GRADUATE STUDIES

MARTIN LUTHER COLLEGE

CAPSTONE PROPOSAL

GUIDELINES FOR SUBMISSION

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EDU5005

Foundations of Educational Reserach

Martin Luther College Graduate Studies
Capstone Proposal

Introduction

Martin Luther College graduate students complete their degrees with either a *capstone project* or a *comprehensive examination.* Many choose a capstone project because it allows students to practically apply their graduate learning to classroom or education issues that they care about. Capstone projects include a *field project,* a *thesis,* and an *internship.* Not all options are available for all degrees, so consult your program plan and your advisor to see which apply to you.

This guide is only about capstone project proposals. A **capstone proposal** is a written document in which you persuade your capstone committee of the need for and appropriateness of your project. It involves (a) identifying an educational issue, (b) using the literature to inform a solution, and (c) designing a way to carry out and assess the solution. These three topics are arranged into *chapters* (sections) titled *Introduction, Literature Review,* and *Design.*

- A *field project* is a type of action research. Action research happens in one's own setting. It involves identifying a problem, finding and implementing a solution, and assessing the effectiveness of that solution. For example, a teacher finds she has too little time for discussion and practice in class (problem). The literature suggests that a "flipped classroom" can increase time in class for application (solution). She implements a flipped classroom for a set period of time and assesses its impact on learning (assessment).

- A *thesis* is a traditional research study that attempts to shed light on an educational issue, often one that has meaning for a larger audience than herself. A thesis has specific research questions, and the researcher gathers data to answer the question empirically. It can involve non-experimental or experimental means. In recent years, Lutheran school leaders have designed studies to identify factors that improve gospel outreach to non-member school families or to test the effectiveness of outreach strategies. The purpose is to shed light on the issue for themselves and others.

- An *internship* provides a practical experience in which the candidate gets practice with and gathers evidence of meeting professional standards for a skilled position, like a principal, an early childhood director, a special education teacher, or a technology director. This option is only available to candidates who aspire to but are not currently serving in those roles. It also requires an in-house mentor or cooperating teacher.

The information that follows describes each of the capstone proposal sections. Since there is some variation depending on the specific type of capstone being proposed, these directions may need to be tweaked to match your own proposal. Your advisor can help you customize your proposal.

Chapter One – Introduction

The purpose of Chapter One is to persuade your readers—such as your capstone committee, instructors, or peers—that your project is important and necessary. Strong introductions are supported by evidence rather than impressions or anecdotes. Evidence may include past research, current data, and literature references. That evidence may come from available data and previous research, and it should be cited. An argument supported by data and the literature is stronger than one based on your own impressions, beliefs, or experiences. A well-supported argument establishes your credibility as a researcher and the significance of your study.

Purpose of a Research Proposal (Mertler, Introduction to Educational Research, Ch. 10)

According to Craig A. Mertler (2021), a research proposal is both a plan and a persuasive document. The introduction should clearly define the educational problem, explain its significance, and identify the goals or questions driving the research. All components must be logically aligned and supported by credible sources. Ethical responsibility, methodological feasibility, and scholarly clarity are all essential at this stage.

Required Sections of Chapter One

The Issue or Problem

Provide background on the classroom, school, or professional context of your issue. This section provides the reader with the necessary classroom, school, or education profession background to understand the program or issue you wish to address. Include past information and present circumstances. Include data that shows the problem is something that should be addressed.

Importance or Significance

This section provides a logical pathway to lead the reader to understand why your field project, thesis, or internship is necessary. A good way to do that is to describe the gap in knowledge that currently exists. Words like “although,” “however,” and “but” are great ways to introduce a gap. Here are some examples:

- **Although** this approach has been successful in rural schools, it has not yet been tested in an urban classroom.
- The students do well on daily assignments, **but** the test scores do not reflect the same mastery.
- Public school principals who receive peer mentoring are less likely to resign, **however** no such study has been conducted among Lutheran school principals.

The above statements point to a gap in knowledge and a reason for your study. It is important to provide evidence to set up the statement of significance.

