MDES600

RESEARCH METHODOLOGY & COMMUNICATION SKILLS

(Section 02)

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Covered Topics:

1. Introduction to Research Techniques and Effective Writing

2. Conducting Research and Effective Speaking

3. Code of Ethics and Plagiarism

4. Literature Review

5. Research Methods

6. Planning and Writing Research Proposal

7. Atılım's Graduate School: Forms, Regulations and Thesis Guideline

Lectures (Section 02): Friday 9:30-12:20
Classroom: Faculty of Engineering, Building A, 2017

Textbook: Not required. Lecture notes will be used.

Course web page:

moodle.atilim.edu.tr → MDES600 (Section 02)

Grading Policy:

Homework Assignments	25%
Midterm Exam	35%
Term Project & Presentation	40%

An Introduction to Research Methods

- Research methods are specific procedures for **collecting** and **analyzing** data.

- Developing your research methods is an integral part of your **research design**.

- When planning your methods, there are two key decisions you will make:

    - First, decide how you will **collect data**.

    - Second, decide how you will **analyze the data**.

Collecting the Data

Your methods depend on what type of data you need to answer your **research question**:

- Qualitative vs. quantitative – Will your data take the form of words or numbers?

- Primary vs. secondary – Will you collect original data yourself, or will you use data that has already been collected by someone else?

- Descriptive vs. experimental – Will you take measurements of something as it is, or will you perform an experiment?

Analyzing the Data

- For *quantitative data*, you can use statistical analysis methods to test relationships between variables.

- For *qualitative data*, you can use methods such as thematic analysis to interpret patterns and meanings in the data.

Methods For Collecting Data

- Data is the information that you collect for the purposes of answering your **research question**.

- The **type of data** you need depends on the **aims of your research**.

Qualitative vs. Quantitative Data

- Your **choice** of qualitative or quantitative data collection depends on the **type of knowledge you want to develop**.

- For questions about **ideas**, **experiences** and **meanings**, or to study something that **can't be described numerically**, collect qualitative data.

- If you want to develop a more **mechanistic understanding** of a topic, or your research involves **hypothesis testing**, collect quantitative data.

Qualitative vs. Quantitative Data

	✓ Pros	✘ Cons
Qualitative	• Flexible – you can often adjust your methods as you go to develop new knowledge. • Can be conducted with small samples.	• Can't be analyzed statistically or generalized to broader populations. • Difficult to standardize research.
Quantitative	• Can be used to systematically describe large collections of things. • Generates reproducible knowledge.	• Requires statistical training to analyze data. • Requires larger samples.

You can also take a **mixed methods approach**, where you use both qualitative and quantitative research methods.

Primary vs. Secondary Data

- Primary data is **any original information that you collect** for the purposes of answering your research question (e.g. through surveys, observations and experiments).

- Secondary data is information that **has already been collected by other researchers** (e.g. in a government census or previous scientific studies).

- If you are exploring a **novel research question**, you'll probably need to **collect primary data**.

- But if you want to **synthesize existing knowledge**, **analyze historical trends**, or **identify patterns** on a large scale, **secondary data** might be a better choice.

Primary vs. Secondary Data

	✓ Pros	✘ Cons
Primary	• Can be collected to answer your specific research question. • You have control over the sampling and measurement methods.	• More expensive and time-consuming to collect. • Requires training in data collection methods.
Secondary	• Easier and faster to access. • You can collect data that spans longer timescales and broader geographical locations.	• No control over how data was generated. • Requires extra processing to make sure it works for your analysis.

Descriptive vs. Experimental Data

- In descriptive research, you collect data about your study subject **without intervening**. The **validity of your research** will depend on your **sampling method**.

- In experimental research, you **systematically intervene in a process** and **measure the outcome**. The **validity of your research** will depend on your **experimental design**.

- To conduct an experiment, you need to be able to **vary your independent variable**, precisely **measure your dependent variable**, and **control for confounding variables**. If it's practically and ethically possible, this method is the best choice for answering questions about cause and effect.

Descriptive vs. Experimental Data

	✓ Pros	✘ Cons
Descriptive	• Allows you to describe your research subject without influencing it. • Accessible – you can gather more data on a larger scale.	• No control over confounding variables. • Can't establish cause and effect relationships.
Experimental	• More control over confounding variables. • Can establish cause and effect relationships.	• You might influence your research subject in unexpected ways. • Usually requires more expertise and resources to collect data.

