Data analysis in mixed methods research consists of analyzing the quantitative data using quantitative methods and the qualitative data using qualitative methods. Thus, knowing the steps in both forms of analysis is necessary in mixed methods research. In addition, the data are analyzed to address the mixed methods question. Because the mixed methods question relates to the type of design being used, the mixed methods analysis will differ depending on the type of design.

This chapter will address

- The procedures for quantitative and qualitative data analysis in a research study
- Mixed methods data analysis procedures for the mixed methods designs, based on concurrent and sequential forms of analysis
- Validity in mixed methods research

PROCEDURES IN QUANTITATIVE AND QUALITATIVE DATA ANALYSIS

Before we discuss mixed methods data analysis, it is helpful to review the basics of both quantitative and qualitative data analysis. For both forms of analysis, researchers go through a similar set of steps: preparing the data for analysis, exploring the data, analyzing the data, representing the analysis, and validating the data. As shown in Table 7.1, these procedures differ for quantitative and qualitative research. These steps may be familiar, so the presentation here will be a review and will highlight essential aspects of data analysis (see Creswell, 2005a, for a more detailed presentation).

Preparing the Data for Analysis

The investigator begins by converting the raw data into a form useful for data analysis. In quantitative research, this means scoring the data by assigning numeric values to each response, cleaning data entry errors from the database, and creating special variables that will be needed, such as recoding items on instruments with inverted scores or computing new variables that comprise multiple items that form scales. Recoding and computing are completed with statistical computer programs such as those made by SPSS (see their Web site, at http://www.spss.com) and SAS (http://www.sas.com). A codebook that lists the variables, their definitions, and the variable numbers for each also needs to be developed.

For qualitative data, preparing the data means organizing the document or visual data for review or transcribing text from interviews and observations into a word-processing file for analysis. During the transcription process, the researcher checks the transcription for accuracy and then enters it into a qualitative data analysis software program, such as MAXqda (http://www.maxqda.com/maxqda-eng/index.htm), Atlas.ti (http://www.atlasti.de), NVivo (http://www.qsrinternational.com) or HyperRESEARCH (http://www.researchware.com).

Table 7.1 Procedures in Quantitative and Qualitative Data Analysis

Quantitative Procedures	*General Procedures in Data Analysis*	*Qualitative Procedures*
• Coding data by assigning numeric values • Cleaning the database • Recoding or computing new variables for computer analysis • Establishing codebook	Preparing the data for analysis	• Organizing documents and visual data • Transcribing text • Preparing the data for computer analysis
• Visually inspecting data • Conducting a descriptive analysis • Checking for trends and distributions	Exploring the data	• Reading through the data • Writing memos • Developing qualitative codebook
• Choosing an appropriate statistical test • Analyzing to answer research questions or test hypotheses • Reporting inferential tests, effect sizes, confidence intervals • Using quantitative statistical software programs	Analyzing the data	• Coding the data • Assigning labels to codes • Grouping codes into themes (or categories) • Interrelating themes (or categories) or abstracting to smaller set of themes • Using qualitative software programs
• Choosing an appropriate statistical test • Analyzing to answer research questions or test hypotheses • Reporting inferential tests, effect sizes, confidence intervals • Using quantitative statistical software programs	Analyzing the data	• Coding the data • Assigning labels to codes • Grouping codes into themes (or categories) • Interrelating themes (or categories) or abstracting to smaller set of themes • Using qualitative software programs
• Representing results in statements of results • Providing results in tables and figures	Representing the data analysis	• Representing findings in discussions of themes or categories • Presenting visual models, figures, tables
• Using external standards • Validating and checking the reliability of scores from past instrument use • Establishing validity and reliability of current data	Validating the data	• Using researcher, participant, and reviewer standards • Employing validation strategies (e.g., member checking, triangulation, peer review)

Exploring the Data

Exploring the data means (a) examining the data with an eye to developing broad trends and the shape of the distribution or (b) reading through the data, making memos, and developing a preliminary understanding of the database.

In quantitative analysis, exploring the data entails visually inspecting the data and conducting a descriptive analysis (the mean, standard deviation, and variance of responses to each item on instruments or checklists) to determine the general trends in the data. Researchers explore the data to see the distribution of the data and determine whether it is normally or non-normally distributed so that proper statistics can be chosen for analysis. Descriptive statistics are generated for all major variables in the study, especially the main ones, such as the independent and dependent variables.

