# IS 221: ICT RESEARCH METHODS

## Lecture 1

**March 2025**

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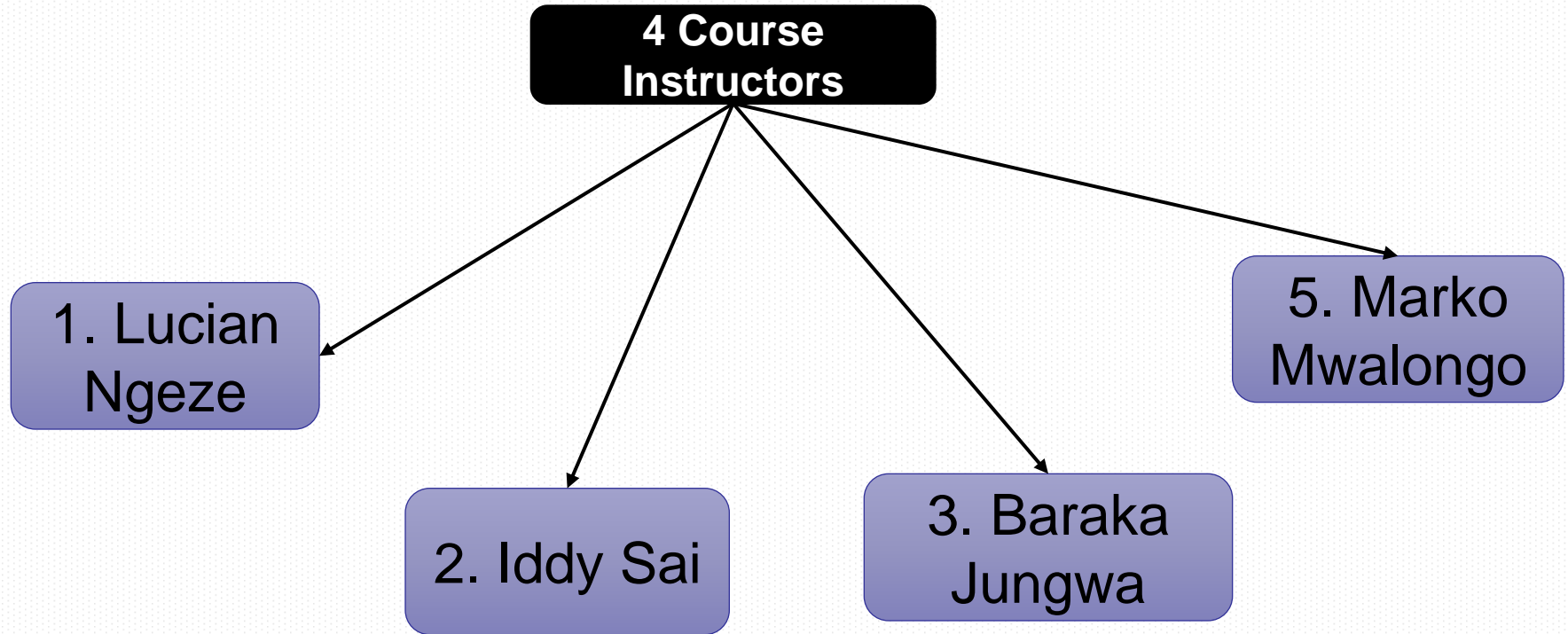
# Lecture 1

# INTRODUCTION TO RESEARCH

By

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# **Learning Objectives for Lecture 1**

By the end of the class session (2 hrs), you will be able to:

1. Define Research
2. Explain the application of research with examples
3. Discuss the steps of conducting a scientific research
4. Research Hierarchy
5. Discuss the types of research

Ω Talk to your neighbor

Ω Discuss the meaning of Research

# What is Research?

Ω Note your points in your notebook

Ω Share with the rest of the class

3 Minutes

# Activity 2: Research Experience

Ω How many of you have done research before?

Ω How many have participated in some part of research as research assistant?

