "mixed methods matrix", "mixed methods findings"). Methodological publications discussing the findings from empirical studies were included, while conceptual publications or purely methodological ones that failed to include any empirical research were excluded. Empirical publications lacking any clear evidence of integration, and those that reported only quantitative or qualitative data or findings, were also excluded.

Table 1
Search terms.

Concept	Search Terms (in Title, Abstract, or Keywords)
Mixed Methods	"mixed method*" OR "multimethod*" OR "multi method*" OR "multiple method*" OR (qualitative* AND quantitative*)
Visual Joint Display	"joint display*" OR "side-by-side" OR "data display" OR "data visualization" OR "mixed analysis" OR "combination chart*" OR "matrix chart*"

Table 2
Inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria

• Reports empirical research
• Conforms to a broad definition of mixed methods research:
  ○ Quantitative and qualitative data or approaches
  ○ Evidence of integration
• Represents the integration through a joint display
• The joint display contains at least one visual:
  ○ Bar chart or pie chart
  ○ Scatter plot
  ○ Path or structural equation model visual
  ○ Map or GIS
  ○ Photographs or drawing
  ○ Qualitative model of findings or display organized into a visual format
	• Editorial, commentary or review
	• Purely methodological or conceptual publication that does not report any type of empirical research
	• Not mixed methods research or not evidence of integration
	• The joint display does not include quantitative and qualitative research aspects and does not represent integration
	• The joint display does not contain any type of visual

3.4. Study selection

The study selection was carried out in two phases. Two reviewers (RS and SF) independently screened all the publications by title and abstract. Any disagreements between reviewers were discussed and resolved with the help of a third reviewer (TG). Then, the same reviewers assessed the eligibility of the remaining publications using a full text assessment. As previously, disagreements were resolved by consensus of the research team.

3.5. Data extraction and coding

A data extraction form in Excel was created to extract the data from the publications included. The following elements of each publication were extracted: publication metadata (i.e., publication year and type), study purpose, type of mixed methods design, integration strategy (see Table 3), procedures followed in the quantitative and qualitative strands (i.e., data collection and analysis), and features characterizing the visual joint display (i.e., research questions or objectives addressed by the joint display, type of quantitative and qualitative data represented, type of visual used, level of aggregation of the quantitative and qualitative data, and whether meta-inferences were included in the display). To ensure consistency in the extraction, the same two reviewers that had been involved in the study selection phase (RS and SF) independently carried out the extraction of all the included publications. Any discrepancies between the two data extraction forms were discussed and resolved with the help of a third reviewer (TG). Once extraction was finished, a qualitative content analysis (Schreier, 2012) of the extracted information was carried out to identify patterns across publications and to facilitate synthesis.

Table 3
Terms for integration strategies.

Term	Definition	Example
Merging	Bringing qualitative and quantitative data or results together to compare or relate and generate meta-inferences	Compare the results of a qualitative grounded theory model to the results of a structural equation modelExamine qualitative themes for groups who experienced different outcomes in an intervention
Connecting	Using the results of one strand of research to inform the sampling of the other strand	Based on a path model of quantitative data, identify a sample specific individuals or sites who are likely to be most informative in explaining significance or non-significance
Building	Using the results of one strand of research to inform the data collection approach of the other strand	Based on the results of thematic analysis, develop an instrument

Note: for more information on integration, see Fetters, Curry, and Creswell (2013)

4. Results

The database search generated 2035 publications, of which 1846 were identified through database searching, while 190 were identified through complementary strategies (i.e., review preparation, citation searching). After removing duplicate publications and assessing eligibility, 33 publications reporting empirical mixed methods research and containing a visual joint display were included. The reasons for exclusion were: no joint display (n=340), not a mixed methods study (n=35), not accessible (n=30), or not empirical (n=17). Fig. 1 shows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of the review process. Table 4 summarizes the characteristics of the articles reviewed, and Supplemental Tables 1-4 show the detailed coding results for each article.