In qualitative research, exploring the data involves reading through all of the data to develop a general understanding of the database. It means recording initial thoughts by writing short memos in the margins of transcripts or field notes. In this general review of the data, all forms of data are reviewed, such as observational field notes, journals, minutes from meetings, pictures, and transcripts of interviews. Making these memos becomes an important first step in forming broader categories of information, such as codes or themes. The memos are typically short phrases or ideas written in the margins of transcripts or field notes. At this time as well, a qualitative codebook can be developed. The codebook is a statement of the codes for a database. It is generated during a project and may rely on codes from past literature, as well as codes that emerge during an analysis. The process of generating this codebook helps organize the data, and it facilitates agreement (if several individuals code the data) on the contents of the transcripts as new codes are added and other codes removed during the coding process. Not all qualitative researchers use such a systematic procedure, but it helps to organize large databases.

Analyzing the Data

Analyzing the data consists of examining the database to address the research questions or hypotheses. In both quantitative and qualitative analysis, we see multiple levels of analysis. In quantitative research, the researcher analyzes the data based on the type of questions or hypotheses and uses the appropriate statistical test to address the questions or hypotheses. The choice of a statistical test is based on the type of questions being asked (do they describe trends, compare groups, or relate variables?), the number of

independent and dependent variables, the types of scales used to measure those variables, and whether the population is normally or non-normally distributed. Information in research methods texts discusses each of these factors (e.g., Creswell, 2005a). Another aspect of quantitative analysis is the necessity of keeping in mind that although hypothesis testing is useful, journal editors also look for evidence of practical results, reported as effect sizes and confidence intervals. The quantitative data analysis proceeds from descriptive analysis to inferential analysis, and multiple steps in the inferential analysis build a greater refined analysis (e.g., from interaction effects to main effects to post-hoc group comparisons).

Qualitative analysis begins with coding the data, dividing the text into small units (phrases, sentences, paragraphs), and assigning a label to each unit. This label can come from the exact words of the participants (in vivo coding), a term composed by the researcher, or a concept in the social or human sciences. If the researcher codes directly on the printed transcript, the transcript pages need to be typed with extra-large margins so that codes can be placed in the margins. In this hand-coding process, researchers assign code words to text segments in the left margin and record broader themes in the right margin.

A more practical approach today is to use one of the many qualitative data analysis software programs (see Creswell & Maietta, 2002). These programs all contain some combination of the following features. They can store text documents for analysis; enable the researcher to block and label text segments with codes so that they can be easily retrieved; organize codes into a visual, making it possible to diagram and see the relationship among them; and search for segments of text that contain multiple codes. The programs vary in how and the extent to which they carry out these functions.

The core feature of qualitative data analysis is the coding process. Coding is the process of grouping evidence and labeling ideas so that they reflect increasingly broader perspectives. Evidence from a database is grouped into codes, and codes are grouped into broader themes. Themes then can be grouped into even larger dimensions or perspectives, related, or compared. A typical example of relating themes can be seen in grounded theory, in which researchers form themes or codes (called categories) and then relate them in a theoretical model. Another example can be seen in narrative research, in which a chronology of an individual's life is composed using a sequence of codes or themes from the data. In this process, the themes, interrelated themes, or larger perspectives are the findings or results that provide answers to the qualitative research questions.

Representing the Data Analysis

The next step in the analysis process is to present the results of the analysis in summary form. These summaries may be statements summarizing the results, tables, or figures. In quantitative research, this involves representing the findings in statements summarizing the statistical results, such as "The scores varied for the four groups in the experiment. The analysis indicated a statistically significant difference ($p < .05$) among the groups, $F(4,10) = 9.98$, $p = .023$, effect size = .93 *SD*."

Tables in quantitative research can report results related to descriptive questions or inferential questions. If hypotheses are tested, tables report whether the results of the test were statistically significant (as well as the effect size and confidence intervals). Researchers usually present only one statistical test in each table. Tables need to be well organized, with a clear, detailed title and with the rows and columns labeled. There is standard information that should be reported for each type of statistical procedure, and various statistics books provide sample tables as models.

