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Mixing Qualitative and Quantitative Methods: Insights into Design and Analysis Issues

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This article describes and discusses issues related to research design and data analysis in the mixing of qualitative and quantitative methods. It is increasingly desirable to use multiple methods in research, but questions arise as to how best to design and analyze the data generated by mixed methods projects. I offer a conceptualization for such design, discuss issues of sampling, and describe a strategy for processing qualitative data in ways that allow for more sophisticated and dynamic integration with quantitative data. Finally, drawing on data from previous research, I describe tools and strategies for this dynamic data integration and illustrate how effective strategy and use of tools allow for more efficient and sophisticated analysis, interpretation, and presentation.

Applying a variety of methodological approaches to address research questions is not a new idea. Using qualitative (Qual) and quantitative (Quant) methods together has most often been used in sequential design. Nieto, Mendez, and Carrasquilla (1999), for example, used a Qual → Quant design to study malaria control in Columbia. The authors created stratified samples based on focus group findings before proceeding with more survey-type approaches. On the other hand, Hancock, Calnan, and Manley (1999) used a Quant → Qual design to study dental service usage. They first built a probability sample of service utilization and then interviewed members of high, medium, and low usage groups. Other approaches to mixing methods can be concurrent, multi-level, or some combination of several designs depending on the nature of the research question (Creswell, Clark, Gutmann, & Hanson, 2002; Ivankova, Creswell, & Stick, 2006). All of these mixed methods strategies are intended to maximize the benefits available when applying different approaches in addressing a research question (Hedrick, 1994; Tashakkori & Teddlie, 1998).

It is important to keep some general questions in mind when considering whether to apply qualitative, quantitative, or mixed methods to research questions. Quality and successful research will be attentive and responsive to the key research question and primary goals. Understanding the kinds of data that will be essential to meet a project's goals, developing a well-planned strategy for collecting, managing, and analyzing the data, and organizing thoughtful presentation of findings are also critical to the overall success of a project. Moreover, practical issues of time constraints, resources (funding, staffing, and time/energy availability), and intended deliverables must also be considered as the researcher makes design and implementation strategy decisions. Failure to fully appreciate and plan for the challenges that a researcher or research team will face may result in one or more sacrifices to what the project will ultimately achieve. The costs of these sacrifices can include the collection of relatively poor quality data, having poorly managed, confusing, and inefficient data sets, limitations on the sophistication, variety, or depth of approaches in the data

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analysis, generating fewer and lesser quality publications/presentations or, at worst, failure to complete the project. Making prudent decisions when designing and conducting any research project requires sufficient appreciation for the strengths and weaknesses of particular methods. This wisdom includes understanding the value of choosing particular methods for a given research question, how to apply these methods in efficient and effective ways, the management and analysis of the data to be collected, data collection costs, and how to accurately assess the project resources and limitations (House, 1994).

This article focuses on the issues that surround the application of mixed methods research design. Alongside thought about the aforementioned guiding principles, investigators will benefit from considering the general rationale for applying any particular method in their research design decisions. Scientific methods are applied in order to allow researchers (a) to move closer to the phenomenon of interest, (b) discover truths about the world, (c) produce research findings that are meaningful and valuable to the social sciences, (d) provide findings that are "believable" and supportive of the research claims, and (e) instill self-confidence and audience-confidence when disseminating work products (Weisner, 2002). When researchers properly select and systematically apply methods, they increase the likelihood of reaching targeted audiences, engaging them in meaningful ways, and delivering findings that are important, accessible, and useful. These principles apply equally well to any research method. As such, optimal decisions will be made following thoughtful foresight and a thorough evaluation of all the issues that will impact a project team's ability to successfully meet its intended goals within the realistic constraints of available resources.

Issues, Strategy, and Sampling in Mixed Methods Research Design

Recognizing the value of multiple approaches is a meaningful first step (House, 1994), but the effective strategy and tools available for doing so in efficient and effective ways are at an emergent stage. Qual methods take researchers closer to the phenomenon of interest than can be achieved with broader surveys or scales. They help to understand peoples' beliefs and theoretical models for how they perceived and organize their life activity and routines in subjectively meaningful ways. Pre-specified hypotheses guide Quant methods. These methods help researchers to understand more context-independent and particularistic phenomena that are relatively distant from the "natural" and holistic experiences lived by individuals. Qual data collection and analysis are relatively more expensive and exploratory than Quan projects. Qual methods focus on concept discovery, definition, and development—generating rich information for deeper understandings of human experience. Quant data collection and analysis are less expensive and more confirmatory in nature. Quant methods focus on generalizable understandings of population distributions and the relationships between variables. Challenges to integrating these approaches stem from a number of practical design and logistical issues: (a) balancing the relative strengths of each, (b) finding ways to bring relatively incompatible data closer without sacrificing quality, and (c) developing strategies to dynamically integrate these data for efficient and cross-discipline analysis (Yoshikawa, Weisner, Kalil, & Way, 2008).