Through the review, we identified two types of side-by-side joint displays the incorporate visuals: 1) side-by-side joint displays with graphs and dendrograms and 2) side-by-side joint displays depicting a model or figure (Table 5). One type of joint display included bar graphs, line graphs, circle charts, boxplots, or dendrograms (n = 14). Among these articles, six were convergent designs, two were explanatory sequential, one was exploratory sequential, and five were complex designs like multistage, mixed methods action research, or mixed methods

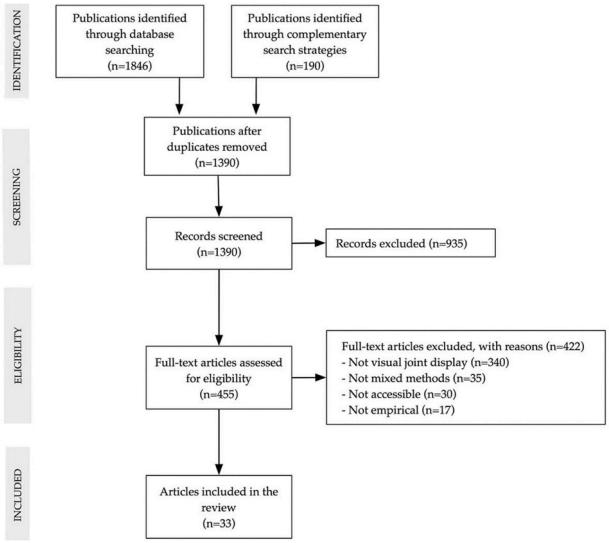

Fig. 1. PRISMA flowchart.

Table 4
Summary of selected articles for review.

Mixed methods design	*N*	Discipline	*N*
Core designs		Health science	9
Convergent	14	Education	5
Explanatory sequential	5	Social sciences	5
Exploratory sequential	3	Educational psychology	4
Complex designs		Psychology	4
Mixed methods case study	4	Business	3
Multistage design	3	Nursing	2
Other complex MM designs[a]	4	Video game technology	1
Type of joint display	***N***	**Integration strategy represented in joint display**	***N***[b]
Side-by-side joint display	26	Merging	31
Joint display with unique visualizations (photos, map, gameplay)	4	Building	4
Joint display for instrument, model, or intervention development	3	Data transformation	1

[a] Other complex mixed methods designs include one each of mixed methods action research, intervention, participatory social justice, and community-based participatory research designs.
[b] Some joint displays depicted more than one integration strategy.

Table 5
Summary of joint display characteristics in selected articles.

Qualitative strand		Quantitative strand	
Type of data represented in JD	*N*		*N*
Interviews	21	Surveys	23
Focus groups	5	Secondary data	6
Observations	5	Experimental data	3
Open-ended survey items	3	Observation checklists	2
Photos	2	Others	6
Secondary data (documents, articles, policy data)	2		
Others	6		
Type of data visuals	***N***		***N***
Figure or model representing qual findings, themes, codes	14	Figure or model representing quan findings, constructs, survey items	13
Color-coding	2	Bar graphs	7
Photos	2	Line graphs	3
Annotations added during focus groups	1	Maps	3
Gameplay data visualizations	1	Box plots	2
Illustrations of codes	1	Boxes with quantitative data	1
Maps	1	Circle graph	1
No visual	11	Dendrogram	1
		Gameplay data visualizations	1
		Illustrations of descriptive stats	1
		Logic model	1
		Photos	1
		Swarm plots	1
Data aggregation level represented in JD *N*			***N***
Aggregated data	14	Aggregated data	27
Raw data	11	Descriptions of measures, survey items	3
Both aggregated and raw data	8	Raw data	2
		Both aggregated and raw data	1
Data aggregation level is consistent	***N***	**Meta-inferences described in JDs**	***N***
Yes	22	Yes	18
No	11	No	15

case study. All were published since 2017, reflecting a clear trend of recency. Seven joint displays used bar graphs, three used line graphs, two included boxplots, one had a circle graph, and one each used a dendrogram, map, or swarm graph. Three included more than one quantitative visual. Three also included a visualization of qualitative data such as annotations or color coding of narratives and quotes to match quantitative constructs. We then examined the level of aggregation of the data represented in the joint display. Based on Voils et al.

(2011), we define the level of aggregation as the degree to which raw data have been transformed into a new entity as a result of analysis or interpretation (i.e., whether the qualitative and quantitative data are raw, such as quotes, raw numbers or aggregated, such as themes, narrative summary, statistics). The level of aggregation was consistent between the qualitative and quantitative data represented in six articles, which may facilitate better comparison (e.g., merging themes with descriptive statistics). Of course, quotes are often included as well as illustrative and showcasing the participants' voices. In addition, meta-inferences were included within eight of the 14 of this type of joint display.