Researchers use figures to present quantitative results in a visual form, such as in bar charts, scatterplots, line graphs, or charts. These visual forms depict the trends and distributions of the data. The information needs to augment rather than duplicate information provided in the text, be easy to read and understand, and omit visually distracting details. Some statistical programs permit figures to be copied directly into word processing documents.

In qualitative research, presenting the results may involve a discussion of the evidence for the themes or categories; the presentation of figures that depict the physical setting of the study; or frameworks, models, or theories. When discussing the evidence for a theme or category, the basic idea is to build a discussion that convinces the reader that the theme or category emerges from the data. Writing strategies for providing this evidence include conveying subthemes or subcategories, citing specific quotes, using different sources of data to cite multiple items of evidence, and providing multiple perspectives from individuals in a study to show the divergent views (see Creswell, 2005a, for specific examples of these strategies). Apart from these discussions, researchers may represent their findings through visuals, such as figures, maps, or tables, that present the different themes. The interrelated themes may comprise a model (as in grounded theory), a chronology (as in narrative research), or comparison tables (as in ethnography). A map may show the physical layout of the setting in which the research took place.

Validating the Data

Another component of all good research is a report on the validity of the data and results. Validity differs in quantitative and qualitative research, but in both approaches, it serves the purpose of checking on the quality of the data and the results. In quantitative research, validity means that the researcher can draw meaningful inferences from the results to a population; reliability means that scores received from participants are consistent and stable over time. The standards are drawn from a source external to the researcher and the participants: statistical procedures or external experts.

In quantitative research, there are two contexts in which to think about validity and reliability. The first pertains to scores from past uses of the instruments and whether the scores are valid and reliable. The second relates to an assessment of the validity and reliability of data collected in the study the researcher is currently doing. In both senses, researchers use similar procedures. For past uses of instruments, researchers examine reviews of instruments or reports on the validity and reliability of scores taken earlier from the instruments. Specifically, researchers look for content validity (how judges assess whether the items or questions are representative of possible items), criterion-related validity (whether the scores relate to some external standard, such as scores on a similar instrument), or construct validity (whether the scores are consistent or measure what they intend to measure). As mentioned earlier, the *Standards for Educational and Psychological Testing* (1999) uses new terminology based on the type of evidence collected (test content, response processes, internal structure, other variables, and consequences testing) and focuses on the interpretation of test scores in relation to the proposed use of the test.

To assess validity for a current study, investigators establish the validity of their instruments through content validity and of their scores through criterion-related and construct validity. In addition, in experimental studies, researchers need to design their studies to reduce the threats to internal validity and external validity. Internal validity means that the investigator can only draw correct cause-and-effect inferences from the sample to the population if threats are accounted for in the design (such as participant attrition, selection bias, maturation of participants) (see Creswell, 2005a). External validity means that correct inferences can only be drawn from features of other persons, settings, and past and future situations if certain aspects of the design are considered by the investigator (e.g., the treatment interacts with the selection of, the setting, or the history of the participants) (see Creswell, 2005a).

Reliability of scores from past uses, assessed in terms of reliability coefficients, and instrument test-retest results need to be addressed. In a current study, researchers need to check for the reliability of scores (through statistical procedures of internal consistency) and any test-retest comparisons.

In qualitative research, there is more of a focus on validity to determine whether the account provided by the researcher and the participants is accurate, can be trusted, and is credible (Lincoln & Guba, 1985). Validity comes from the analysis of the researcher and from information gleaned while visiting with participants and from external reviewers. Reliability plays a minor role in qualitative research and relates primarily to the reliability of multiple coders on a team to reach agreement on codes for passages in text.

Qualitative validation is important to establish, but there are so many commentaries and types of qualitative validity that it is difficult to know which approach to adopt. We will work from standards we have set in prior publications (Creswell, 1998; Creswell & Miller, 2000). Overall, checking for qualitative validity means assessing whether the information obtained through the qualitative data collection is accurate. There are strategies available to determine this validity, and qualitative researchers typically use more than one procedure. Member checking is a frequently used approach, in which the investigator takes summaries of the findings (e.g., case studies, major themes, theoretical model) back to key participants in the study and asks them whether the findings are an accurate reflection of their experiences. Another validity approach is triangulation of the data, from several sources (e.g., transcripts and pictures) or from several individuals. This procedure is a common data analysis practice: The inquirer builds evidence for a code or theme from several sources or from several individuals. Another approach consists of reporting disconfirming evidence. Disconfirming evidence is information that presents a perspective that is contrary to the one indicated by the established evidence. The report of disconfirming evidence in fact confirms the accuracy of the data analysis, because in real life, we expect the evidence for themes to diverge and include more than just positive information. A final approach is to ask others to examine the data. These others may be in the form of peers (e.g., graduate students or faculty), who are familiar with qualitative research as well as the content area of the specific research, or external auditors, individuals not affiliated with the project who review the database and the qualitative results using their own criteria (Creswell, 1998).