Investigators must address sampling issues early in project planning to maximize their possibilities of integrating the mixed methods data and capitalizing on the various methods employed (Teddlie & Yu, 2007). Prudent sampling decisions follow from a sound understanding of what can be gained from a mixed methods project. While researches can draw contrasts between Qual and Quant methods sampling, it is useful to recognize the differences as relative emphases rather than stark "all-or-none" trade-offs. Qual methods focus on generally smaller samples and tend to employ purposive sampling strategies. In contrast, Quant methods tend to employ probability sampling in order to maximize power and meet the assumptions of particular analytic strategies. Research planning benefits from understanding both purposive and probability sampling and how they compare in terms of generalizability, case selection, focus of information (level of analysis), timing, rigidity of sampling frame, and the types of data generated (see Table 1).

Nested designs (Qual samples as a subset of larger Quant samples) can be implemented within larger studies when resources are limited and mixed methods are desirable. These designs provide for satisfactory levels of within subject analysis of both Qual and Quant data (Yoshikawa, Weisner, Kalil, & Way, 2008). Essential to the success of a nested design study is how the researcher selects the subset of participants for the more intensive

TABLE 1: *Purposive versus probability sampling*

	Sampling Strategy	
Sampling Issue	Purposive Sampling	Probability Sampling
Generalizability	Transferability	External Validity
Reason for Selecting Cases	Value of Information Collected	Representativeness of the Population
Information Focus	Depth in Cases	Breadth of Sample
Sample Timing	Before or During Study (or Both)	Before Study
Sampling Frame	Less Formal Requirements—Relatively Flexible	More Formal Requirements—Relatively Rigid
Generated Data	Primarily Narrative (can be Numeric)	Primarily Numeric (can be Narrative)