We also identified a type of side-by-side joint displays that included a model or figure (n = 12). A total of six articles were convergent, two explanatory sequential, three mixed methods case study, and one intervention design. Most of these joint displays were published in the last few years. In all these articles, a model or figure was used to represent results of the qualitative strand, such as a figure that indicates the relationship among themes and a conceptual model. All articles also included some sort of visual to represent the quantitative strand. These quantitative figures in joint displays included figures of survey items, conceptual models, or figures of findings that include statistics like descriptive or regression coefficients. In all but two articles, the aggregation level was consistent, with the function of the joint display to compare a qualitatively generated model to a quantitatively developed or tested model. The majority of these joint displays (n = 8) also included meta-inferences.

We also found joint displays (n = 3) used to convey model, instrument, or intervention development (Table 5). Two were exploratory sequential studies and one was a participatory, social justice design. All these conveyed building some type of quantitative feature or data collection approach. For example, the joint displays were used to link a qualitative theoretical figure of themes to a quantitative model of measures or to depict the iterative development of a model. In another study by NeMoyer et al. (2020), photos from the qualitative strand and maps of existing data were included in the joint display.

Finally, we identified a general type of joint display (n = 4) that includes unique visuals like photos or maps (Table 5). Among these four joint displays, two represented convergent designs, one explanatory sequential, and one community based participatory research. In two, the qualitative strand was represented by photos, such as those used in photo-elicitation interviews. Another included an illustration of codes, and the final was a way to visualize game play experiences. All of these joint displays also included a visual for the qualitative strand—illustration of statistics, photos, maps with data included, or photos with a quantitative ranking of importance.

5. Discussion

Through our review and analysis of the included articles, we identified four major takeaways: the majority of studies rely on convergent designs and the use of merging as an integration strategy; certain joint displays often lack consistency at the level of aggregation that is included; visuals are not commonly used in joint displays to represent qualitative results; and joint displays can be a helpful tool when used to connect quantitative and qualitative empirical findings to preexisting theories and for developing new theories.

First, our findings show that the convergent design was most prevalent in the included studies included in our review, followed by the explanatory sequential, mixed methods case study, exploratory sequential, and multistage designs. These findings are consistent with the review by Guetterman et al. (2015b), who searched for mixed methods studies in the health sciences that used joint displays to report the quantitative and qualitative findings in an integrated manner. Of the 19 articles that met their inclusion criteria, 12 used a convergent design, three an explanatory sequential design, two an exploratory sequential design and two an intervention design. Subsequently, Younas et al. (2019) examined the characteristics of joint displays in mixed methods studies published in nursing journals. These authors also found that most studies used a convergent design, while only one used an exploratory sequential design. In line with our findings, most studies included in these two reviews used joint displays to illustrate integration through merging (i.e., report the ways in which the quantitative and qualitative findings relate to each other), while there were fewer examples of other integration strategies, such as building, connecting, and data transformation. Although key mixed methods publications (Creswell and Plano Clark, 2018; Guetterman et al., 2015a) have shown that the use of joint displays can be a useful way to represent integration at the data collection stage in sequential designs, our findings and those of the two reviews cited above indicate that these displays are mainly conceived as a tool for integrating data at the interpretation stage. Future research would be needed to analyze the reasons that lead mixed methods researchers to use joint displays mainly to illustrate merging in convergent designs. However, we encourage researchers to consider the range of potential research designs and integration strategies in order to be able to best address the particular research questions of each mixed methods study.

Second, another notable finding in our review is that the level of consistency of aggregation of the quantitative and qualitative findings in the side-by-side joint displays utilizing graphs and dendrograms is lower than in the other types of displays. In the former, the findings in the qualitative strand were mainly presented in the form of quotes, while the findings in the quantitative strand were all presented using graphs and dendrograms to represent the results of quantitative analyses. Fetters and Molina-Azorin (2017) state that integration at the interpretation stage involves examining the "fit" between or the coherence of the quantitative and qualitative findings. However, in these displays, the presentation of the qualitative findings at a lower level of aggregation might make it difficult for readers to assess the fit and, by extension, the quality and accuracy of the meta-inferences arising from the integration process. Therefore, it would be better to present quantitative and qualitative data using a similar level of aggregation. Thus, although using quotes is a useful way to demonstrate that the findings accurately represent the participants' views and experiences, when using displays of this type, the quotes should be presented together with the qualitative themes in order to ensure consistency with the level of aggregation of the findings in the qualitative strand.