Purpose, Goals, or Research Questions

The title and focus of this section depend on the kind of capstone you are proposing. You use this section to be as clear as possible to your readers what you hope to accomplish through this study. The purpose or goals should flow from the gap you presented in the previous section. For field projects and internships, describe your goals. For a thesis, pose specific research questions. The purpose, goals, or research questions will drive your design section. (Internship Only: Refer to the Internship Handbook for the exact format.)

(Thesis Only) Definitions, Assumptions, and Limitations

The thesis introduction will also include sections titled *Definition of Terms* and *Assumptions and Limitations of the Study.* Define the terms that may have multiple meanings (e.g., assessment) or used in a novel or unique way so the readers know exactly what you mean by them in your study. Use scholarly definitions from the literature when possible. Also include assumptions you are making and limitations that may affect your study's scope or findings. These help to define the boundaries of your research and clarify its validity. The assumptions and limitations are used to reveal potential bias and things that bound or limit the study in any way.

See the appendices for an outline of the various capstone proposal formats and a side-by-side comparison of a *proposal* to a *finished project.*

Chapter Two – Literature Review

The **literature review** may be the most important part of the researcher's work. It gives the study its **purpose and direction**. A well-executed review makes the case for why the study is necessary, how it should be conducted, and what outcomes might be expected. In educational research, **good literature** refers to sources that are credible, relevant, rigorous, and insightful in addressing a research question or topic. A strong literature review not only draws on good sources but also fulfills essential scholarly purposes. Specifically, a good literature review fulfills these four purposes:

- *It provides the context for your study.* Others have written about and research this problem or aspects of it in the past. What did they learn? What is the current thinking on the topic and how did educational scholars arrive at this thinking? Educational issues do not exist in a vacuum. Good literature shows what is already known about a topic and how current thinking evolved. It helps the reader understand the problem through the lens of past scholarship, identifying key findings and dominant perspectives in the field.
- *It frames the study.* The literature review places your study or project into the larger conversation to show where it fits. To do that, the literature review describes what has been shown to be effective, and how that will impact your study. It may also share what is still unclear or unknown that requires further clarification and study. Sometimes those are called gaps in the literature. Framing the study also includes ways the issue can be studied. What previous methods have been used that this study follows, or will new understandings require a new method? This framing also includes identifying **gaps in the literature** or areas needing further investigation. It helps justify why the study matters and how it connects with or diverges from prior research.
- *It includes or introduces theory.* The theory is needed to explain why treatments are effective or why certain results might be expected. Good literature reviews are **theoretically grounded**. They do not simply summarize findings but connect those findings to educational theories that explain why certain outcomes occur. These theories help clarify the mechanisms behind observed phenomena and may guide hypothesis development or intervention design.
- *It reveals the study's underlying logic.* The study's logic is commonly called a conceptual framework. It explains how the variables fit together, and how they cause possible outcomes. The conceptual framework can be illustrated by a drawing and, or it can be described by the verbal organization of the literature review. Usually, the headings help identify the components of a conceptual framework.

Insights from Craig A. Mertler (Chapter 5, Introduction to Educational Research)