FIGURE 1: *Stratification model for nested study design*

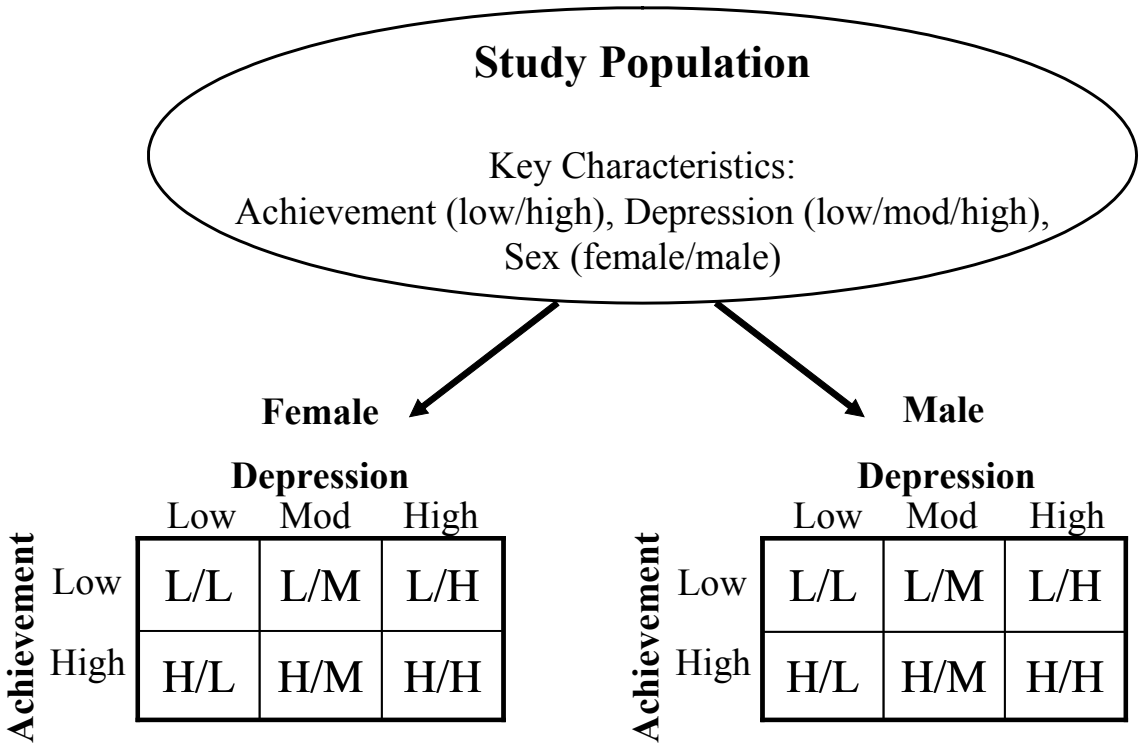
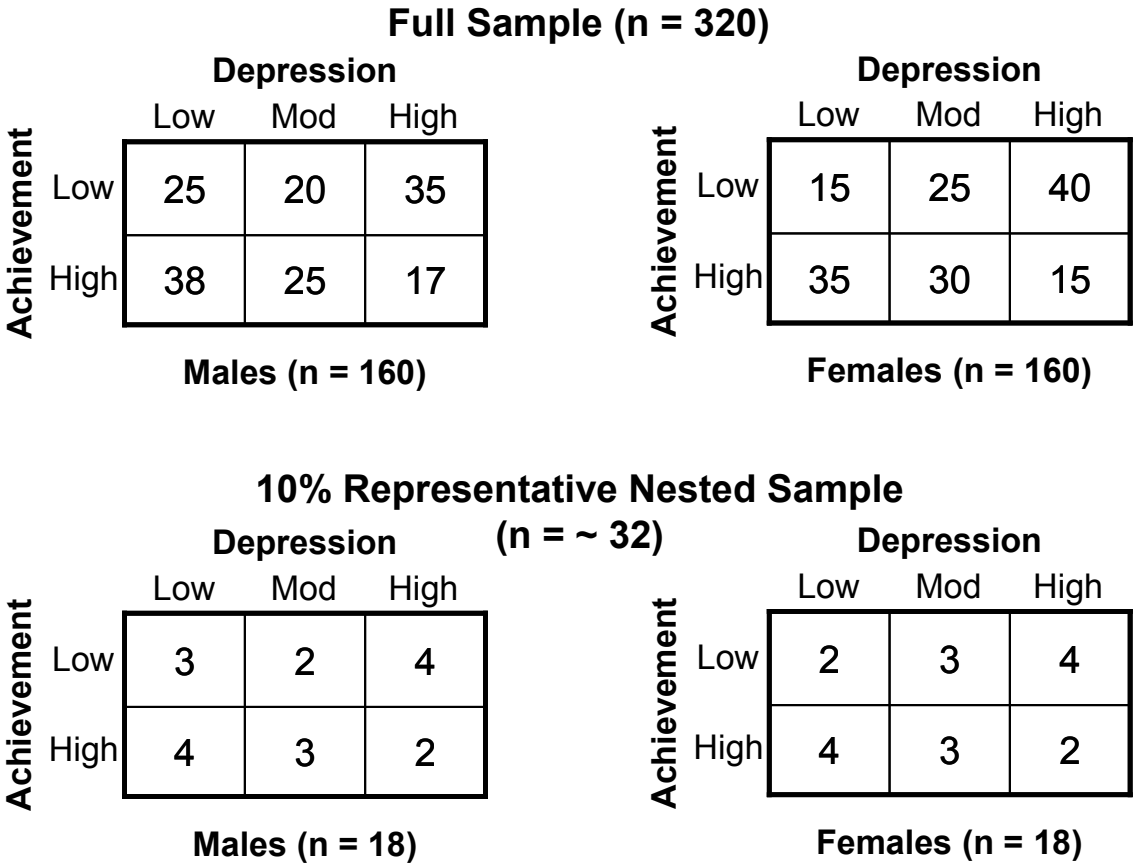


FIGURE 2: *Illustration of 10% stratified random-sampling in nested design*



Qual aspects from within the entire study population. Ideally, an investigator will first conduct a survey of all participants across a set of variables related to the research question. For example, one may hypothesize that variation in parent sex, academic achievement, and depression will impact parenting behavior in a study on parenting practice and its impact on children's literacy development. The investigator can examine, cross, and then use distributions of parent sex, achievement, and depression in the sample as strata for a random selection of participants for the smaller Qual study sub-population. Project resources may allow for a full survey of, say, 320 participants and intensive interviewing of, say, 32 (10% sub-sample). Once the researcher administers the survey, then he/she may evaluate distributions of the essential variables and create strata. Figure 1 illustrates a sample model for strata creation in a 2 (sex) x 2 (achievement level) x 3 (depression level) design. Following the identification of strata based on the distribution of key variables within the full sample, the investigator can determine the number of members (and calculation of the 10% sub-sample) within each stratum. Stratified random sampling would then take place with a 10% random sample selected from each stratum to participate in the intensive interview phase of the study (see Figure 2). Data analysis would proceed from the appropriate perspective: Quant for the full sample population and Qual for the 10% sub-sample. Finally, the researcher would seek ways to integrate the approaches based on common threads afforded by the within-subject design.