Third, all the joint displays in our sample included a graphical representation of the quantitative strand, while slightly less than one-third did not use any visuals in the qualitative strand. This finding is consistent with Sandelowski's (2003) statement that in quantitative research, researchers tend to use figures and graphs, while qualitative research is usually reported using verbal forms, except in the case of certain approaches such as grounded theory. According to this author, some qualitative researchers may avoid using visuals because, by removing "texts from their contexts" (Sandelowski, 2003, p. 337), they might reduce the meaningfulness of the qualitative findings. However, the use of visuals has been cited by many qualitative scholars as a way of allowing researchers to make sense of the data (Parmentier-Cajaiba and Cajaiba-Santana, 2020), assist analytic thinking (Bazeley, 2018), systematically communicate research findings (LeCompte and Schensul, 1999), and develop and represent theory (Verdinelli and Scagnoli, 2013).

Fourth, while only a few examples found in our sample illustrate how visuals can be used with theory, these examples call attention to the potential use of visual joint displays to both highlight the links between the empirical data and preexisting theoretical frameworks and to transform the empirical data into a new theoretical conceptualization. A clear example of the former is use of a visual joint display model to illustrate the cross-tabulation of quantitative subscales and qualitative themes with Anselm Strauss' Articulation of Project Work (APW) theoretical framework. A good example of the latter is Millien et al. (2021). Based on the integration of their quantitative and qualitative findings,

these authors developed a theoretical visual joint display that demonstrated the cyclical processes that affect the experiences of women living with fibroids in rural Haiti. They called this joint display the 'Poverty cycle'. Nevertheless, the use of visual joint displays seems to afford authors more opportunities to visually represent qualitative strands in joint displays.

5.1. Exemplars

Based on our review, we identified four joint displays as exemplars that demonstrate a number of features and innovative uses of visuals. The exemplars represent the following different types of joint displays: a side-by-side joint display with a boxplot, a side-by-side joint display that depicts a figure, a joint display for model development, and a joint display with a unique visualization of quantitative and qualitative data plotted on axes.

5.1.1. Side-by-side joint displays utilizing graphs and dendrograms: Enggaard et al. (2020)

Enggaard and colleagues (2002) used a convergent mixed methods design to evaluate the impact of a guided self-determination intervention among adolescents with co-existing ADHD and medical disorders aimed at increasing self-management and care involvement. They collected quantitative and qualitative data about three related constructs (support from nurses, support from parents, and self-management) through self-reported questionnaires and semi-structured interviews. Descriptive statistics and qualitative themes were compared and integrated through joint display analysis, in which the iterative process of constructing and re-working the joint displays revealed deeper insights. The final products represent descriptive statistics in visually pleasing swarm plots or box plots alongside descriptions of qualitative results. These visuals allow authors to utilize space efficiently when communicating a large amount of data. For instance, the joint display containing the boxplot concisely conveys data from a survey comprised of 42 items with six subscales representing different dimensions of parental support. Since qualitative findings were more robust for the joint displays containing swarm plots, the authors used matching marker shapes in the plots and the qualitative results column to help connect results from the two different data sources. This facilitated merging integration by allowing authors to easily assess the fit of the two data types (confirmation, expansion, discordance). Descriptions of these integrated findings can be found in the meta-inferences column, which also doubles as a key for the marker shapes. This type of joint display might be helpful for other psychological and mental health intervention studies when integrating quantitative outcome results with qualitative results about experiences with the intervention.

5.1.2. Side-by-side joint displays depicting a model or figure: Bustamante (2019)

Bustamante (2019) evaluated the professional development on Web 2.0 technologies for Spanish teachers, both from the participants' experiences and the measured outcomes of the program using a mixed methods case study design. In her article, she describes developing a unique circular joint display built around the Technological Pedagogical Content Knowledge (TPACK) theoretical model. The TPACK model provides a framework for teachers to effectively integrate technology into the classroom and posits that successful integration of technology requires teachers to have comprehensive knowledge of content, pedagogy, and technology. Bustamante used this model to guide quantitative and qualitative data collection and analysis, and integration through joint display. For the quantitative strand, a survey measuring knowledge of content, pedagogy, and technology was conducted before and after teachers participated in the professional development program. These three knowledge elements were also used to categorize codes and themes in the qualitative analysis of data collected from several data sources (interviews, observations, documents). The theory-based joint display is made up of concentric circles featuring the three knowledge elements at its center. The next circle shows the survey scales in black, followed by circles showing themes and quotes in white. Non-significant results from pre-to follow-up tests (p-values) and reports of negative experiences in the program from the qualitative strand (quotes) are depicted with lines through the circle layers. The use of colors and lines facilitated merging integration, allowing the author to easily visualize the fit of the qualitative and quantitative data. This assessment of fit is depicted in the outermost circle that categorizes integrated findings as "confirmation," "discordance," or "expansion." While the confirmatory findings lend credibility to the study, the discordant findings shed light on areas to investigate further. For instance, the discordance between positive experiences reported by participants alongside a non-significant growth in knowledge led the author to re-examine the instrument and found issues with the wording of items in some of the scales. In this case, a model-based joint display helped illustrate the integration of theory throughout all aspects of the study and served as a method to validate a theory-based quantitative instrument.