✓ Share your experience with others

3 Minutes

# Etymology

Ω   Research comes from:

- ✓ from Old French recercher "seek out, search closely,"

- ✓ from Latin circare "go about, wander, traverse,"

- ✓ in Late Latin "to wander hither and thither,"

# Meaning of research

Ω  Research is a process of steps used to collect and analyze information to increase our understanding of a topic or issue.

Ω  At a general level, research consists of three steps:

1.  Pose a question.
2.  Collect data to answer the question.
3.  Present an answer to the question.

# Meaning of research

Research activity comprises the following activities

1. Defining and redefining problems,
2. Formulating hypotheses,
3. Collecting, organizing and evaluating data,
4. Making deductions,
5. Attaining conclusions
6. Testing the conclusions to determine if they fit the formulated hypotheses.

# Meaning of research

Ω Research is the systematic and rigorous ***investigation of a specific topic or problem.***

  ✓ It is a process of inquiry that aims to develop new knowledge, insights, and understanding about a particular phenomenon or issue.

  ✓ Research is a systematic and organized inquiry aimed at discovering new knowledge, verifying existing knowledge, or refining and enhancing our understanding of a particular phenomenon.

Ω It involves a methodical process of collecting, analysing, and interpreting data to answer specific questions or solve problems.

# Meaning of research

Ω Using a "scientific method," of inquiry researchers:

- ✓ Identify a problem that defines the goal of research
- ✓ Make a prediction that, if confirmed, resolves the problem
- ✓ Gather data relevant to this prediction
- ✓ Analyze and interpret the data to see if it supports the prediction and resolves the question that initiated the research