Data Collection, Processing, and Analysis in Integrated Methods Design

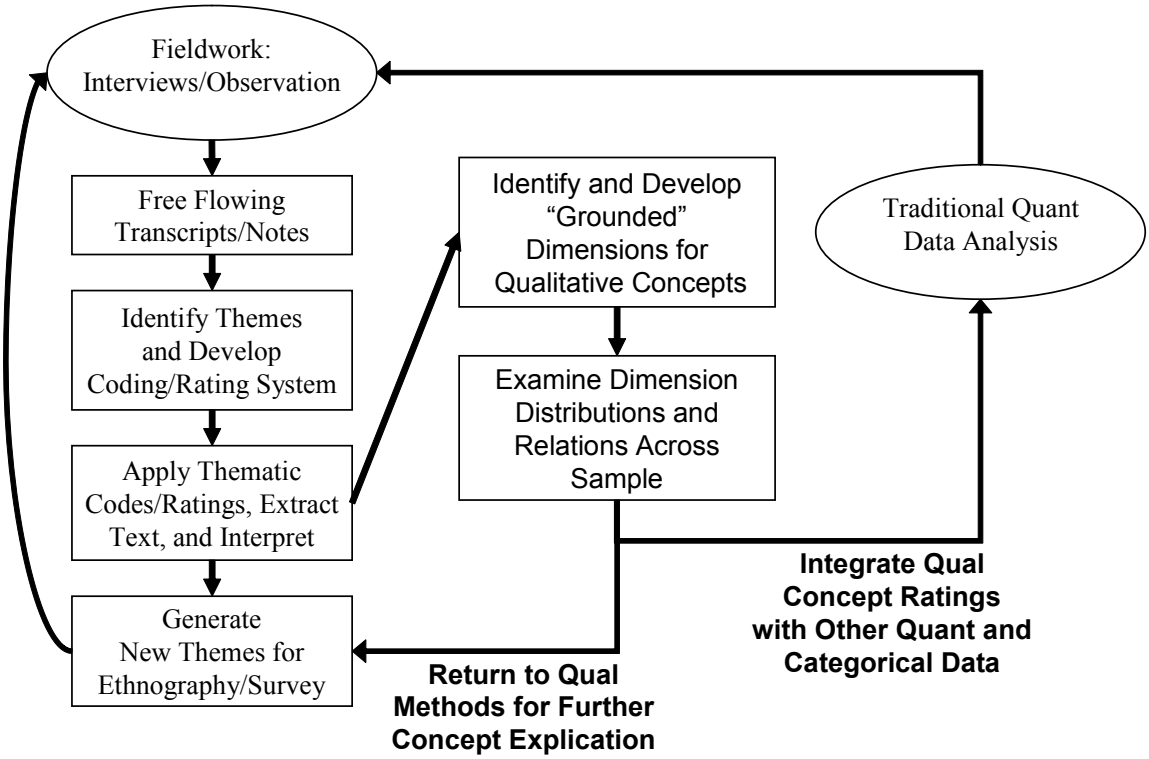
Having discussed the importance of methods in general, the complementary nature of Qual and Quant approaches, and some practical issues related to sampling, I turn to more concrete possibilities in the design and implementation of mixed methods research. Again, a cost-benefit approach is central to striking the right balance between real costs of collecting, managing, and analyzing quality qualitative data and the desire to capitalize on the benefits of maximum power in

the quantitative analyses. The degree of structure built into the qualitative data collection will be a major determinant of how large the sample can be for the qualitative component as a function of project resources: More structure leads to relatively less cost in data processing, management, and analysis. Ideally, there are enough resources to sample generously from a target population to assure adequate power in sophisticated quantitative analyses and sufficiently rich qualitative data to thoroughly exploit both approaches. Questions remain, however, of how best to process or transform the data in ways that allow a seamless and dynamic integration and what tools are available to increase efficiency in all aspects of data management, processing, analysis, integration, and presentation.