5.1.3. Joint displays for instrument, model, or intervention development: Howell Smith et al. (2020)

In the field of educational psychology, Howell Smith et al. (2020) used a mixed methods-grounded theory (MM-GT) design to develop and test a theoretical model for how undergraduate engineering students develop an interest in pursuing an engineering PhD. Their study consisted of four sequential phases. The first phase was a qualitative grounded theory study to develop a theoretical model of interest in an engineering PhD, the second phase developed an instrument based on the model, and the third phase tested the instrument. In the final phase, they integrated the quantitative results with the grounded theory model and created a joint display to depict the evolution of the model-testing process. Each refined grounded theory model in the joint display is depicted alongside the research study phase that informed the necessary revisions. This visualization allowed the authors to compare the two research strands and consider whether the instrument's factor structure was confirming the theoretical model, or if the theoretical model required revision. This facilitated building integration, as the visualization provides evidence that the quantitative instrument was designed based on the grounded theory model. This type of joint display is especially relevant for instrument and test development in educational psychology as well as instrument development in other fields of psychology.

5.1.4. Joint display with unique visualizations: Haugdahl et al., (2017)

Haugdahl et al., (2017) conducted a qualitatively driven sequential mixed methods study to understand experiences of breathlessness among patients requiring mechanical ventilation during their stay in the intensive care unit (ICU). They interviewed patients who previously participated in a quantitative study measuring breathlessness, feeling of security, and breathing progress at the end of a spontaneous breathing trial (SBT) and purposely selected their qualitative participants to obtain a broad range of patient experiences of breathlessness. The joint display features simple illustrations of the 11 people who were interviewed against a grid divided by vertical and horizontal axes. Notably, the authors chose to dichotomize quantitative and qualitative results to determine the facial expressions and positioning of illustrated people along the axes. Using results from the qualitative strand, they drew patients who reported they did not remember breathlessness during their hospital stay with smiley faces and those who did with frowning faces. In addition, they positioned the illustrations of patients who reported having breathing problems several months after coming off of mechanical ventilation along the right side of the horizontal axis and those that did not have problems along the left. Using results from the quantitative strand, they placed illustrations of patients who self-reported a breathlessness score of four or more toward the top of the

vertical axis and those who scored below a four toward the bottom. They marked those who reported feeling secure and those who reported making breathing progress in the quantitative survey with a circle and an arrow next to the illustrations, respectively. These illustrations depict dichotomized data about breathing experiences in the people's facial expressions (smile vs. frown), thereby helping authors transform the rich qualitative data into a form that is easier to integrate with numerical data from the quantitative strand of the study. In doing so, they found that some patients who reported breathlessness during the SBT had no memory of experiencing breathlessness during their ICU stays. This contradictory finding would not have been apparent without the visualization. See Fig. 2 for a reprint of this innovative joint display.

5.2. Recommendations

The joint displays we reviewed have reflected substantial innovation in the use of visuals beyond a simple table with text. While textual joint displays remain a valuable tool, the use of graphs, figures of models, images, or other unique visual organization schemes can communicate integration in a different way that resonates with readers. Based on our review, we provide recommendations for developing joint displays that include visuals in Table 6.

Our review suggests there are more opportunities for using visuals in joint displays to achieve integration. Descriptive statistics can be represented as a graph or chart rather than numeric results, which can both reduce burden of reading it, but also make distributions of quantitative data more explicit than means and standard deviations. We see opportunities for including histograms, boxplots, and bar charts in joint displays. As noted, more of the articles we reviewed included visual depictions of quantitative than qualitative results. Visuals are perhaps underutilized in depicting qualitative results in joint displays. For example, themes can be represented by figures that show their interrelationships or the flow of a process. Visuals can simplify and aid communication. When faced with the complex task of integration, visuals in joint displays could help researchers to identify meta-inferences and help readers to understand the mixed methods analysis process.