# Meaning of research
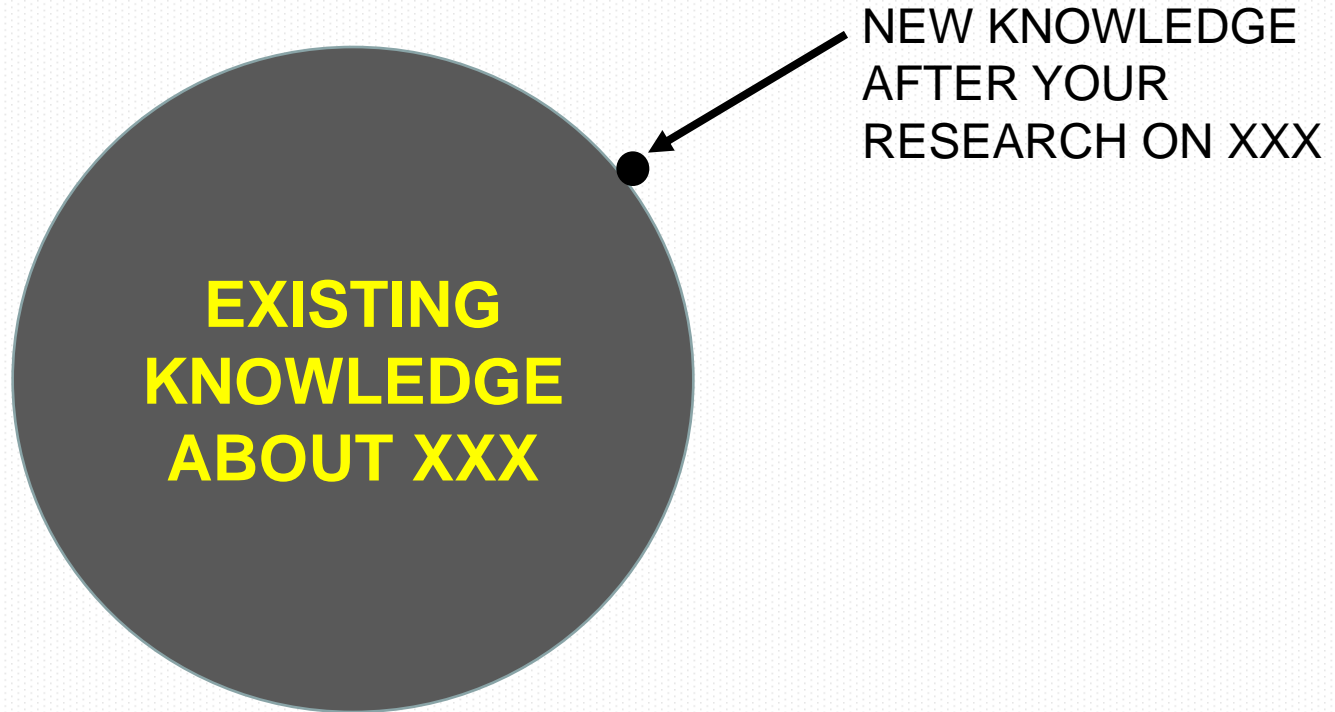
# WHY DO RESEARCH?

# Significance of research

Ω   The main goal of research is to produce ***new knowledge and contribute to the advancement of a particular*** *field* **or** *discipline.*

Ω    It can also be used to

- ✓    inform policy decisions,
- ✓     improve practices, and
- ✓    solve real-world problems.

# Research Adds to Our Knowledge

Ω   Adding to knowledge means that ICT practitioners undertake research to contribute to existing information about issues.

Ω   We are all aware of pressing societal/education/business/health issues being debated today, such as the integration of emerging technologies in various sectors.

Ω   Research plays a vital role in addressing these issues. Through research we develop results that help to answer questions, and as we accumulate these results, we gain a deeper understanding of the problems.

# Research Adds to Our Knowledge

Ω How can research specifically add to the knowledge base and existing literature?

- ✓ A research report might provide a study that has not been conducted and thereby fill a void in existing knowledge.

- ✓ It can also provide additional results to confirm or disconfirm results of prior studies.

- ✓ It can help add to the literature about practices that work or advance better practices that people might try in their particular setting.

- ✓ It can provide information about people and places that have not been previously studied

# Research Improves Practice

Ω   Research is also important because it suggests improvements for practice.

Ω   Armed with research results, ICT practitioners and other academicians become more effective professionals

Ω   Research offers practicing ICT practitioners new ideas to consider as they go about their jobs.

Ω   Research also helps practitioners evaluate approaches that they hope will work with individuals in their settings.

Ω   This process involves sifting through research to determine which results will be most useful

# Research Informs Policy Debates

Ω Research also provides information to policy makers when they research and debate ICT related topics.

✓ When policy makers read research on issues, they are informed about current debates and stances taken by other public officials.

Ω Talk to your neighbor

Ω Discuss the application of Research

# Where is Research Applied?

Ω Note your points in your notebook

Ω Share with the rest of the class

3 Minutes

# Research Applications in Real Life

# What is Research?

In medicine



Research is widely used in the medical industry and various pharmaceuticals in order to conduct testing and find new medicines to cure different diseases

# What is Research?

In business



Different streams of businesses have found a wide variety of applications of research in order to attract customers to build better brands and make better products.

# What is Research?

Product Research



Developing a new product requires a huge amount of research on the market. The companies should study the existing products and their market along with the customer demands and needs.

# Look at the pic…



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# Researcher and Research Assistants

Ω  Researcher: Typically leads the research project, formulates research questions, designs methodologies, analyzes findings, and writes reports or publications.

Ω  Research Assistant: Supports the researcher by collecting data, conducting literature reviews, organizing materials, and sometimes assisting in data analysis.

Ω  Works under the supervision of the researcher, following instructions and assisting with tasks.

# Researcher and Research Assistants

# SOME TYPES OF RESEARCH

# Activity 5: Types of Research

Ω Talk to your neighbor

Ω Discuss the types of Research you may be aware of

Ω Note your points in your notebook

Ω Share with the rest of the class

3 Minutes

# Types of Research

Ω **Basic research**, also known as pure research or fundamental research, is scientific research that aims to increase our understanding of the natural world, without necessarily having any immediate practical applications.

- ✓ It is a type of research that aims to expand the knowledge base of a particular field.

- ✓ Basic research is often driven by curiosity and aims to answer fundamental questions about the natural world.

- ✓ Basic research is conducted for the sake of knowledge itself, rather than for any specific practical application or goal.