Perhaps the most unresolved challenges to mixed methods research relate to questions of data management, processing, and analysis. Figure 3 illustrates a model for representing potential directions of data flow in a within-subject mixed methods study. A qualitative approach can simply collect Qual data and develop themes within the "Fieldwork" column. However, these data also can be transformed into "grounded dimensions" that may be seamlessly integrated with the quantitative data. At that point, a researcher may conduct a range of analyses that can seek answers and deeper understandings from both qualitative or quantitative perspectives and any place in between.

Complete Qual and Quant method integration requires the establishment of a middle ground in which the data from both approaches are reliable and exist in forms that allow for their combined analysis. Demographic and other categorical data are valuable starting points for this integration. The researcher can apply familiar parametric and non-parametric approaches to this analysis. More advanced would be transforming the interview and/or observational data more common to Qual approaches into dimensions that can be integrated with other data from Quant approaches. This processing requires two steps if the resultant data are to be viewed as valid and reliable. First is the code system development and application typical of Qual methods (Miles & Huberman, 1994). Briefly, Ryan and Bernard (2003) presented and evaluated a variety of strategies for identifying and developing qualitative themes in narrative data. The investigator explores and develops potential codes through the iterative process of hypothesis testing, evaluation, and revision until a

FIGURE 3: *"Getting there from here and back again"—integrated methods conceptual model*



valid and useful code system emerges. The coding manual that documents this system should, at a minimum, include code titles, descriptions, and application criteria. Codes can vary in specificity depending on the nature of the data. Yet, objective application criteria are necessary if each code is to be sufficiently described, reliably applied, or convincingly communicated to others (Hruschka, et al. 2004; MacQueen, McLellan, Kay, & Milstein, 1998; Miles and Huberman, 1994). Demonstrating and reporting inter-rater reliability via Cohen's Kappa statistic procedures are a prerequisite for moving further into the data integration process. As with the confidence that comes from standard acceptable levels of Alpha coefficient in Quant scale data, demonstrating and documenting reliable application of a code across independent raters promote confidence in the validity and meaning of a Qual code.

Pile Sorting Strategy for Developing "Grounded Dimensions"

The second step to developing "grounded dimensions" that can be easily integrated with Quant data is the identification and elucidation of distributions within commonly coded data. The quantification of qualitative data is not a new idea (Johnson, 1978), but systematic strategies for this transformation into reliable data are demanding and commonly misused. As such, great care must be taken when deciding to implement these strategies. Not all reliably coded Qual data will allow for such a process. However, where possible and appropriate, the resultant data provide a mechanism through which one can bring together the Qual and Quant approaches.

This process involves the exploration of commonly coded excerpts to identify and define a scaled distribution. The example of Letter Recognition Skills (to be expanded upon later) is used here for illustration. In a study of the home literacy environments of families, parents reported on their preschool-aged child's activities and achievement related to alphabet knowledge. The researchers coded excerpts including information about the child's ability to recite, recognize, or attempts to write letters, words, or their name and/or parent efforts to encourage the development of these skills with "Letter Recognition Skills." Project team members carried out an iterative pile-sort exercise with a sample of Letter Recognition Skills excerpts. Each member independently created "high," "medium," and "low" Letter Recognition Skills piles and described their decision criteria for each. After sharing explanations and examples among team members, they repeated and expanded the activity to create a 5-point "Letter Recognition Skills" scale that could be reliably applied across raters. The early stages of this process tend to be relatively straightforward. The project team members easily identified very "low" and very "high" excerpts with the remainder being initially classified as "medium." The exercise repeated as the "medium" pile is further sorted to "high," "medium," and "low." Activity continued until they established clear criteria for each point on the newly identified distribution. In the Letter Recognition Skills example, the result was a 5-point distribution, but any number of points can be created to the extent that the data allow for clear and distinguishable criteria between points. The last step of this process is the establishment of inter-rater reliability akin to that established for the application of codes. Members of the research team independently rated unfamiliar excerpted data and tested the rating system validity via Cohen's Kappa statistic procedures. They then confidently included "grounded dimensions" based on this process of development and testing of both code and rating-system reliability in traditional Quant data analysis with other mixed methods project data. These "grounded dimensions" were systematic, reliable, and direct representations of the qualitative data upon which researchers developed them. They may then explore the psychometric characteristics of these variables and include them in bi and multi-variate analyses. Moreover, the "grounded" nature of these variables provides for deeper understanding of the results from the analyses. Where questions regarding group differences or bi-variate relations arise, one can seek answers by returning directly to the qualitative data on which the study bases these variables.

