

Qualitative and Quantitative Research



Qualitative and Quantitative Research

Basis for Comparison Definition	 Qualitative Data Qualitative data is information that can't be expressed as a number	 Quantitative Data Quantitative data is data that can be expressed as a number or can be quantified
Can data be counted?	NO	YES
Data type	Words, objects, pictures, observations, and symbols	Number and statistics

Qualitative and Quantitative Research

Qualitative Research

Used to explore and understand the complex phenomena in-depth by subjective experiences and perspectives.

Focus on the non-numerical data such as textual and visual material collected through interviews, observations etc.

Definition: Focus on non-numerical data, meaning, and interpretation.

Characteristics: Subjective, inductive, seeks to explore phenomena.

Examples: Interviews, focus groups, observations.

Strengths: Rich insights, context-driven.

Limitations: Time-intensive, less generalizable.

Qualitative Research

Characteristics

Exploratory and descriptive: Focus on to explore and describe phenomena in-depth and often generating insights and hypotheses rather than testing pre-existing theories.

Subjective and interpretive : different individuals perceive and interpret the same phenomena differently.

Naturalistic settings : allows researchers to observe and interact with participants in their everyday environments.

Flexible and iterative: Allow research to adapt to their approaches based on emerging findings. Data collection and analysis concurrently with researchers refining their research questions and data collection strategies as the study progress.

Qualitative Research

Example of Qualitative Data:

Scenario: Users testing a new code editor powered by an ML model for autocompletion.

Qualitative Data: User surveys or usability testing sessions

Examples

"The suggestions are usually helpful, but sometimes they're way off and confuse me."

"I love how sleek the design is - it feels modern and intuitive."

"It crashes randomly, which drives me nuts when I'm in the middle of coding."

Scenario: IT managers evaluating an ML-based intrusion detection system for a company network.

Qualitative Data: Stakeholder interviews or meeting transcripts.

"It catches threats I wouldn't have noticed, but the alerts are too vague to act on."

"I'm worried it might miss something subtle because it's all automated."

"The dashboard looks professional-it gives me confidence in the system."

Qualitative Research

Scenario: Public reactions to a new quantum computing demo posted on X (Twitter).

Qualitative Data: Social media posts or comments.

Examples:

"This quantum stuff sounds amazing, but I don't get how it's practical yet."

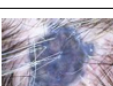
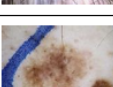
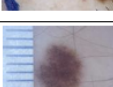
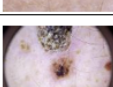
"Finally, something to break through AI limits-super excited!"

"Feels like hype to me-show me real results."

Qualitative Research

Scenario: The visual effects of preprocessing on the HAM10000 dataset

Diagnostics 2022, 12, 34415 of

Serial	Property	Image	Ground Truth	Effect of Artifact Removal	Effect of Contrast Enhancement	Effect of Non-Preprocessing
1	1 and 3					
2	2 and 3					
3	3 and 10					
4	5					
5	6					
6	7					
7	8					
8	9					
9	10					