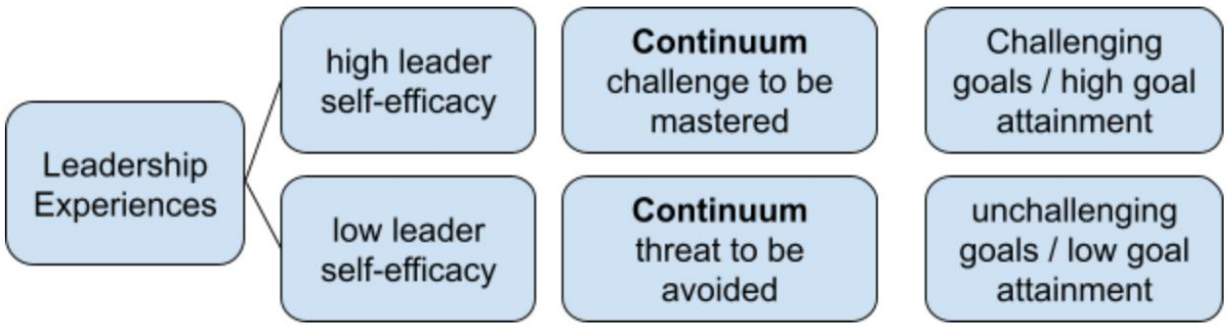
Craig A. Mertler (2021) emphasizes that a strong literature review clarifies the research topic, guides method choices, and highlights inconsistencies in prior findings. The review should focus on peer-reviewed, empirical studies to ensure rigor and objectivity. It should not be a simple list of summaries but a synthesized, flowing narrative. The best literature reviews are organized thematically and conclude by summarizing key findings, gaps, and opportunities that justify the current study.

Characteristics of Good Educational Literature

To serve the purposes above, the literature cited in a review must possess the following qualities:

Characteristic	Description
Scholarly & Peer-Reviewed	Published in credible, peer-reviewed academic journals by recognized experts.
Relevant	Clearly related to the research question, population, setting, or methodology.
Methodologically Rigorous	Demonstrates clear, valid research design and reliable findings.
Theoretically Informed	Connects findings to educational theories or conceptual models.
Current (when appropriate)	Reflects recent developments, especially in rapidly changing areas like technology or policy.
Insightful	Offers significant findings, implications, or interpretations that go beyond basic reporting.
Well-Cited	Referenced by others in the field, showing influence and credibility.

Here's an example from a possible study of how theory can inform a conceptual framework. The study examines how a standards-based continuum of principal development impacts a principal's professional development goals. The literature about principal goals and motivation to reach those goals finds that leader self-efficacy is an important variable in several ways. The logic in the literature describes self-efficacy as influencing the quality of a leader's goals and their motivation to reach those goals. Additional literature explains that the level of self-efficacy predicts whether people approach challenges as a threat or motivation. We combined the two concepts to predict that previous leadership experiences will influence self-efficacy, and the level of efficacy will impact how the standards-based continuum will be viewed and utilized. The leader's self-efficacy will further influence the goals and motivation to achieve them. That verbal description might look like this when diagrammed.



This conceptual map visualizes the theory, and the subsequent literature review is synthesized under the headings of (a) Importance of Leadership Self-efficacy, (b) Factors Affecting Self-Efficacy, (c) Self-efficacy's Impact on New Experiences, (d) Self-efficacy and Goal Setting, and € Self-efficacy and Motivation.

It is helpful to take notes in an outline format as you read the literature so you can lay out what is known and begin to see common themes and connections. Ask yourself what the literature is telling you, and then craft your synthesis to help your readers see those same insights, patterns, and possible theories.

Effective literature reviews are concise and well-cited. They are the logical glue that connects your problem to your implemented solution or your research questions to your research design.

Ineffective literature reviews are rambling with no obvious organization. They often simply report one study at a time and contain direct quotations.

Keep the following tips in mind.

Do

1. Be concise.
2. Synthesize findings across studies, rather than summarizing one at a time.
3. Use a logical organizational structure.
4. Use **level-two headings** to reflect themes and guide readers.
5. Write in your own words and voice, citing appropriately to support claims.

Don't

1. Organize your review by author, book, or article.
2. Use direct quotations.
3. Ramble in long, unfocused paragraphs without topic sentences.

There can be several ways to organize your literature. You can organize by **themes.** Thematic organization might be by key concepts. The literature can also be organized **chronologically** or **historically.** A historical approach is especially useful if the evolution of research in the field is critical to understanding the topic. Finally, the literature can be organized by **methodologies.** By grouping studies by methodology, you can highlight similarities or differences to show trends or weaknesses.

Good literature reviews use thoughtful organization to help the reader make sense of the findings:

- **Thematically:** Group by ideas, such as "student engagement," "teacher efficacy," or "technology integration."
- **Chronologically:** Use this when tracing the development of a theory or topic over time.
- **Methodologically:** Useful for comparing how different research designs (e.g., case studies vs. RCTs) affect findings.