Reliability has limited meaning in qualitative research, but it is popular in qualitative research when there is interest in comparing coding among several coders. Called intercoder agreement, the basic procedure involves having several individuals code a transcript and then compare their work to determine whether they arrived at the same codes and themes or different ones (Miles & Huberman, 1994). Typically coders look for text passages that they have all coded and, using a predetermined coding scheme, identify whether they assigned the same or different codes to the text passage. Rates are developed for the percentage of codes that are similar, and reliability statistics (kappas) can be computed for systematic data comparisons. Creswell, (2007). pp. 128-135.

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Question # 1

Normal Distribution is a bell-shaped curve that can distribute random variables from negative to positive infinity. This creates an optimal instrument using *z* – transformations, which gives the exemplary status of normality - the standard normal of *z* – distributions. The *z* – distributions correspond to normal random variables under the curve. The mean and standard deviation equates the x value to z value, Hawkes, (2019)

$$z =$$

$$z \bullet \sigma =$$

$$z \bullet \sigma + =$$

The center line on the above curve is the central tendency (Mean, Median, or Mode), each is used differently depending on the application and utilization of the curve. The curve is symmetrical in reference to the center line. Between -1 and 1 are one standard deviation, between -2 and 2 are two standard deviations, and between -3 and 3 are three standard deviations. Between -2 and -3, 2 and 3 are the tails of the curve. The standard deviation is the data that deviates around the central tendency, Hawks, (2019).

Question # 2

Relationships that are explained among or between variables is the hypothesis, though it isn't the end-of-all answers to science, it evaluates and test phenomena in research studies. When a population or populations are being examined that has no effect, no change, or no relationship, the null hypothesis describes and investigates that nothing happened. The alternative hypothesis (research hypothesis) is a resolution statement illustrating the relationship between variables, Gravetter & Forzavo, (2006).

Hypothesis testing is a procedural statistical method that evaluates sample data to establish the credibility of a hypothesis. It establishes that the results of a research study are improbable to have occurred by chance. It uses test statistics to determine the alpha level (level of significance) that provides a criterion for the interpretation of the test statistic. The hypothesis alpha level is the greatest probability that research results occur by chance. If the alpha level is above or below a predetermined value, the null hypothesis is determined to be rejected or accepted. If rejected, the alternative hypothesis is accepted. If the null hypothesis is accepted other tests may need to be done, Gravetter & Forzavo, (2006).

Question # 3

The use of simple linear regression administers predictive analytics using a statistically significant explanatory independent variable Digital Storytelling, [(M) = 54.675, (SD) 6.1660] and the dependent variable Social Studies Test [(M) = 83.925, (SD) = 6.9222], given an R Square of .776, an Adjusted R Square

of .770 with a regression significance of .000, and a Standardized Coefficient dependent variable B value of .989, also with a statistical significance of .000.

The data model created by using simple linear aggression uses existing Digital Storytelling data and delivers predictive data to prepare Mrs. Historical-Wonders students to take the Standardized Social Studies Test.

Graphically, Digital Storytelling would be put on the X axis and The Standardized Social Studies test data on the Y axis. A left to right upward linear of line of best fit that shows a positive predictive Y values Social Studies test for a given value of X Storytelling.

Developing a formula that recommends practices for correlative predictability of policy. For example, simple linear regression can be used to develop strategies to combat Adult Education Attendance issues, by using Motivational Framework for Culturally Responsive Teaching which can be journaled in the professional field of Education Technology.

Question # 4

The one-sample t test is used in this study takes the mean value 83.9250 and SD 6.92223 of the variable Social Studies test. The standard error's mean is 1.09450, the t statistic is 5.413, (*df*) is 39, the test value is 78, the statistical significance is .000, Faherty, (2008),

With the p value being less than .05, we can reject the null hypothesis and except the alterative hypothesis. Suggesting with 95% confidence that the Social Studies test mean of 83.9250 of class performance comparison to other students in the state. Since the t statistics lie at 5.413 in the right tail of the normal distribution curve at a distance where we can reject the null hypothesis at a p value less than .05. We can conclude that sample population was not drawn for sample test value of 78, and it was drawn from between the two-tail confidence interval lower value of 3.7112 and the upper value of 8.1288.