Qualitative Research

Data collection Techniques

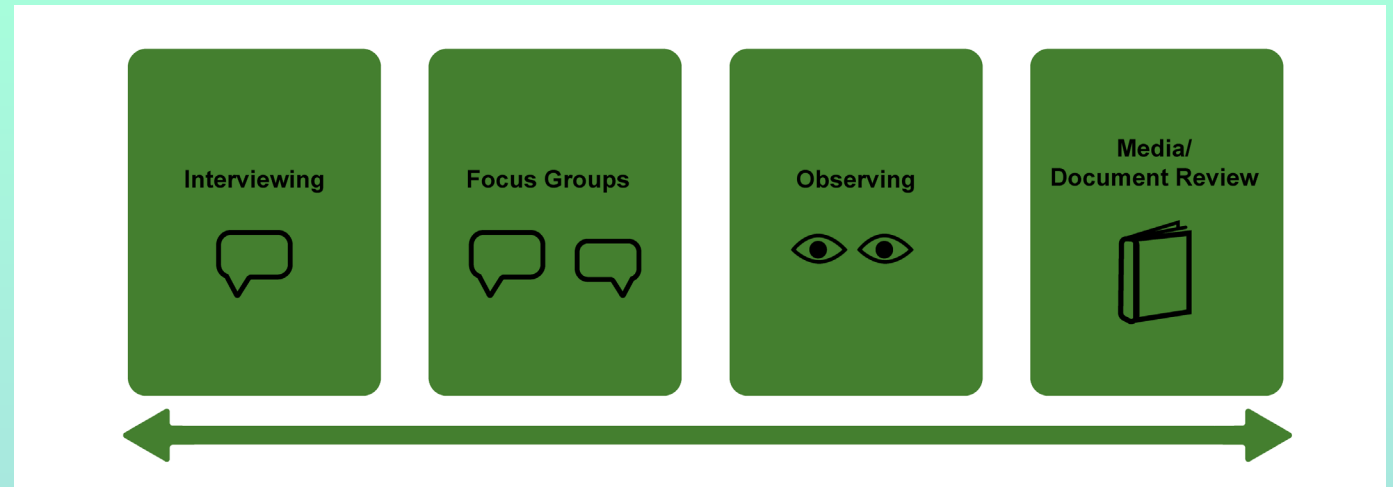
- Interviews
- Focus groups
- Observation
- Document analysis

Allow the researchers to gather data that capture the perspectives and experience of the participants

Data analysis

- Thematic analysis
- Content analysis

Commonly used to identify, themes, patterns and meaning withing the data.



Qualitative Research

Thematic analysis

Used to systematically analyse textual, visual, or audiovisual content to identify patterns, themes, and relationships within the data.

Interprets and understands WHAT IT MEANS

Interpret meaning and themes

Example

Research study : exploring the experience of students transition to online learning during COVID-19 pandemic

Qualitative Research

Identified Themes (after conducting the interview with several students)

1. Challenges with Technology

- Challenges in accessing online platform, network connectivity issues, lack of experience with new online teaching tools
- Example quote : "*I struggled to keep up with classes because my internet kept disconnecting during lectures.*"

2. Feeling of Isolation

- Loneliness and disconnection from peers and teachers
- Example quote : "*I miss the face-to-face interactions with my classmates. It feels lonely studying alone all the time.*"

3. Adapting study habits

- Describes how students have had to adapt their study habits and routines to accommodate online learning
- Example quote : "*I've had to find new ways to stay focused at home. It's been challenging, but I'm slowly getting used to it.*"

These themes offer a rich understanding of the challenges, emotions, and adaptations associated with this phenomenon.

Qualitative Research

Content analysis

Content analysis involves systematically categorizing and counting or describing content in data to understand its frequency or meaning.

Counts and measures WHAT is in the text

Example:

1. Define research objectives and questions

- Objective: to identify common topics and trends in online discussion about programming languages.
- Research questions :
 - What are the most frequently discussed programming languages?
 - What are the common issues or challenges users encounter with specific programming languages?

Qualitative Research

Content analysis

- Example continues...

2. Sampling and data collection

- Select several popular online discussion forums related to programming, such as Stack Overflow, Reddit's programming communities, or specialised forums for specific programming languages.
- Collect a representative sample of discussion threads or posts from each forum, ensuring diversity in topics and participants.

3. Develop coding scheme

- Develop a coding scheme that includes categories for analysing the content of the discussion threads, such as:
 - Programming language discussed
 - Discussion topic (trouble shooting; learning resources; best practices)
 - Issues or challenges raised
 - Solutions or recommendation provided

Qualitative Research

- Example continues...

4. Coding the content

- Systematically analyse the content of each discussion thread by applying the coding scheme.
- Code each post or thread according to the predefined categories, recording relevant information for each code.

5. Data analysis

- Analyse the coded data to identify patterns, themes, and trends in the discussions.
- Calculate frequencies and percentages for each category to determine the most discussed programming languages, common topics of discussion, and prevalent issues or challenges.
- Use qualitative techniques to explore the context of the coded content, such as examining the language used in discussions or the sentiments expressed by participants.

Qualitative Research

Example continues....