The literature review has three major parts. The **Introduction** outlines the purpose, the scope, and the organization of the review. Let your reader know what's coming up. The **Body** of the review is the main

part. This is where you discuss the literature by themes, chronology, or methodologies. Make sure to use headings (level two) and topic sentences to guide the reader through your logic. End the review with a **Conclusion** that summarizes the key findings and reiterates the gaps. Also, highlight theories, frameworks, or data gathering tools from the literature that will be important to your design.

Structure of the Literature Review

1. **Introduction:** Explain the scope, purpose, and organization of the review. Let the reader know what to expect.
2. **Body:** The main discussion, organized around themes, time, or methods. Use headings and topic sentences to guide the reader.
3. **Conclusion:** Summarize key findings, highlight gaps, and point to theoretical or methodological contributions relevant to your research design.

Chapter Three – The Design

The third chapter of a capstone proposal (Field Project or Thesis) is called the "design" or "methodology" section. It outlines how the study will be conducted. Its purpose is to (a) remind your readers of your project's purpose and, (b) describe how you will use a scientific approach to either implement your intervention and test its effectiveness (field project) or empirically investigate your issue (thesis). It is very important that the design flows logically from your problem, research purpose or questions, and literature review. The best designs adhere to a logical framework laid out in the previous chapters of the proposal. The design should be clear, systematic, and aligned with the research problem.

The design chapter begins with a brief review of the problem/issue, purpose/questions, and theoretical framework. It then provides detailed information about the setting, subjects, intervention, data collection tools, and data analysis techniques. Your goal is to persuade your audience (capstone committee, IRB) that you will use sound methods, empirical data, and proper precautions to avoid extraneous variables and participant harm.

The design chapter should have the following sections, each with a level-two heading. Consult with your advisor as these sections may vary in name and type depending on the specific project you will conduct. (Internship Only: Refer to the specific Internship Handbook for how to write chapter three.)

I. Introduction

The design begins with a *short* introduction that reminds the readers of the reasons for your research and either the purpose (field project) or questions (thesis) you are pursuing. When possible, also include a summary of your theoretical framework.

Specify the kind of research methodology you will use and why it is appropriate for this study (action research, case study, experimental study, descriptive or non-experimental, participatory, correlational, etc.).

II. Procedures

This section explains how you will carry out your project. Describe the specific action, strategy, or intervention to be implemented. Justify why this intervention is expected to bring about change. Explain how it will be carried out (e.g., training sessions, curriculum modifications, process improvements). Provide a timeline for when the various stages of the design will be carried out.

The nature of this section will vary depending on your purpose, goals, or research questions. You may need to describe the procedures you will use to investigate the problem, develop a program, or implement a solution. Provide as much detail as you can.

For example, if your action research involves a plan for effective peer coaching, you will need to describe the model or framework you are following, the procedures you will use to introduce it to the faculty, and what you will do to implement it with fidelity. This procedure or intervention should flow logically from the literature review, where it has been previously introduced with literature support as best practice. Include how you will assess the effectiveness of the action research.

If you are conducting an investigation (thesis), you will detail the steps you will take to gather the data that will answer the research questions. You should demonstrate how your investigative approach will provide data that is both valid and reliable.

III. Context or Setting

Describe the environment where the research will take place (e.g., a classroom, workplace, community). Explain why this setting is relevant to the research problem.

IV. Subjects

Describe the subjects and your rationale for selecting them. Who will be studied, why are they the right people for this study, and how will they be selected? Discuss ethical considerations like informed consent and confidentiality. Mention institutional review board (IRB) or ethics committee approvals, if applicable.

The subjects should provide a sufficient sample size for the type of study you are conducting. Explain how they meaningfully represent of the population and any steps you are taking to minimize any confounding variables. Are you using random sampling or random assignment to a treatment and control? If you are using convenience sampling, what are you doing to identify group and individual differences, such as using matched pairs? What criteria will be used for focus group participants or case studies?