# 1. Examples of Basic Research

Ω  Computer Scientists
- ✓ Developing new algorithms for machine learning
- ✓ Studying the underlying principles of cryptography
- ✓ Exploring new programming paradigms

Ω  Information system specialist:
- ✓ Investigating the impact of new technologies on business operations
- ✓ Studying the role of information systems in disaster response
- ✓ Exploring how information systems can be used to promote social equity

# 1. Examples of Basic Research

✓ Multimedia technologist:
- Developing new techniques for immersive virtual reality
- Studying the cognitive impact of different types of multimedia on learning
- Investigating the use of multimedia in healthcare education

✓ Computer engineer:
- Developing new hardware architectures for artificial intelligence
- Studying the impact of different types of memory on computer performance
- Exploring new approaches to computer networking

# 1. Examples of Basic Research

Ω Computer engineer:
- ✓ Developing new hardware architectures for artificial intelligence
- ✓ Studying the impact of different types of memory on computer performance
- ✓ Exploring new approaches to computer networking

Ω Health Informatician:
- ✓ Investigating the use of health information systems to improve patient outcomes
- ✓ Studying the impact of electronic health records on patient privacy
- ✓ Exploring how machine learning can be used to predict disease outbreaks

# 1. Examples of Basic Research

Ω  Instructional designer:
- ✓ Investigating the impact of instructional design on student engagement
- ✓ Studying the use of different types of media in online learning
- ✓ Developing new models for evaluating the effectiveness of instructional design

Ω  Computer networks and information security engineers
- ✓ Cyber Threat Intelligence: Developing and evaluating new tools for detecting and responding to cyber threats in real-time.
- ✓ Network Resilience and Availability: Designing and testing techniques to ensure network availability and resilience in the face of cyber attacks or natural disasters.
- ✓ Cyber Forensics: Investigating and developing new techniques for digital forensics, including incident response, malware analysis, and forensic investigation.

# 1. Examples of Basic Research

Ω Telecommunications engineer:

- ✓ Studying the impact of new technologies on telecommunications infrastructure
- ✓ Investigating the use of artificial intelligence in network management
- ✓ Exploring new approaches to wireless communication

Ω Business information systems specialist:

- ✓ Investigating the impact of blockchain on supply chain management
- ✓ Studying the use of data analytics in financial forecasting
- ✓ Developing new models for assessing the effectiveness of cybersecurity measures.

# Types of Research

Ω **Applied Research:** Applied research aims to solve practical problems. It focuses on generating solutions or interventions. Examples include action research and program evaluation.

# 2. Examples of Applied Research

Ω  Applied research is a type of scientific research that is focused on developing practical applications based on the knowledge gained from basic research.

- ✓ It is a type of research that aims to solve practical problems or address specific issues.
- ✓ The primary goal of applied research is to solve practical problems, improve existing technologies, or develop new products, processes, or services.

Ω  Applied research involves taking the insights and discoveries gained from basic research and using them to develop practical solutions to real-world problems.

- ✓ It often involves working closely with industry partners or other stakeholders to ensure that the research is relevant and useful.
- ✓ Applied research is often focused on developing new products, technologies, or strategies.

# Types of Applied Research

Ω  Applied research can be further categorized into two types based on the nature of the problem being addressed:

- ✓ **Problem-oriented research:** This type of applied research is focused on addressing specific practical problems or challenges faced by industries or communities. It involves conducting research to identify the root causes of the problem, developing and testing potential solutions, and implementing the best solution.

- ✓ **Product-oriented research:** This type of applied research is focused on developing new products or improving existing ones. It involves conducting research to identify customer needs and preferences, developing new products that meet those needs, and testing and refining the products to ensure they are effective and efficient.

# 2. Examples of Applied Research

Ω Computer scientists:

- ✓ Developing algorithms and software for machine learning applications in healthcare to predict medical outcomes
- ✓ Developing new methods for optimizing computer networks and data centers to reduce energy consumption and increase efficiency.

Ω Information system specialist:

- ✓ Implementing and testing new software solutions for managing large datasets in a financial institution
- ✓ Developing cybersecurity strategies to protect against cyber threats and mitigate risks to critical systems and data.

# 2. Examples of Applied Research

Ω Multimedia technologist:

   ✓ Designing and developing virtual and augmented reality experiences for education and training purposes

   ✓ Creating and editing digital media content for marketing campaigns, including graphics, audio, and video elements.