6. Interpretation and reporting

- Interpret the findings of the content analysis in relation to the research objectives and questions.
- Provide explanations, insights, and implications based on the identified patterns and trends in the discussions
- Report the findings using clear and concise language, supported by illustrative examples or quotations from the discussion threads.

• Example findings

- *Most Discussed Programming Languages: Python, JavaScript, Java, and C++ are the most frequently discussed programming languages across the analyzed forums.*
- *Common Topics of Discussion: Troubleshooting issues, sharing learning resources and tutorials, discussing best practices and coding techniques, and seeking advice on specific programming tasks.*
- *Prevalent Issues or Challenges: Common challenges include debugging errors, understanding complex concepts, choosing the right tools or libraries, and optimizing code performance.*

NVivo Demo

01 Import each text as a separate file

Files → Import Files → Select Word/PDF files → Each text becomes one NVivo document

02 Run Word Frequency Query (Content Analysis)

Explore → Word Frequency Query → Select all three texts → Show word cloud and frequency table

03 Code passages manually (Thematic Analysis)

Open each text → Highlight key passage → Right-click → Code at New Node → Name your theme

04 Run Matrix Coding Query

Explore → Matrix Coding → Rows: nodes/themes → Columns: texts → See patterns across documents

NVivo Demo

"ChatGPT has significantly changed how engineering students approach problem-solving. Students now use AI to generate initial solutions, but critical thinking skills appear to be declining as a result."

Content Analysis

ChatGPT: 1 mention

Engineering students: 1 mention

Problem-solving: 1 mention

Critical thinking: 1 mention

Negative framing: 1 instance

Thematic Analysis

Suggested node:

"GenAI as threat to skills"

Code: *'critical thinking skills appear to be declining as a result'*

NVivo Demo

Text 1 — Engineering Focus

"...critical thinking skills appear to be declining..."

Node:

"GenAI as threat to skills"

Text 2 — Opportunity Focus

"...preparing them for an AI-driven workplace..."

Node:

"GenAI as skills enabler"

Text 3 — Institutional Focus

"...critically evaluate AI-generated outputs..."

Node:

"HE curriculum rethink"

Overarching theme emerging across all 3 texts:

"GenAI as a double-edged force in STEM HE — simultaneously enabling skills and disrupting traditional learning"

Qualitative Research - Content analysis

Counting and measuring what appears in the text - Frequency

Word	Length	Count	Weighted Percentage (%)
students	8	6	6.25
skills	6	4	4.17
stem	4	3	3.12
analysis	8	2	2.08
appear	6	2	2.08
approach	8	2	2.08
changed	7	2	2.08
chatgpt	7	2	2.08
critical	8	2	2.08
data	4	2	2.08
declining	9	2	2.08
develop	7	2	2.08
digital	7	2	2.08
driven	6	2	2.08
engineering	11	2	2.08
genai	5	2	2.08
generate	8	2	2.08
increasingly	12	2	2.08
initial	7	2	2.08
literacy	8	2	2.08



Qualitative Research - Thematic analysis

What it means across multiple texts - coding

☐ GenAI as skill enabler

2

2

☐ GenAI as threats to skills

1

1

<Files\\Qualitative Data analysis Institute> - § 1 reference coded [22.28% Coverage]

Reference 1 - 22.28% Coverage

critically evaluate AI-generated outputs

<Files\\Qualitative Data analysis Opportunities> - § 1 reference coded [27.84% Coverage]

Reference 1 - 27.84% Coverage

develop digital literacy and data analysis skills

	A : Qualitative Data analy... ▾	B : Qualitative Data analy... ▾	C : Qualitative Data analy... ▾
1 : GenAI as skill enabler ▾	0	1	1
2 : GenAI as threats to skills ▾	1	0	0

Qualitative Research

Qualitative data analysis Tools

- Nvivo
- MAXQDA
- ATLAS.ti



Quantitative Research

Quantitative Research

Definition: Focus on numerical data, measurement, and statistical analysis.

- Characteristics: Objective, deductive, seeks to test hypotheses.
- Examples: Surveys, experiments, statistical modeling.
- Strengths: Generalizability, precision.
- Limitations: Lacks depth in understanding human experience.