V. Materials and/or Measures

Describe the materials that will be used as part of the intervention. Make sure to connect these materials to your purpose, framework, and literature review to demonstrate that these are the best materials to use for your action research or investigation. Include all materials and measures in the appendices.

Materials can also include measures or data gathering tools. Common data gathering tools are surveys, interviews, focus group interviews, observations, and document analysis. Explain how the tools selected align with the research questions. Discuss steps to ensure the trustworthiness of the tools used, including the validity and reliability of the measures, pilot testing, triangulation, member checking, peer debriefing, and tests for interrater reliability. Use established tools from educational practice and literature whenever possible.

For self-authored surveys, describe the types of items used (Likert, forced choice, open-ended, ratings, demographic), and explain how the type of item will provide useful information. This may be especially helpful for the next section, data analysis. Include any limitations the study may have, including researcher bias for self-authored tools.

VI. Data Analysis

Review each data gathering tool (survey items, interviews, document analysis, etc.) and explain how the collected data will be analyzed. For example, you can name and describe the types of statistical analyses, like descriptive statistics (averages, means, correlations) or inferential statistics (t-test, Chi-Square, ANOVA) for quantitative measures and thematic analysis of coding for qualitative measures. Be as specific and detailed as possible.

Indicate how the results will be used to evaluate the impact of the intervention, fulfill the research purpose, or answer the research questions.

VII. Limitations

Every design has certain limitations, including bias. You should acknowledge the designs impact on bias, reliability, validity, and possible conclusions. For example, if you are the only researcher who implements the intervention, gathers data, and interprets it, your findings will be subject to your own desire to interpret findings in a way that reflects positively on you and your project. If your measurements are self-created and not piloted, you will have validity and reliability issues. If measures are not triangulated or analyses checked by others, your data and interpretations may be unreliable.

Capstone Proposal Outlines

Field Project

A field project is a form of action research that allows the student to investigate an educational issue or implement a strategy that has meaning within the student's local educational context. The student uses a research-informed approach for decision-making, program development, or evaluation. In general, the following outlines can be used for the *proposal* and the *final capstone report.*

Field Project Proposal

I. Introduction
   - The Issue
   - Importance of the Project
   - Project Purpose or Goal
II. Literature Review
   - Introduction
   - Main Body
   - Conclusion or Summary
III. Design
   - Introduction
   - Procedures
   - Subjects or Participants
   - Assessments
   - Analysis
IV. Reference
V. Appendices

Field Project Final Report

I. Introduction
   - The Issue
   - Importance of the Project
   - Project Purpose or Goal
II. Literature Review
   - Introduction
   - Main Body
   - Conclusion or Summary
III. Implementation
   - Introduction
   - Procedures
   - Subjects or Participants
   - Assessments
   - Analysis or Results
IV. Reflective Essay
   - Introduction
   - Conclusions
   - Recommendations
V. Reference
VI. Appendices

Thesis

A thesis is a systematic approach to investigating an educational problem that has application for the educational community in general. The thesis proposes an educational problem, a research question or questions, and a design that allows for empirical investigation. The findings are analyzed and reported once the investigation is completed.

Thesis Proposal

I. Introduction
   - Statement of the Problem
   - Significance of the Study
   - Research Questions
   - Definitions of Terms
   - Assumptions & Limitations
II. Literature Review
   - Introduction
   - Main Body
   - Conclusion or Summary
III. Design
   - Introduction
   - Procedures
   - Subjects or Participants
   - Measures
   - Data Analysis
   - Limitations
IV. Reference
V. Appendices

Thesis Final Report

I. Introduction
   - Statement of the Problem
   - Significance of the Study
   - Research Questions
   - Definitions of Terms
   - Assumptions & Limitations
II. Literature Review
   - Introduction
   - Main Body
   - Conclusion or Summary
III. Implementation
   - Introduction
   - Procedures
   - Subjects or Participants
   - Measures
   - Data Analysis
   - Limitations
IV. Results
   - Introduction
   - Analysis
   - Interpretations
V. Results
   - Summary
   - Conclusions
   - Recommendations
VI. Reference
VII. Appendices

Data Analysis Summary

The following information can be used to review data analysis methods and language. It provides wording you can use when writing chapter three of the proposal.