Research Methods for Collecting Data

Research method	Primary or secondary?	Qualitative or quantitative?	When to use
Experiment	Primary	Quantitative	To test cause-and-effect relationships.
Survey	Primary	Quantitative	To understand general characteristics of a population.
Interview/focus group	Primary	Qualitative	To gain more in-depth understanding of a topic.
Observation	Primary	Either	To understand how something occurs in its natural setting.
Literature review	Secondary	Either	To situate your research in an existing body of work, or to evaluate trends within a research topic.
Case study	Either	Either	To gain an in-depth understanding of a specific group or context, or when you don't have the resources for a large study.

Methods for Analyzing Data

- Your data analysis methods will depend on the **type of data you collect** and how you **prepare it for analysis**.

- Data can often be analyzed both **quantitatively** and **qualitatively**.

- For example, survey responses could be analyzed qualitatively by **studying the meanings of responses** or quantitatively by **studying the frequencies of responses**.

Qualitative Analysis Methods

Qualitative analysis is used to **understand words**, **ideas**, and **experiences**. You can use it to interpret data that was collected:

- From open-ended survey and interview questions, literature reviews, case studies, and other sources that use text rather than numbers.

- Using non-probability sampling methods.

Qualitative analysis tends to be **quite flexible** and **relies on the researcher's judgement**, so you have to reflect carefully on your choices and assumptions.

Quantitative Analysis Methods

Quantitative analysis **uses numbers** and **statistics** to understand **frequencies**, **averages** and **correlations** (in descriptive studies) or **cause-and-effect relationships** (in experiments).

You can use quantitative analysis to interpret data that was collected either:

- During an experiment.
- Using probability sampling methods.

Because the data is collected and analyzed in a **statistically valid way**, the results of quantitative analysis can be easily **standardized** and **shared** among researchers.

Research Methods for Analyzing Data

Research method	Qualitative or quantitative?	When to use
Statistical analysis	Quantitative	• To analyze data collected in a statistically valid manner (e.g. from experiments, surveys, and observations).
Meta-analysis	Quantitative	• To statistically analyze the results of a large collection of studies. • Can only be applied to studies that collected data in a statistically valid manner.
Thematic analysis	Qualitative	• To analyze data collected from interviews, focus groups or textual sources. • To understand general themes in the data and how they are communicated.
Content analysis	Either	• To analyze large volumes of textual or visual data collected from surveys, literature reviews, or other sources. • Can be quantitative (i.e. frequencies of words) or qualitative (i.e. meanings of words).

The Main Types of Research Compared

When you start planning a research project, developing research questions and creating a research design, you will have to make various decisions about the type of research you want to do.

There are many ways to categorize different types of research. The words you use to describe your research depend on your discipline and field. In general, though, the form your research design takes will be shaped by:

- The type of knowledge you aim to produce
- The type of data you will collect and analyze
- The sampling methods, timescale and location of the research

Lets take a look at some common distinctions made between different types of research and outlines the key differences between them.

Types of Research Aims

The first thing to consider is what kind of knowledge your research aims to contribute.

Type of research	What's the difference?	What to consider
Basic vs applied	Basic research aims to **develop knowledge, theories and predictions**, while applied research aims to **develop techniques, products and procedures**.	Do you want to expand scientific understanding or solve a practical problem?
Exploratory vs explanatory	Exploratory research aims to **explore the main aspects of an under-researched problem**, while explanatory research aims to **explain the causes and consequences of a well-defined problem**.	How much is already known about your research problem? Are you conducting initial research on a newly-identified issue, or seeking precise conclusions about an established issue?
Inductive vs deductive	Inductive research aims to **develop a theory**, while deductive research aims to **test a theory**.	Is there already some theory on your research problem that you can use to develop hypotheses, or do you want to propose new theories based on your findings?

Types of Research Data

The next thing to consider is what type of data you will collect. Each kind of data is associated with a range of specific research methods and procedures.

Type of research	What's the difference?	What to consider
Primary vs secondary	Primary data is **collected directly by the researcher** (e.g. through interviews or experiments), while secondary data **has already been collected by someone else** (e.g. in government surveys or scientific publications).	How much data is already available on your topic? Do you want to collect original data or analyze existing data (e.g. through a literature review)?
Qualitative vs quantitative	Qualitative research methods **focus on words and meanings**, while quantitative research methods **focus on numbers and statistics**.	Is your research more concerned with measuring something or interpreting something? You can also create a mixed methods research design that has elements of both.
Descriptive vs experimental	Descriptive research gathers data **without controlling any variables**, while experimental research **manipulates and controls variables to determine cause and effect**.	Do you want to identify characteristics, patterns and correlations or test causal relationships between variables?

Types of Sampling, Timescale and Location

Finally, you have to consider three closely related questions: how will you select the subjects or participants of the research? When and how often will you collect data from your subjects? And where will the research take place?