Quantitative Research

- Systematic empirical investigation in which data are quantified and analysed to answer research questions or test hypotheses.
- Collection and analysis of numerical data to identify patterns, relationships and association within a population or sample.

Types of Quantitative Data



Counter



Measurement of
physical objects



Sensory
calculation



Projection of
data



Quantification of
qualitative entities

Quantitative Research

- Nature of Data: Quantitative research deals with data that can be precisely measured and counted, while qualitative research works with non-numerical data, focusing on the meaning and interpretation of that data.
- Goal: The goal of quantitative research is to determine relationships between variables, predict outcomes, or test hypotheses. In contrast, qualitative research seeks to understand underlying motivations, beliefs, and emotions.

Quantitative Research

Characteristics

- **Objective and empirical:** Relies on observable and measurable data; aims to uncover pattern and relationships that exists independently of researcher's subjective interpretation.
- **Hypothesis testing:** Test hypothesis using statistical methods; It seeks to determine whether a significant relationship between variables or whether difference exists among groups.
- **Structured data collection:** surveys, experiments, observational studies. Involve collection of data from a large number of participants.
- **Numerical representation :** Data are represented numerically facilitating mathematical calculations and statistics.

Quantitative Research

- **Data collection Techniques**

- Survey (based on questionnaire)
- Experiments
- Observational studies
- Secondary data (analyzing datasets that were collected by other researchers or organizations)
 - Survey data, experimental data

- Data collection Technique
- Questionnaire Example:

A. Age ☐ 16-25 ☐ 26-35 ☐ 36 -45 ☐ 46-55
☐ > 56

B. Gender ☐ Female ☐ Male

C. Experience with computers ☐ Never ☐ < 1 year ☐ < 2 years ☐ > 2years

D. Experience with e-government ☐ Never ☐ < 1 year ☐ < 2 years ☐ > 2years

E. Internet access by Compute ☐ Never ☐ Daily ☐ Weekly
☐ Monthly ☐ Yearly

F. Internet access by mobile ☐ Never ☐ Daily ☐ Weekly ☐ Monthly
☐ Yearly

G. Owning computers ☐ Yes ☐ No

H. Residence Location ☐ Township ☐ Rural ☐ Urban

I. Municipality

J. Province

[illegible]

Quantitative Research

- Data collection Technique
- Types of Questions

Format	Example	Description
Closed ended question	Would you recommend our service? ☐ Yes ☐ No	Predetermined list of responses are provided
Open ended question	What are your reasons for choosing our health service? _____	No predetermined answers and allows for creative expressions
Numerical rating scale	How would you rate your pain level? 	Simple rating that quantifies attitudes, emotions opinions on a scale
Symbols	Please rate your experience with us 	Simple to use and can evoke responses from children or those with literacy problems
Adjectival scale	The service provided by the doctor was 	Provides adjectival descriptions as an add-on to define attitudes and opinions
Likert scale	The course material was well organised Strongly agree Agree Neutral Disagree Strongly disagree 	The scale is framed on an agree-disagree continuum

Quantitative Research

• Data analysis

Statistical analysis techniques to analyse and interpret the data

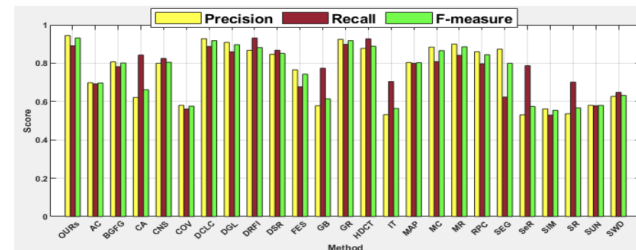
Statistical methods:

- Descriptive statistics (Mean, median, mode, standard deviation)
- Inferential statistics (t-test, analysis of variance (ANOVA))

Groups	Control Group 1				Control Group 2			
Tests	Pre-test	While-test 1	While-test 2	Post-test	Pre-test	While-test 1	While-test 2	Post-test
Mean	14.66	15.41	14.83	16.16	14.33	14.83	15.00	14.41
Median	14.50	16.50	14.50	17.50	16.00	15.50	14.00	15.00
Mode	12.00	17.00	10.00	19.00	18.00	15.00	10.00	15.00
Std. Deviation	5.44	6.05	5.44	5.32	4.99	4.60	4.51	3.20
Skewness	.590	-.718	.247	-.302	-.940	-.186	.378	-.912

Table 3. Performance statistics on ECSSD dataset in terms of precision, recall, F-measure, MAE and OR.