Qualitative Data Analysis

Qualitative data includes written and spoken words or symbols derived from observations, documents, interviews, and participant responses. This data may come from *open-ended responses* to survey questions or interviews, conversations in focus groups and *narratives* from journal entries, documents, transcriptions, and researcher observation notes.

Analyzing qualitative data is induction and labor intensive. It begins by getting an overview and understanding of the big picture and then drilling down more specifically into the nuances of meaning. Use the following steps to analyze qualitative data.

1. **Begin with the big picture.** Read through all of the data to get a holistic understanding of the meaning. You may note various themes that emerge. Sometimes people begin to perceive themes in the first exposure to the data. It's ok to note such themes, but avoid being bound by them.
2. **Identify the major themes.** Read through the data a second time, noting the major ideas that emerge. Write down those big themes.
3. **Narrow the themes into subthemes (subcategories, nodes, child nodes).** You will begin to see that data can be grouped within themes. For example, a theme of "the importance of parenting" may emerge, but some falls into a "helpful parenting" category and others into a "toxic parenting" category. The subtheme of "helpful parenting" may be further divided into "spiritual guidance" and "secular guidance."
    - Importance of Parenting
        - Helpful parenting
            - Spiritual guidance
            - Secular guidance
        - Toxic parenting
4. **Create codes.** Many researchers like to create abbreviations or codes for themes and subthemes to help them track statements. These can be marked directly into the text. For example "P" might be used for "Parenting," and "P+" might be a code for helpful parenting.
5. **Use a framework for a lens.** Often the research involves a theoretical framework. The framework can help the researcher identify important themes specific to this research that otherwise might have gone unnoticed. It is important to be mindful of themes that fit within the framework as well as those themes that do not fit within the framework. This will help you decide whether the data supports or negates the framework's ability to explain a phenomenon.
6. **Organize the data.** List each theme and subtheme. Spreadsheets work well for this purpose as do various kinds of qualitative software. Copy the text that has been coded and paste it under the theme that it fits. Some text may fit under more than one theme.

7. **Look for patterns.** Data has patterns. Some themes are found or mentioned more frequently than others. Some are described more passionately than others. To whom are the themese important, and to whom are they not.
    a. **Note the relative importance of each theme.** As the data is organized, you will begin to notice that some themes are more common than others. You can count the times data fits a theme or subtheme to get a picture of its relative importance. For example, you might notice that the parenting theme is mentioned most often with three-fourths of those being about positive parenting.
    b. **Look within and across.** The patterns may have nomothetical (across settings or individuals) or idiographic meaning (within settings or individuals) or both. There may be many instances of a given code, but they are only among two cases and those cases share a particular quality. Other codes may be evenly distributed across cases (individuals). These distributions all have meaning and should be noted.
8. **Report the Findings.**
    a. **Display the data.** Coded data can be displayed in meaningful ways. It might be in tables to show the number of instances, or it might be in graphs to show trends. Qualitative data that has been analyzed with codes can be counted and displayed by individuals and across the sample.
    b. **Use illustrative cases.** A statements or image that typifies a particularly noteworthy pattern can be used as an example to support the interpretation.

Quantitative Data Analysis

Quantitative data refers to numbers. Numbers are collected in both experimental and descriptive research. It can come from categorical data, ratings, Likert scales, testing, and a variety of other types of numbers. It's easy to understand how ratings and tests are numerical. **Categorical data** and **Likert** scales are words that often come from surveys in which respondents are asked to select one or more than one forced-choice responses. Categorical data occurs when a person selects a category from a list of options, and Likert scales require people to select from a range of opinions, like "poor," "neutral," and "good."