Ω Computer engineer:

   ✓ Designing and implementing embedded systems for control and automation applications in manufacturing and production environments

# 2. Examples of Applied Research

Ω Health informatician:

  ✓ Developing electronic health record (EHR) systems to improve patient care and reduce medical errors

  ✓ Analyzing and interpreting healthcare data to identify trends and patterns and inform clinical decision-making

  Developing and implementing telemedicine solutions to increase

Ω Instruction designer:

  ✓ Developing online courses and training materials for corporate and educational organizations

  ✓ Conducting needs assessments to determine training requirements and identify gaps in knowledge and skills

  ✓ Evaluating the effectiveness of instructional materials and making recommendations for improvements.

# 2. Examples of Applied Research

Ω Telecommunication engineer:
- ✓ Designing and implementing telecommunications networks for data, voice, and video communication
- ✓ Developing and testing new telecommunications technologies for mobile and wireless communication
- ✓ Developing security protocols to protect against cyber threats and ensure the integrity of telecommunications networks and data.

Ω Business information systems specialist:
- ✓ Analyzing and optimizing business processes using data analytics and process modeling techniques
- ✓ Developing and implementing enterprise resource planning (ERP) systems to streamline operations and increase efficiency
- ✓ Developing and implementing business intelligence solutions to support strategic decision-making and performance monitoring.

# Types of Research

Ω **Exploratory Research:** Exploratory research seeks to explore a topic to gain insights and ideas. It is often used to formulate hypotheses for further research. Examples include literature reviews, focus groups, and interviews.

# Exploratory Research

Ω Exploratory research is a type of research that is used to investigate a new area of study or to generate new ideas and hypotheses.

    ✓ The primary goal of exploratory research is to gain insights into a problem or phenomenon, develop a deeper understanding of it, and generate new research questions and hypotheses that can be further tested in future research.

Ω Exploratory research is typically conducted in the early stages of a research project, when the researcher has limited information about the problem or phenomenon being studied.

Ω It is often used when there is little previous research on the topic, or when the existing research is inconclusive or contradictory.

Ω Exploratory research is often used in the early stages of a research project to gather preliminary information

# Exploratory Research

Ω The methods used in exploratory research are often qualitative in nature, as they are focused on understanding the subjective experiences and perspectives of individuals.

✓ One of the benefits of exploratory research is that it can help researchers identify new research questions and develop new theoretical frameworks or models.

✓ By gaining a deeper understanding of a problem or phenomenon, researchers can generate new ideas and hypotheses that can be tested in future research.

Ω However, exploratory research also has some limitations. Because it is often qualitative in nature, it can be difficult to generalize the findings to larger populations.

✓ Additionally, exploratory research can be time-consuming and resource-intensive, as it often involves collecting and analyzing large amounts of data.

# 3. Examples of Exploratory Research

Ω Conducting surveys or interviews to gather feedback on the usability of a new software system

Ω Analysing user behaviour data to identify patterns or trends that could inform system design decisions

Ω Investigating different approaches to data storage and management to determine the most effective method for a particular application

Ω Exploring new technologies and tools for creating and delivering multimedia content

Ω Conducting user testing to gather feedback on the usability and effectiveness of multimedia products

Ω Investigating different multimedia formats and delivery methods to determine the most appropriate approach for a particular audience or application

# 3. Examples of Exploratory Research

Ω Researching new technologies and techniques for designing and developing computer hardware and software systems

Ω Investigating the performance of different types of computer hardware to determine the most effective components for a particular application

Ω Studying the behaviours of computer systems in different environments to identify potential vulnerabilities or areas for improvement

Ω Conducting theoretical research to develop new algorithms or models for solving complex computational problems

Ω Investigating the performance of different programming languages and development frameworks to determine the most effective tools for a particular task

Ω Analyzing data to identify patterns or trends that could inform the development of new machine learning or artificial intelligence systems

# Types of Research

Ω **Explanatory Research:** Explanatory research aims to explain why a phenomenon occurs. It focuses on identifying causal relationships. Examples include experiments and longitudinal studies.