Type of research	What's the difference?	What to consider
Probability vs non-probability sampling	Probability sampling allows you to **generalize your findings to a broader population**, while non-probability sampling allows you to draw conclusions **only about the specific subjects of the research**.	Do you want to produce generalizable knowledge that applies to many contexts or detailed knowledge about a specific context (e.g. in a case study)?
Cross-sectional vs longitudinal	Cross-sectional studies **gather data at a single point in time**, while longitudinal studies **gather data at several points in time**.	Is your research question focused on understanding the current situation or tracking changes over time?
Field vs laboratory	Field research takes place in **a natural or real-world setting**, while laboratory research takes place in **a controlled and constructed setting**.	Do you want to find out how something occurs in the real world or draw firm conclusions about cause and effect? Laboratory experiments have higher internal validity but lower external validity.
Fixed vs flexible	In a fixed research design the subjects, timescale and location are **set before data collection begins**, while in a flexible design these aspects may **develop through the data collection process**.	Do you want to test hypotheses and establish generalizable facts, or explore concepts and develop understanding? For measuring, testing and making generalizations, a fixed research design has higher validity and reliability.

Choosing between all these different research types is **part of the process** of creating your research design, which determines exactly **how the research will be conducted**.

But the type of research is only the first step: next, you have to make more concrete decisions about your research methods and the details of the study.

Inductive vs. Deductive Reasoning

The main difference between inductive and deductive reasoning is that inductive reasoning aims at **developing a theory** while deductive reasoning aims at **testing an existing theory**.

Inductive reasoning moves **from specific observations to broad generalizations**, and deductive reasoning **the other way around**.

Both approaches are used in various types of research, and it's not uncommon to **combine** them in one large study.

Inductive Research Approach

When there is **little to no existing literature on a topic**, it is common to perform inductive research because there is **no theory to test**. The inductive approach consists of three stages:

- Observation
  - ❑ A low-cost airline flight is delayed
  - ❑ Dogs A and B have fleas
  - ❑ Elephants depend on water to exist
- Observe a pattern
  - ❑ Another 20 flights from low-cost airlines are delayed
  - ❑ All observed dogs have fleas
  - ❑ All observed animals depend on water to exist
- Develop a theory
  - ❑ Low cost airlines always have delays
  - ❑ All dogs have fleas
  - ❑ All biological life depends on water to exist

Limitations of an Inductive Approach

A conclusion drawn on the basis of an inductive method **can never be proven**, but it **can be invalidated**.

Example

- You observe 1000 flights from low-cost airlines.
- All of them experience a delay, which is in line with your theory.
- However, you **can never prove** that flight 1001 will also be delayed.
- Still, the **larger your dataset**, the **more reliable the conclusion**.

Deductive Research Approach

When conducting deductive research, you always **start with a theory** (the result of inductive research). Reasoning deductively means **testing these theories**. If there is **no theory** yet, you **cannot conduct deductive research**. The deductive research approach consists of four stages:

- Start with an existing theory
  - ❑ Low cost airlines always have delays
  - ❑ All dogs have fleas
  - ❑ All biological life depends on water to exist
- Formulate a hypothesis based on existing theory
  - ❑ If passengers fly with a low cost airline, then they will always experience delays
  - ❑ All pet dogs in my apartment building have fleas
  - ❑ All land mammals depend on water to exist
- Collect data to test the hypothesis
  - ❑ Collect flight data of low-cost airlines
  - ❑ Test all dogs in the building for fleas
  - ❑ Study all land mammal species to see if they depend on water
- Analyze the results: does the data reject or support the hypothesis?
  - ❑ 5 out of 100 flights of low-cost airlines are not delayed = reject hypothesis
  - ❑ 10 out of 20 dogs didn't have fleas = reject hypothesis
  - ❑ All land mammal species depend on water = support hypothesis

Limitations of a Deductive Approach

The conclusions of deductive reasoning **can only be true** if all the **premises set in the inductive study are true** and the **terms are clear**.

Example

- All dogs have fleas (premise)
- Benno is a dog (premise)
- Benno has fleas (conclusion)

Based on the premises we have, the conclusion must be true. However, if the **first premise turns out to be false**, the **conclusion that Benno has fleas cannot be relied upon**.

Combining Inductive And Deductive Research

Many scientists conducting a larger research project begin with an inductive study (developing a theory).

The inductive study is followed up with deductive research to confirm or invalidate the conclusion.

In the examples above, the **conclusion (theory) of the inductive study** is also used as a **starting point for the deductive study**.