Tools of the Trade

Traditional computer generated tools are available for analyzing primarily quantitative data (e.g., SPSS) or qualitative data (e.g., Atlas.ti). EthnoNotes (Lieber, Weisner, & Presley, 2003), however, was designed primarily for the analysis of mixed methods data and is an excellent option for integrating and analyzing different types of data together in a single application. Figure 4 presents two screen-shots that introduce the EthnoNotes environment. Here, one can see that a

FIGURE 4 : *The ethnonotes environment*

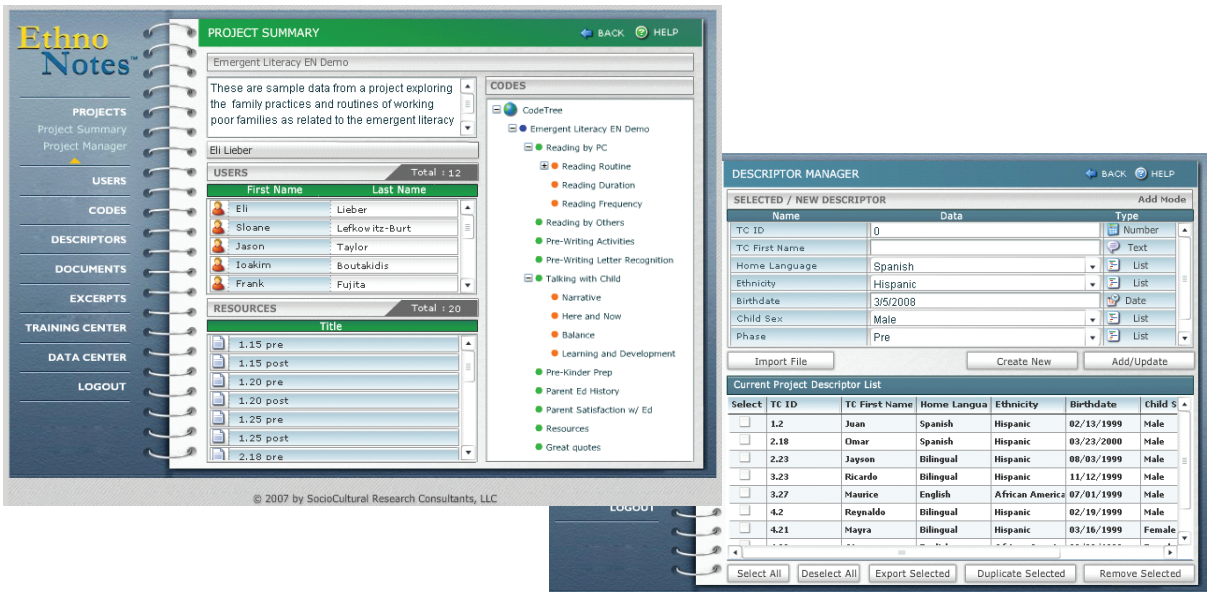
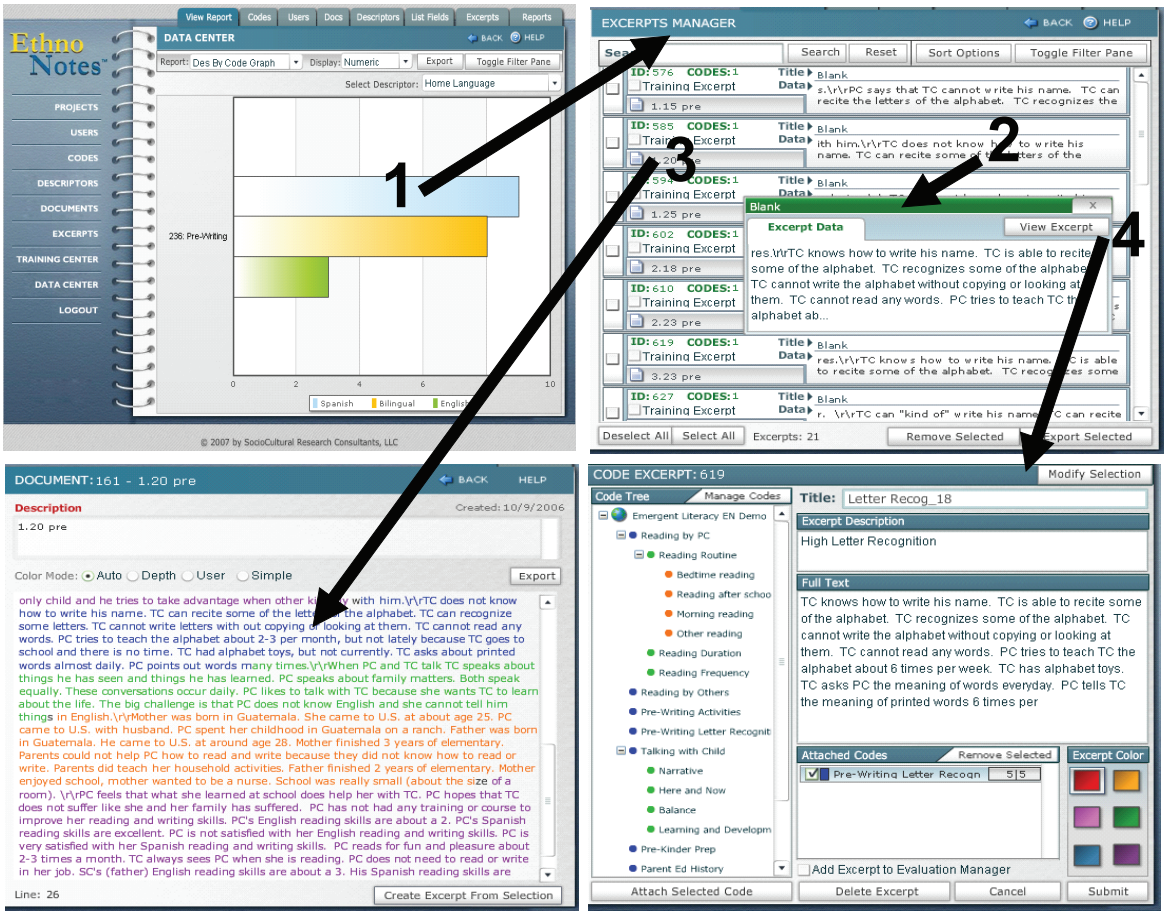