# Explanatory Research

Ω One of the key features of explanatory research is the use of control groups or comparison groups to isolate the effects of the independent variable.

  ✓ This helps to ensure that any observed changes in the dependent variable are due to the manipulation of the independent variable, rather than to other factors.

Ω Explanatory research is often used in the natural and social sciences to test theories and hypotheses about the relationships between variables.

  ✓ For example, explanatory research might be used to determine whether a particular drug is effective in treating a disease, or whether a particular teaching method is more effective than others in improving student learning outcomes.

# 4. Examples of Explanatory Research

Ω **Information system specialist:**

- ✓ Investigating the effectiveness of different software development methodologies in improving project outcomes.

- ✓ The research could examine various methodologies such as Agile, Waterfall, and DevOps and compare their success rates in delivering projects on time, within budget, and meeting stakeholders' requirements.

# 4. Examples of Explanatory Research

Ω Multimedia technologist:

  ✓ Studying the impact of different multimedia design techniques on user engagement and interaction.

  ✓ The research could investigate different approaches such as virtual reality, gamification, and interactive multimedia to determine which techniques are most effective in achieving specific user experience goals.

# 4. Examples of Explanatory Research

Ω Computer scientist:

✓ Investigating the impact of different algorithms on artificial intelligence (AI) systems' performance.

✓ The research could examine different algorithms such as decision trees, neural networks, and support vector machines to determine their effectiveness in solving specific AI problems.

# 4. Examples of Explanatory Research

Ω Health informatician:

- ✓ Studying the effectiveness of different electronic health record (EHR) systems in improving patient outcomes.

- ✓ The research could examine different EHR systems' features such as decision support, clinical documentation, and patient engagement to determine which systems are most effective in improving patient care and outcomes.

# 4. Examples of Explanatory Research

Ω  Business information systems specialist:

- ✓ Investigating the factors that influence the adoption and use of enterprise resource planning (ERP) systems in organizations.

- ✓ The research could examine different factors such as organizational culture, user training, and system customization to determine the most significant factors that affect ERP system adoption and use.

# 4. Examples of Explanatory Research

Ω Telecommunication engineer:

✓ Exploring the impact of different network topologies on data transmission performance.

✓ The research could examine different network topologies such as star, mesh, and ring to determine their effectiveness in achieving specific performance goals such as high data transfer rates, low latency, and reliable connections.

# Types of Research

Ω **Descriptive Research:** Descriptive research aims to describe characteristics of a population or phenomenon. It focuses on answering questions like "What is?" Examples include surveys, case studies, and observational research.

# Types of Research

Ω **Quantitative Research:** Quantitative research involves collecting and analyzing numerical data. It focuses on measuring and quantifying relationships. Examples include surveys and experiments.

# Types of Research

Ω **Qualitative Research:** Qualitative research involves collecting and analyzing non-numerical data. It focuses on understanding meanings and interpretations. Examples include interviews and observations.

# Types of Research

Ω **Cross-sectional research:** This type of research involves collecting data at a single point in time. It is often used to examine relationships between variables and can be used to generate hypotheses.

# Types of Research

Ω **Longitudinal research:** Longitudinal research involves collecting data over an extended period of time. It can be used to examine changes in variables over time and to track the development of individuals or groups.

# Types of Research

Ω **Case study research:** Case study research involves in-depth analysis of a particular individual, group, or situation. It can be used to gain insights into complex phenomena and is often used in fields such as psychology and sociology.

# Comparative research

Ω Comparative research is a type of research that involves the systematic comparison of two or more entities, such as countries, regions, organizations, or individuals.

  ✓ The primary goal of comparative research is to identify similarities and differences between the entities being studied and to explain why those similarities and differences exist.

Ω Comparative research can take many forms, including cross-sectional studies, longitudinal studies, case studies, and experiments.

  ✓ The methods used in comparative research are often both quantitative and qualitative in nature, as they involve collecting and analyzing both numerical and non-numerical data.

# Comparative research

Ω One of the benefits of comparative research is that it allows researchers to identify commonalities and differences across a range of contexts, which can help to develop more general theories and concepts.