Categorical and Likert data can be quantified. For example, a question might ask people to identify their highest degree earned with choices of (a) high school diploma, (b) associate degree, (c) bachelor's degree, (d) master's degree, (e)doctoral degree, or (f) other. The count of each response can be reported numerically.

Categorical data may also be **demographic** data. Respondents select demographic data that describes themselves in some way, such as "male" or "female." Demographic data should be left to the end of the survey because it is personal. Many people choose to skip surveys that request personal demographic data in the first couple of questions. For example, when a survey begins by asking for income level, people get turned off. Demographic data can serve as a way to organize other responses to look for trends. For example, you might want to know whether people responded to other questions differently depending on their highest degree earned. *Do people with a particular degree tend to belong to a particular political party?*

A researcher should think about the kind of data she wants to gather to help answer the research questions. Data that is not gathered cannot be analyzed. At the same time, you should not gather data you don't intend to use.

Key Differences Between Descriptive & Inferential Statistics

Quantitative data can be analyzed descriptively or inferentially. You should explain which way you will analyze the data. Descriptive statistics *describes* existing data. It is used to organize the data into meaningful information. Averages, totals, and percentages of test scores or numerical responses can be useful. For example, you might explain the average rating or score.

Inferential statistics is used to *make inferences* about the data. It helps the researcher make meaning that can be especially useful to see how various sets of data may or may not be related to one another. For example, a t-test compares the averages of two groups of similar data to determine whether the populations are essentially the same or different from one another.

The following table can provide a useful comparison between descriptive and inferential statistics. This and the following tables were generated by ChatGPT using the prompt, “name and describe various descriptive and inferential statistical tests. Distinguish between them” (OpenAI, 2025).

Feature	Descriptive	Inferential
Purpose	Summarize data	Make predictions or generalizations
Population	Only sample described	Inferences about population
Use of Probability	Not used	Central to methods
Examples	Mean, SD, Mode	t-test, ANOVA, Regression
Data Scope	Only sample data	Sample → Population

Descriptive Statistics

Descriptive statistics summarize and organize features of a dataset. They **do not infer or predict**, just **describe**.

Common Descriptive Statistical Measures:

Test / Measure	Description
Mean	The average value.
Median	The middle value in an ordered dataset.
Mode	The most frequent value(s).

Test / Measure	Description
Range	Difference between the maximum and minimum values.
Variance	Measure of spread—average of squared deviations from the mean.
Standard Deviation (SD)	The square root of variance; indicates data spread.
Skewness	Measures the asymmetry of the distribution.
Kurtosis	Measures "tailedness" of the distribution.
Frequency tables / histograms	Organize and visualize data distribution.
Correlation	Describes the relationship between two sets of linear data

Purpose: To *describe* data. No generalizations are made beyond the observed sample.

Inferential Statistics

Inferential statistics make predictions or inferences about a population based on a sample. These tests involve **probability** and **hypothesis testing**.

Common Inferential Statistical Tests:

Test	Type	Description
t-test (independent)	Parametric	Compares means of two independent groups.
t-test (paired)	Parametric	Compares means of the same group at two different times.
ANOVA (Analysis of Variance)	Parametric	Compares means across 3+ groups.
Chi-square test	Non-parametric	Tests relationships between categorical variables.
Correlation (Pearson)	Parametric	Measures strength and direction of linear relationship.
Correlation (Spearman)	Non-parametric	For ranked/ordinal data; doesn’t assume normality.
Regression Analysis	Parametric	Predicts outcome variable based on one (or more) predictors.
Mann-Whitney U Test	Non-parametric	Compares two independent groups when assumptions of t-test aren't met.
Wilcoxon Signed-Rank Test	Non-parametric	Compares paired samples when assumptions of paired t-test aren't met.
Kruskal-Wallis Test	Non-parametric	Compares 3+ independent groups (non-parametric equivalent of ANOVA).
Logistic Regression	Parametric	Predicts a binary outcome from predictors.

Purpose: To *infer*, *test hypotheses*, or *predict* about a population based on a sample.