6. Conclusion

Joint displays are one emerging approach to represent mixed methods research integration. Moreover, the iterative development of joint displays, as researchers grapple with what to include and how to organize it, can assist with integrative mixed methods analysis. In this article, we have identified researchers who have innovative and evolved beyond traditional text-based joint displays to include diagrams of models, graphs of quantitative results, figures of qualitative findings, dendrograms, pictures, and other visuals. This article has identified new types of joint displays that add to the current typology. Most of the joint displays using visuals depicted merging integration qualitative and quantitative results in side-by-side displays. These displays used bar charts, boxplots, dendrograms and other graphs to represent quantitative results, or they used figures of themes or theoretical models of the qualitative results. Visuals for either qualitative or quantitative results can reduce cognitive burden and make integration clearer for the reader. For instance, looking at a boxplot, patterns might be more apparent than numeric descriptive statistics, making it easier to compare to qualitative results and identify mixed methods meta-inferences. Another type of joint display with visuals depicted instrument, model, or intervention development. Although we only identified a few of this type of visual usage, they offer tremendous opportunity to show the iterative development of theoretical models or how qualitative findings can inform interventions and assessment instruments. In the systematic review, we identified some inconsistencies that may hinder integration. For example, when developing joint displays that make a comparison, we recommend researchers to be cautious and to avoid comparisons of aggregated results with raw data, such as quotes, unless the quotes serve in a supporting way.

Table 6
Recommendations for developing joint displays that include visuals to represent integration.

- Ensure that the visual joint display is self-explanatory and includes the information needed to be easily understood by readers
- Ensure that the visual joint display avoids unnecessary complexity and prioritizes clear communication of integrated findings over technical or visual sophistication
- Ensure that the visual joint display contains a balanced combination of detail and synthesis of information
- Ensure that the main text of the article describes the content of the visual joint display and how to interpret it
- Ensure that the visual joint display improves the clarity of reporting the integration process and the outcomes as compared to a non-visual joint display
- Ensure that researchers notice and reflect on how the use of visuals can lead them to omit certain information that might be important to help readers more clearly understand the phenomena under study

The visuals used in joint displays in this review might be helpful in presenting complex information in an easier to understand summary. We urge readers to include visuals in joint displays as "a picture can be worth a thousand words" and to use keywords like *visual* or *joint display* to help other researchers identify these displays.

Declaration of competing interest

The authors declare that they have no known competing financial

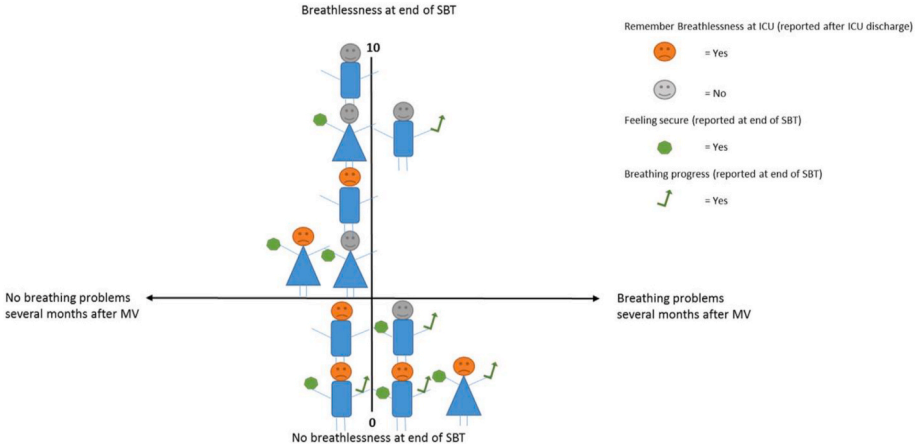

Fig. 2. Exemplar Joint Display. Reprinted with permission. Source: Haugdahl, H. S., Dahlberg, H., Klepstad, P., & Storli, S. L. (2017). The breath of life. Patients' experiences of breathing during and after mechanical ventilation. *Intensive and Critical Care Nursing, 40*, 85–93. https://doi.org/10.1016/j.iccn.2017.01.007.

interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.metip.2021.100080.

References[1]

Bazeley, P., 2018. Integrating Analyses in Mixed Methods Research. Sage.