✓ For example, comparative research might be used to identify common factors that contribute to economic growth across different countries, or to compare the effectiveness of different healthcare systems in reducing mortality rates.

Ω Another benefit of comparative research is that it can help to inform policy decisions and interventions by identifying best practices and lessons learned from other contexts.

✓ For example, a government might use comparative research to identify successful education policies in other countries that could be adapted to their own context.

# Comparative research: Benefits

Ω It allows researchers to identify commonalities and differences across a range of contexts, which can help to develop more general theories and concepts.

✓ For example, comparative research might be used to identify common factors that contribute to economic growth across different countries, or to compare the effectiveness of different healthcare systems in reducing mortality rates.

Ω It can help to inform policy decisions and interventions by identifying best practices and lessons learned from other contexts.

✓ For example, a government might use comparative research to identify successful education policies in other countries that could be adapted to their own context.

# Comparative research: Limitations

- ✓ It can be difficult to control for all the variables that might influence the outcomes being studied, which can make it difficult to establish causal relationships.

- ✓ It can be resource-intensive, as it often involves collecting and analyzing data from multiple sources.

# 5. Examples of Comparative Research

Ω Information system specialist:

1. Comparing the effectiveness of different database management systems in terms of performance, security, and scalability.

2. Comparing the user interface of different project management tools to determine which is more user-friendly and efficient.

3. Comparing the use of open source vs proprietary software in information system development.

# 5. Examples of Comparative Research

Ω Multimedia technologist:

- ✓ Comparing the effectiveness of different video codecs in terms of compression ratio, visual quality, and encoding speed.

- ✓ Comparing the user engagement of different interactive multimedia applications to determine which one is more effective in terms of user experience.

- ✓ Comparing the performance of different virtual reality systems in terms of immersion and interaction.

# 5. Examples of Comparative Research

Ω  Computer engineer:

- ✓ Comparing the power consumption and processing speed of different CPU architectures.
- ✓ Comparing the effectiveness of different memory architectures in terms of access speed and capacity.
- ✓ Comparing the performance of different hardware acceleration technologies in specific applications, such as video rendering or machine learning.

# 5. Examples of Comparative Research

Ω Computer scientist:

✓ Comparing the effectiveness of different machine learning algorithms in terms of accuracy and training time.

✓ Comparing the performance of different data structures and algorithms for specific applications, such as graph traversal or text search.

✓ Comparing the security of different cryptographic algorithms and protocols.