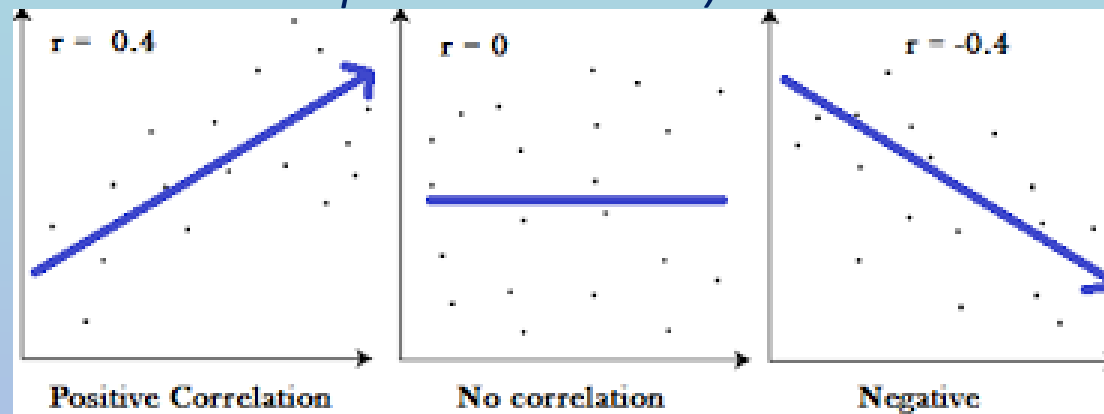
Method	Precision	Recall	F-measure	MAE	OR	Method	Precision	Recall	F-measure	MAE	OR
OURS	0.853	0.635	0.790	0.163	0.573	GR	0.714	0.391	0.600	0.283	0.348
AC	0.439	0.300	0.396	0.210	0.263	HDCT	0.767	0.640	0.733	0.198	0.519
BGFG	0.723	0.606	0.692	0.208	0.467	IT	0.570	0.406	0.521	0.289	0.285
BPFG	0.660	0.820	0.690	0.166		MAP	0.758	0.661	0.733	0.185	0.534
CA	0.532	0.374	0.485	0.310	0.266	MC	0.768	0.652	0.738	0.202	0.531
CNS	0.708	0.600	0.680	0.166	0.480	MCVS	0.780	0.540	0.700	0.170	
COV	0.679	0.527	0.636	0.215	0.388	MR	0.767	0.647	0.736	0.186	0.525
CSV	0.760	0.650	0.740	0.210		MRBF	0.780	0.670	0.760	0.177	
DCLC	0.769	0.636	0.734	0.182	0.530	RPC	0.629	0.489	0.590	0.218	0.372
DGL	0.785	0.655	0.750	0.191	0.548	SEG	0.662	0.230	0.462	0.340	0.212
DRFI	0.794	0.698	0.769	0.170	0.572	SeR	0.366	0.207	0.311	0.404	0.144
DSR	0.753	0.647	0.726	0.171	0.517	SIM	0.365	0.078	0.197	0.433	0.062
FBSS	0.770	0.560	0.709	0.169		SR	0.460	0.302	0.411	0.311	0.212
FCB	0.721	0.515	0.660	0.173	0.422	SUN	0.384	0.102	0.235	0.437	0.087
FES	0.672	0.545	0.638	0.212	0.404	SWD	0.704	0.354	0.573	0.318	0.283
GB	0.629	0.519	0.600	0.263	0.364						



Quantitative Research

• Data analysis

- Correlation (*to measure the strength and direction of linear relationship between two continuous variables*)
 - $+1$ indicates a perfect positive correlation, meaning that as one variable increases, the other variable also increases.
 - -1 indicates a perfect negative correlation, meaning that as one variable increases, the other variable decreases.
 - 0 indicates no linear correlation between the variables.
- Regression analysis (*Regression analysis is used to predict the value of one variable based on the value(s) of one or more independent variable*)