Bramer, W.M., Giustini, D., De Jong, G.B., Holland, L., Bekhuis, T., 2016. De-duplication of database search results for systematic reviews in endnote. J. Med. Libr. Assoc. 104 (3), 240–243. https://doi.org/10.3163/1536-5050.104.3.014.

* Bustamante, C., 2019. TPACK and teachers of Spanish: development of a theory-based joint display in a mixed methods research case study. J. Mix. Methods Res. 13 (2), 163–178. https://doi.org/10.1177/1558689817712119.

Clark, J.M., Sanders, S., Carter, M., Honeyman, D., Cleo, G., Auld, Y., Booth, D., Condron, P., Dalais, C., Bateup, S., Linthwaite, B., May, N., Munn, J., Ramsay, L., Rickett, K., Rutter, C., Smith, A., Sondergeld, P., Wallin, M., Jones, M., Beller, E., 2020. Improving the translation of search strategies using the polyglot search translator: a randomized controlled trial. J. Med. Libr. Assoc. 108 (2), 195–207. https://doi.org/10.5195/jmla.2020.834.

Creamer, E.G., 2018. An Introduction to Fully Integrated Mixed Methods Research. Sage.

Creswell, J.W., Plano Clark, V.L., 2018. Designing and Conducting Mixed Methods Research, third ed. Sage.

* Enggaard, H., Laugesen, B., DeJonckheere, M., Fetters, M.D., Dalgaard, M.K., Lauritsen, M.B., Zoffmann, V., Jørgensen, R., 2020. Impact of the guided self-determination intervention among adolescents with co-existing ADHD and medical disorder: a mixed methods study. Issues Ment. Health Nurs. 1–12. https://doi.org/10.1080/01612840.2020.1780528.

Evergreen, S.D., 2016. Effective Data Visualization: the Right Chart for the Right Data. Sage.

Faust, K., 2005. Using correspondence analysis for joint displays of affiliation networks. In: Carrington, P.J., Scott, J., Wasserman, S. (Eds.), Models and Methods in Social Network Analysis. Cambridge University Press, pp. 117–147.

Fetters, M.D, Guetterman, T.C., 2021. Development of a Joint Display as a Mixed Analysis. In: Onwuegbuzie, A.J., Johnson, R.B. (Eds.), The Routledge Reviewer's Guide to Mixed Methods Analysis. Routledge, pp. 259–275.

Fetters, M.D., Molina-Azorin, J.F., 2017. The Journal of Mixed Methods Research starts a new decade: the mixed methods research integration trilogy and its dimensions. J. Mix. Methods Res. 11 (3), 291–307. https://doi.org/10.1177/1558689817714066.

Greenacre, M., 2007. Correspondence Analysis in Practice, second ed. Chapman & Hall/CRC.

Guetterman, T.C., Creswell, J.W., Kuckartz, U., 2015a. Using joint displays and MAXQDA software to represent the results of mixed methods research. In: McCrudden, M., Schraw, G., Buckendahl (Eds.), Use of Visual Displays in Research and Testing: Coding, Interpreting, and Reporting Data. Information Age Publishing, pp. 145–176.

Guetterman, T.C., Fetters, M.D., Creswell, J.W., 2015b. Integrating quantitative and qualitative results in health science mixed methods research through joint displays. Ann. Fam. Med. 13 (6), 554–561. https://doi.org/10.1370/afm.1865.

Guetterman, T.C., Moss Breen, J.M., 2021. Addressing the challenge of mixed methods integration through joint displays and clear writing. In: Factor, A., Ulhøi, J.P. (Eds.), Sustainability and Small and Medium-Sized Enterprises: Lessons from Mixed Methods Research. Taylor & Francis, pp. 192–208.

Happ, M.B., Dabbs, A.D., Tate, J., Hricik, A., Erlen, J., 2006. Exemplars of mixed methods data combination and analysis. Nurs. Res. 55 (2 Suppl. 1), S43–S49. https://doi.org/10.1097/00006199-200603001-00008.

* Haugdahl, H.S., Dahlberg, H., Klepstad, P., Storli, S.L., 2017. The breath of life. Patients' experiences of breathing during and after mechanical ventilation. Intensive Crit. Care Nurs. 40, 85–93. https://doi.org/10.1016/j.iccn.2017.01.007.

* Howell Smith, M.C., Babchuk, W.A., Stevens, J., Garrett, A.L., Wang, S.C., Guetterman, T.C., 2020. Modeling the use of mixed methods–grounded theory: developing scales for a new measurement model. J. Mix. Methods Res. 14 (2), 184–206. https://doi.org/10.1177/1558689819872599.