ANOVA vs MANOVA

ANOVA and **MANOVA** are both statistical techniques used to compare group means, but they differ in the **number of dependent variables** they analyze.

ANOVA (Analysis of Variance)

Purpose:
Tests whether there are statistically significant differences between the **means of three or more groups** on a **single dependent variable**.

Example:
You want to compare test scores (DV) across 3 teaching methods (IV: Group A, B, C).
→ ANOVA tells you if at least one group's mean score differs.

Assumptions:

- Normal distribution of the DV
- Homogeneity of variances
- Independence of observations

MANOVA (Multivariate Analysis of Variance)

Purpose:
Tests whether groups differ on a **combination of two or more dependent variables** simultaneously.

Example:
You want to compare the effect of 3 teaching methods (IV) on **test scores, motivation, and engagement** (3 DVs).
→ MANOVA assesses if the groups differ on the **set** of dependent variables together.

Assumptions:

- All ANOVA assumptions, plus:
- Multivariate normality
- Homogeneity of covariance matrices
- Linearity among DVs
- Absence of multicollinearity between DVs

Key Differences

Feature	ANOVA	MANOVA
# of Dependent Variables	One	Two or more
Output	One F-value	Multivariate F (e.g., Wilks' Lambda)
Use case	Single outcome	Multiple related outcomes
Complexity	Simpler	More complex; considers intercorrelations among DVs

Use **MANOVA** when:

- You have **multiple dependent variables**, and
- Those variables are **related or correlated**, and
- You want to reduce **Type I error** from running multiple ANOVAs.

The following information was generated by ChatGPT in response to the prompt, "How do you calculate the effect size of a statistical difference" (OpenAI, 2025)?

Effect Size

Effect size tells you **how big or meaningful** a statistical difference is, beyond just whether it's significant. It adds practical interpretation to p-values.

- While a **p-value** tells you **if** there's a statistically significant difference…
- **Effect size** tells you **how big** that difference is.

Common Effect Size Measures

1. Cohen's d **(for t-tests)**

Measures the standardized difference between **two means**.

Cohen's d=M1−M2SDpooled\text{Cohen's } d = \frac{M_1 - M_2}{SD_{\text{pooled}}}

Where:

- M1M_1 and M2M_2 = group means
- SDpooled=(SD12+SD22)2SD_{\text{pooled}} = \sqrt{\frac{(SD_1^2 + SD_2^2)}{2}}

Interpretation (Cohen's conventions):

- 0.2 = small effect
- 0.5 = medium effect
- 0.8 = large effect

2. Eta-squared (η^2) **(for ANOVA)**

Proportion of total variance explained by the independent variable.

η2=SSbetweenSStotal\eta^2 = \frac{\text{SS}_{\text{between}}}{\text{SS}_{\text{total}}}

Interpretation:

- 0.01 = small
- 0.06 = medium
- 0.14 = large

Can be inflated with small sample sizes.

3. r (correlation coefficient) **(for correlation and some non-parametrics)**

Measures strength and direction of association.

r=cov(X,Y)σXσYr = \frac{\text{cov}(X, Y)}{\sigma_X \sigma_Y}

Interpretation:

- 0.1 = small
- 0.3 = medium
- 0.5+ = large

4. Cramér's V **(for Chi-square tests)**

Effect size for **categorical data**.

V=χ2n(k−1)V = \sqrt{\frac{\chi^2}{n(k-1)}}

Where:

- χ2\chi^2 = chi-square statistic
- nn = total sample size
- kk = smaller of (rows, columns)

Interpretation (for 2x2 tables):

- 0.1 = small
- 0.3 = medium

- 0.5 = large

Summary Table

Test Type	Effect Size Measure
t-test	Cohen’s d
ANOVA	Eta-squared (η^2)
Chi-square	Cramér’s V
Correlation	Pearson’s r
Regression	R^2 (coefficient of determination)
MANOVA	Partial η^2

OpenAI. (2025). *ChatGPT 4.0* (March Version) [Large language model]. https://chatgpt.com