Quantitative Research

- **Data analysis**

- Correlation Example:

- A researcher wants to investigate the relationship between the popularity of programming languages and the availability of job opportunities in the software development industry.
 - Variable 1 : Popularity of Programming Languages (This variable represents the relative popularity or usage of different programming languages among developers)
 - How do we measure this variable ?
 - Variable 2 : Job opportunities (This variable represents the availability of job openings or job postings that require proficiency in specific programming languages)
 - How do we measure this variable?
 - Which are the common correlation coefficients?

Quantitative Research

- Quantitative data analysis Software/Tools
 - STATA
 - SPSS
 - Python
 - Excel

Qualitative vs. Quantitative Research

Category	Qualitative Research	Quantitative Research
Definition	Studying non-numerical data (e.g., words, experiences) to explore meanings, patterns, or stories.	Studying numerical data to measure, test, or predict outcomes with precision.
Example	Analyzing user feedback on an ML coding tool: "It lags but saves time."	Measuring accuracy of an ML coding tool: 85% correct suggestions over 500 tasks.
Data	Textual or verbal feedback (e.g., survey responses, interviews): "The predictions are off, but I like it."	Numerical metrics (e.g., scores, counts): Accuracy = 85%, 12 suggestion acceptances per session.
Analysis	Coding and theming (e.g., thematic analysis): Lags → Speed Issues, Theme: "User Experience Challenges."	Statistical calculations (e.g., averages, percentages): $425/500 = 85\%$ accuracy.
Tools	NVivo, MAXQDA, or manual (pen/paper) for coding; word clouds for visualization.	Excel, Python (e.g., NumPy, Pandas), R, SPSS for stats; charts/graphs for visualization.
Results	Descriptive insights: "Users find the tool efficient but slowed by lag."	Measurable outcomes: "Model is 85% accurate, used 12 times per session."
Strengths	Deep understanding of why (e.g., why users dislike lag); captures emotions and context.	Precise and objective; shows how much (e.g., exact accuracy); generalizable to large groups.
Limitations	Subjective; time-intensive; harder to scale or replicate (e.g., depends on coder interpretation).	Misses depth (e.g., doesn't explain why 15% of suggestions fail); requires large, clean data.
Use in ML	Improve usability: "Fix lag based on user complaints." Guides design or training tweaks.	Evaluate performance: "Choose Model B with 85% accuracy over 75%." Optimizes technical specs.
Data Source	Documents like user surveys, developer logs, or focus group transcripts.	Logs, metrics, or surveys with numeric scales (e.g., 1-5 ratings, system performance data).
When to Use	Early stages: Explore user needs or developer challenges (e.g., "Why do predictions fail?").	Validation stage: Test model success (e.g., "How accurate is it?") or compare versions.

Quantitative Research

Example: Evaluating a Coding Assistance ML Model

Scenario: An ML model is developed to suggest code completions in a programming IDE (e.g., like GitHub Copilot). Researchers collect both numerical metrics and user feedback to assess its performance and usability.

Aspect	Qualitative	Quantitative
What?	Explores words: "Why do users like it?"	Measures numbers: "How good is it?"
Example	"It lags but saves time" → Theme: "User Challenges"	85% accuracy, 12 uses/session
Data	Feedback: "Predictions are off"	Metrics: 425/500 correct
Analysis	Codes: Lags, Efficiency → Theme	Stats: 85% accuracy, avg. 12
Tools	NVivo, word clouds	Python, bar charts
Results	"Lag annoys users"	"Model's 85% accurate"
Pros	Deep insights into why	Precise, scalable numbers
Cons	Subjective, slow	Misses context

Quantitative Research

Class Activity

Resources

- [Quantitative methodology: 3 scales you should master | Dorve](#)
- [Thematic vs. Content Analysis | Curiosity Tank](#)
- [Tools and techniques for qualitative and quantitative analysis and how it impacts your business - Reza Moshksar](#)
- [3.3 Methods of Quantitative Data Collection – An Introduction to Research Methods for Undergraduate Health Profession Students](#)