Howell Smith, M.C., Shanahan Bazis, P., 2020. Conducting Mixed Methods Research Systematic Methodological Reviews: A Review of Practice and Recommendations. Journal of Mixed Methods Research. Advance online publication. https://doi.org/10.1177/1558689820967626.

Johnson, R.E., Grove, A.L., Clarke, A., 2019. Pillar integration process: a joint display technique to integrate data in mixed methods research. J. Mix. Methods Res. 13 (3), 301–320. https://doi.org/10.1177/1558689817743108.

Kuckartz, U., 2010. Realizing Mixed-Methods Approaches with MAXQDA. Philipps-Universität, Marburg. https://www.maxqda.com/download/MixMethMAXQDA-Nov01-2010.pdf.

LeCompte, M.D., Schensul, J.J., 1999. Analyzing and Interpreting Ethnographic Data. AlraMira Press.

Miles, M.B., Huberman, A.M., 1994. Qualitative Data Analysis: an Expanded Sourcebook, second ed. Sage.

*Millien, C., Manzi, A., Katz, A.M., Gilbert, H., Smith Fawzi, M.C., Farmer, P.E., Mukherjee, J., 2021. Jan 01). Assessing burden, risk factors, and perceived impact of uterine fibroids on women's lives in rural Haiti: implications for advancing a health equity agenda, a mixed methods study. Int. J. Equity Health 20 (1), 1. https://doi.org/10.1186/s12939-020-01327-9.

* NeMoyer, A., Alvarez, K., Mukthineni, R., Tendulkar, S., Alegría, M., 2020. Addressing youth-focused research questions in a community context: collecting and integrating mixed methods data at multiple ecological levels with the PhotoStories project. J. Mix. Methods Res.. https://doi.org/10.1177/1558689820972916.

O'Cathain, A., 2009. Reporting mixed methods projects. In: Andrew, S., Halcomb, E.J. (Eds.), Mixed Methods Research for Nursing and the Health Sciences. Wiley-Blackwell, pp. 153–158.

O'Cathain, A., Murphy, E., Nicholl, J., 2010. Three techniques for integrating data in mixed methods studies. BMJ 341 (7783), 1147–1150. https://doi.org/10.1136/bmj.c4587. Article c4587.

Parmentier-Cajaiba, A., Cajaiba-Santana, G., 2020. Visual maps for process research: displaying the invisible. M@n@gement 23 (4), 65–79. https://doi.org/10.37725/mgmt.v23i4.4501.

Plano Clark, V.L., Sanders, K., 2015. The use of visual displays in mixed methods research. In: McCrudden, M., Schraw, G., Buckendahl (Eds.), Use of Visual Displays in Research and Testing: Coding, Interpreting, and Reporting Data. Information Age Publishing, pp. 177–206.

Ravasi, D., 2017. Visualizing our way through theory building. J. Manag. Inq. 26 (2), 240–243. https://doi.org/10.1177/1056492616680575.

Sandelowski, M., 2003. Tables or tableaux? The challenges of writing and reading mixed methods studies. In: Tashakkori, A., Teddlie, C. (Eds.), Handbook of Mixed Methods in Social and Behavioral Research. Sage, pp. 321–350.

Schreier, M., 2012. Qualitative Content Analysis in Practice. Sage.

Tashakkori, A., Johnson, R.B., Teddlie, C., 2020. Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences. Sage.

Verdinelli, S., Scagnoli, N.I., 2013. Data display in qualitative research. Int. J. Qual. Methods 12 (1), 359–381. https://doi.org/10.1177/160940691301200117.

Voils, C.I., Crandell, J.L., Chang, Y., Leeman, J., Sandelowski, M., 2011. Combining adjusted and unadjusted findings in mixed research synthesis. J. Eval. Clin. Pract. 17 (3), 429–434. https://doi.org/10.1111/j.1365-2753.2010.01444.x.

Wittink, M.N., Barg, F.K., Gallo, J.J., 2006. Unwritten rules of talking to doctors about depression: integrating qualitative and quantitative methods. Ann. Fam. Med. 4 (4), 302–309. https://doi.org/10.1370/afm.558.

Younas, A., Pedersen, M., Tayaben, J.L., 2019. Review of mixed-methods research in nursing. Nurs. Res. 68 (6), 464–472. https://doi.org/10.1097/NNR.0000000000000372.