Development of educational standards for adult learners with policies in mind can be adapted throughout the state. Persistent research and development of learning ideologies can be made to work within the program in which I teach, and then they can be reported as professional journals and used to be compared and utilized throughout the State of NY.

Question # 5

In this study, the independent sample t-test is used to determine the differences in the social studies test score between two classes. Class A has a mean value of 83.93 and standard deviation (6.922), and the mean value of class B is 78.66 and standard deviation (7.694). Of the lessons with digital storytelling, the t-test value (3.181), the degrees of freedom (76), and the level of statistical significance (.002), Faherty, (2008),

Mrs. Historical-Wonders is informed that our findings determine that with 95% confidence there is a difference between social studies test scores; asserting that the t-test value lies between 1.970 and

8.565. Using Levene's test to determine whether the assumption of the variance is equal or not. The null hypothesis is tested, and since the statistical significance value is .002, the null hypothesis is rejected, and the alterative hypothesis is accepted with the assumption that that the variance is not equal.

Working at two different adult learning locations, eight city blocks away from each other. Policies and practices used at one location can be adopted at the other location. Research studies can be done on how my adult students responded to these new policies and practices. The results of these research studies can be incorporated into professional journals.

Question # 6

Using the paired sample t test to compare averages drawn from the Social Studies Pre-test with a mean of 62.450 with a (SD) of 5.149 and the Social Studies Post-test with a mean of 83.925 with a (SD) of 6.922. A t test value of 18.043, the degree of freedom (df) of 39 and a significant level of .000, Faherty, (2008),

With a significant level of .000, the null hypothesis is rejected, and the alternative hypothesis is accepted; concluding that the scores are significantly different. Since we are concerned about whether the differences between the means occur by plausibility or will Mrs. Historical-Wonders' students be more competent after the post test.

Recommendations can be made to improve and heighten the effectiveness of problem solving and listening skills, along with educational policies that strengthen the frameworks of holistic education.

A professional journal publishing the efficacy of new teaching programs models centered around Digital Storytelling, that highlights the pre-test before learning interventions, and a post-test after learning interventions.

Question # 7

The one-way ANOVA accomplishes the task of observing whether there is a difference in the mean value that exists between the following Digital Storytelling's [(M) 83.925, (SD) 6.92223], Quizizz' [(M) 88.975, (SD) 8.68387, Flipgrid's [(M) 83.175, (SD) 5.49073], Edpuzzles' [(M) 80.400, (SD) 80.400] with a statistical significance p value of .000. With a (*df*) of 3 between groups and the (*df*) of 156 within groups, Faherty, (2008),

In evaluating the SPSS output, it is determined that the statistical significance .000 is less than alpha level of .05, therefore we'll reject the Null Hypothesis (Ho) and accept the Research Hypothesis (Ha).

Mrs. Historical-Wonders, the output stated above doesn't allow for the determination of classes that are best to help your students prepare for the standardized test. A supplementary Tukey test output determined that the Quizizz' show a statistical significance which will help your students learn content and review for their assessments.

Because I'm starting to be known as a valuable researcher, understanding which professional journals to publish is essential to helping my career. This article will be rigorously evaluated for tone, structure, and

format before being published in multiple professional journals. It will make life easier for Mrs. Historical-Wonders and others in the field of educational technology.

Question # 8

Because my research always involves data that needs to be compared, the Statistical test that follows would be of use be me as a researcher.

- **T-Test:** Compares means between two groups.
- **F-Test:** Compares variances or more than two group means.
- **Chi-Square Test:** Evaluates relationships between categorical variables.

Having experience working for two different Adult Educational programs gives me the opportunity to study two different groups of adult students. I've worked with multiple groups of adult learners at different locations within the same educational program; therefore, I can compare variances of two or more groups. Because I taught at different locations with different categories of students, I can evaluate relationships between different categories of those students. For example, students under eighteen years of age, students at 23 years of age, but older than 19, and finally students above 23 years of age.

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