FIGURE 5: *EthnoNotes charting, exploring, and coding*



project contains any number of users, resources (documents), a hierarchical code tree, and linked descriptor data for each resource or document source. Descriptors most commonly consist of individual research participants and can include any type of nominal, demographic, categorical, or quantitative variables. Depending on a project's level of analysis, descriptors might also consist of focus groups, families, communities, businesses, or any categorization of primary document source. These images illustrate the range of data that one can incorporate into an EthnoNotes project.

From the perspective of mixed methods research, EthnoNotes' most attractive features include its transparency, flexibility, and dynamic aspects that allow for easy modification of project data at any time. Further, EthnoNotes provides users the ability to move seamlessly from charts based on coded excerpts and organized by descriptor variables to the excerpts themselves, and to the excerpts in the contexts of their source document. Figure 5 illustrates the dynamic linking within EthnoNotes between (1) charting based on coded excerpts and descriptor data, (2) exploration of the excerpts represented in a particular bar, (3) viewing an excerpt within its original context, and (4) examining/modifying the excerpt coding/rating. This integration of qualitative and quantitative data allows for fluid movement among project documents, coded/rated excerpts, and charts based on categorical or scale data. In the illustration, one can view a graph of how the program distributes excerpts coded as "Pre-Writing" across families of different primary home language, browse the excerpts themselves to "hear from the families" as to better understand the nature of observed variation across language groups as represented in a particular bar in the graph, view an excerpts in context, and return to add/modify how an excerpt was coded or annotated.

One Illustrative Example

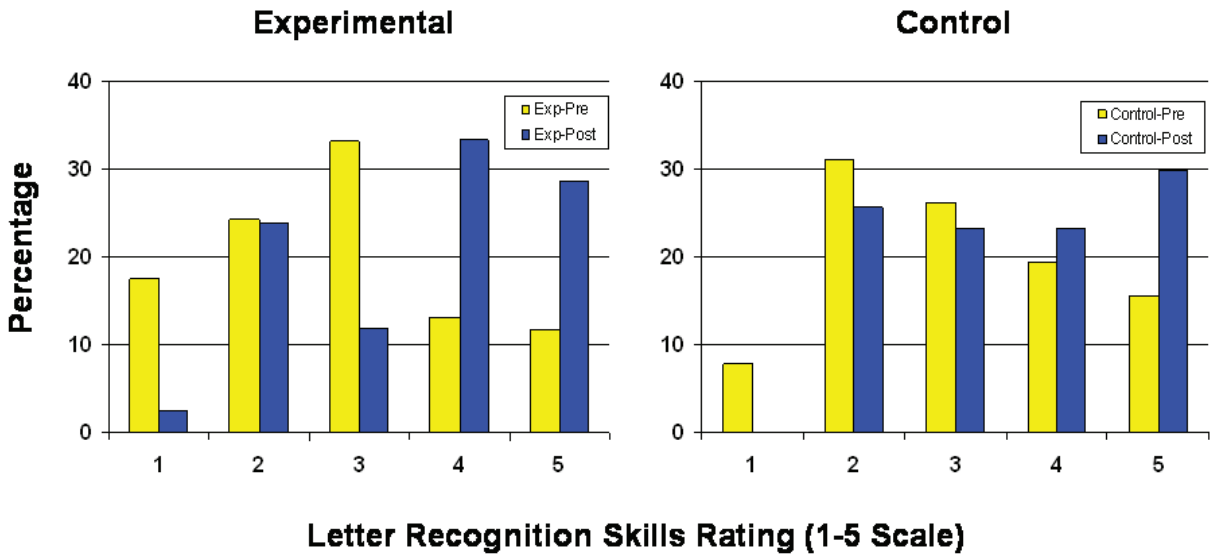
Finally, I provide a brief illustration of how our team applied this model to data collected in a study examining the impact of family practices on the literacy development of children in a Head Start program. In the context of a broader study to examine the effects of a pre-school curriculum in a pre-post experimental design, we randomly assigned participant families to either a home mentoring or control condition—creating a 2 (classroom) x 2 (home condition) design. In a nested design approach, we randomly selected a sub-sample of families from the full sample to participate in one-on-one interviewing. Project resources allowed for approximately 80 families from the over 300 families included in the intensive pre- and post-intervention interviews—an approximately 27% nested sub-sample. We randomly selected 20 families from each stratum of approximately 75 families. We identified interview themes related to the home literacy environment from transcripts, developed and demonstrated a reliable code system, and applied the codes to each family's interview data. Then, as described earlier, we developed a rating system for each code to produce reliable 5-point scales. We applied these scales to each coded excerpt for each family pre- and post-intervention. We processed, managed, and analyzed all project data using the EthnoNotes system (Lieber, Weisner & Presley, 2003).

Finally, as one simple illustration, we used the EthnoNotes charting feature to graph the pre- and post-intervention data associated with Letter Recognition Skills separately for the experimental and control groups. Figure 6 illustrates the relative group changes made over time in Letter Recognition Skills. Observable variations in the pre to post shift in distribution of scores between experimental and control group families suggest that the intervention had a statistically meaningful effect. Further, we analyzed these ratings along with other Quant data (e.g., other code-based ratings, test scores, demographics) and a variety of statistically significant results emerged. While we learned much about the impacts of the intervention from these empirical results, we remained interested in what these changes meant in terms of family behavior in the real contexts of participant families' lives.

"What's a 5?"—Going Back Again

Remembering that the ratings upon which these statistical results were made are grounded in the qualitative data, we turned back to the qualitative data to seek substantive explanations for the quantitative findings. EthnoNotes, in which we processed, coded, and rated the data, allowed for efficient and dynamic exploration of the qualitative excerpts across the range of code-ratings. For example, what does it mean to be a 5? How do families who shift upward in their pre to post-intervention ratings express changes in Letter Recognition activities and skills? Do higher or lower Letter Recognition ratings mean the

FIGURE 6: *Pre-post letter recognition ratings by experimental condition*



same thing for families who use different primary home languages or who have older siblings in the home? By returning to the coded excerpts themselves (and sometimes to the excerpts in context) we were able to provide much deeper and contextualized answers to many of these questions.

Conclusion

This article provides an in-depth description of issues and challenges in the design, sampling, and analysis strategy facing mixed methods research investigators. Blending qualitative and quantitative approaches within a single study can yield more comprehensive findings than research employing only one methodological perspective. Though challenging in conceptualization and cost, I propose a model for successfully carrying out such a project and offer suggestions for sampling, strategy for data analysis, and tools to conduct this work in efficient and effective ways. While it is increasingly desirable to integrate methods in research, there are many questions the researcher must address in deciding how best to design, carry out, and analyze the data generated by mixed methods projects. Strategy and tools for conducting this work are emerging. I believe that research in many areas will benefit from research teams continuing to meet the challenges of employing multi-disciplinary approaches.

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