# 5. Examples of Comparative Research
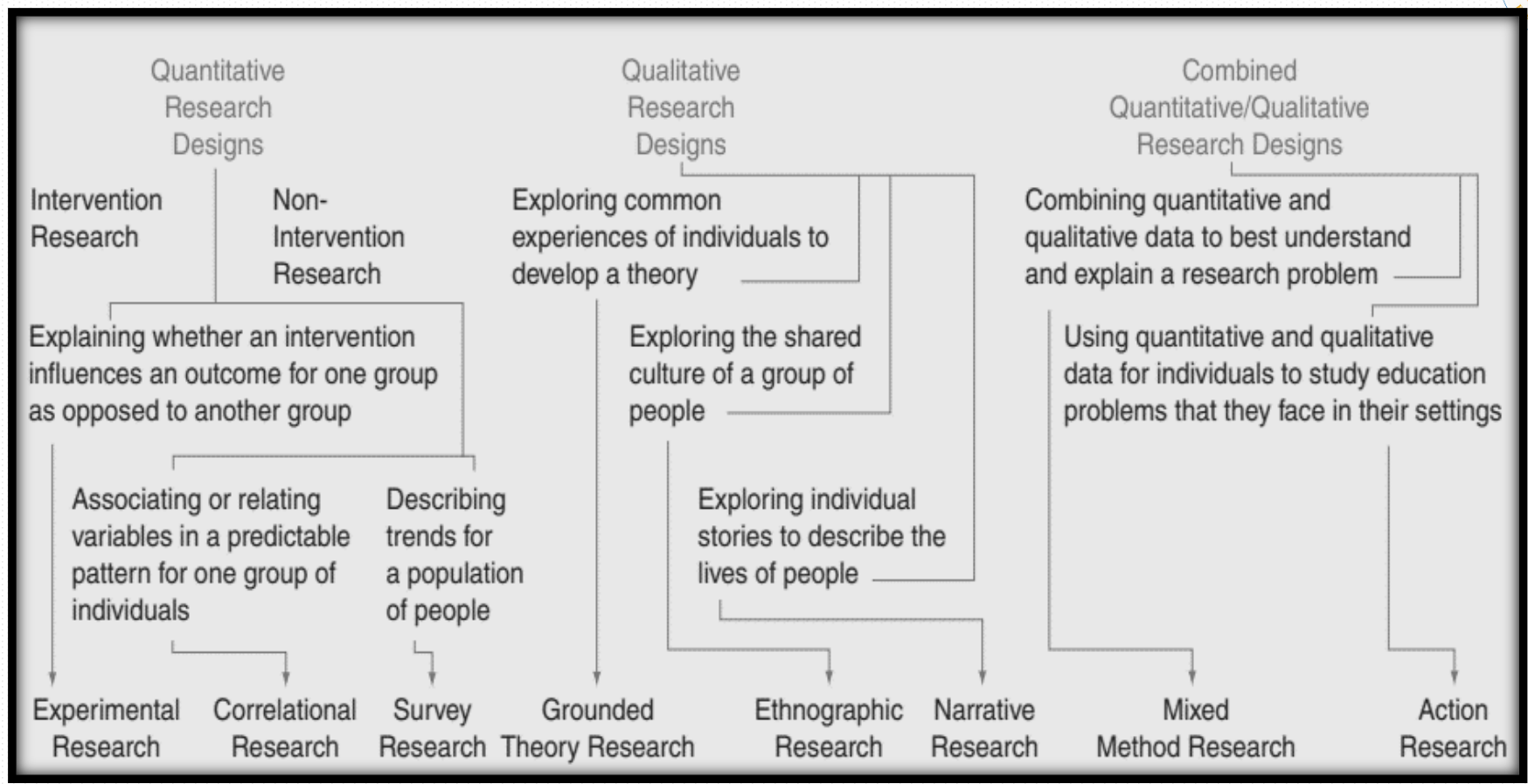
Ω Health Informatician:

- ✓ Comparing the effectiveness of different electronic health record systems in terms of accuracy, completeness, and accessibility.

- ✓ Comparing the use of artificial intelligence vs traditional methods in diagnosing diseases.

- ✓ Comparing the effectiveness of different health information exchange systems in terms of privacy and security.

# 5. Examples of Comparative Research

Ω Business information systems specialist:

✓ Comparing the effectiveness of different customer relationship management systems in terms of customer retention and satisfaction.

✓ Comparing the efficiency of different enterprise resource planning systems in terms of supply chain management and inventory control.

✓ Comparing the effectiveness of different business intelligence systems in terms of decision-making support.

# 5. Examples of Comparative Research

Ω  Telecommunication engineer:

- ✓ Comparing the effectiveness of different network topologies in terms of speed and reliability.

- ✓ Comparing the performance of different wireless communication technologies in terms of range and data transfer rate.

- ✓ Comparing the security of different encryption methods used in telecommunication systems.

Quantitative
Research
Designs

Qualitative
Research
Designs

Combined
Quantitative/Qualitative
Research Designs

Intervention
Research

Non-
Intervention
Research

Exploring common
experiences of individuals to
develop a theory

Combining quantitative and
qualitative data to best understand
and explain a research problem

Explaining whether an intervention
influences an outcome for one group
as opposed to another group

Exploring the shared
culture of a group of
people

Using quantitative and qualitative
data for individuals to study education
problems that they face in their settings

Associating or relating
variables in a predictable
pattern for one group of
individuals

Describing
trends for
a population
of people

Exploring individual
stories to describe the
lives of people

Experimental
Research

Correlational
Research

Survey
Research

Grounded
Theory Research

Ethnographic
Research

Narrative
Research

Mixed
Method Research

Action
Research

# SCIENTIFIC RESEARCH PROCESS

Ω Talk to your neighbor
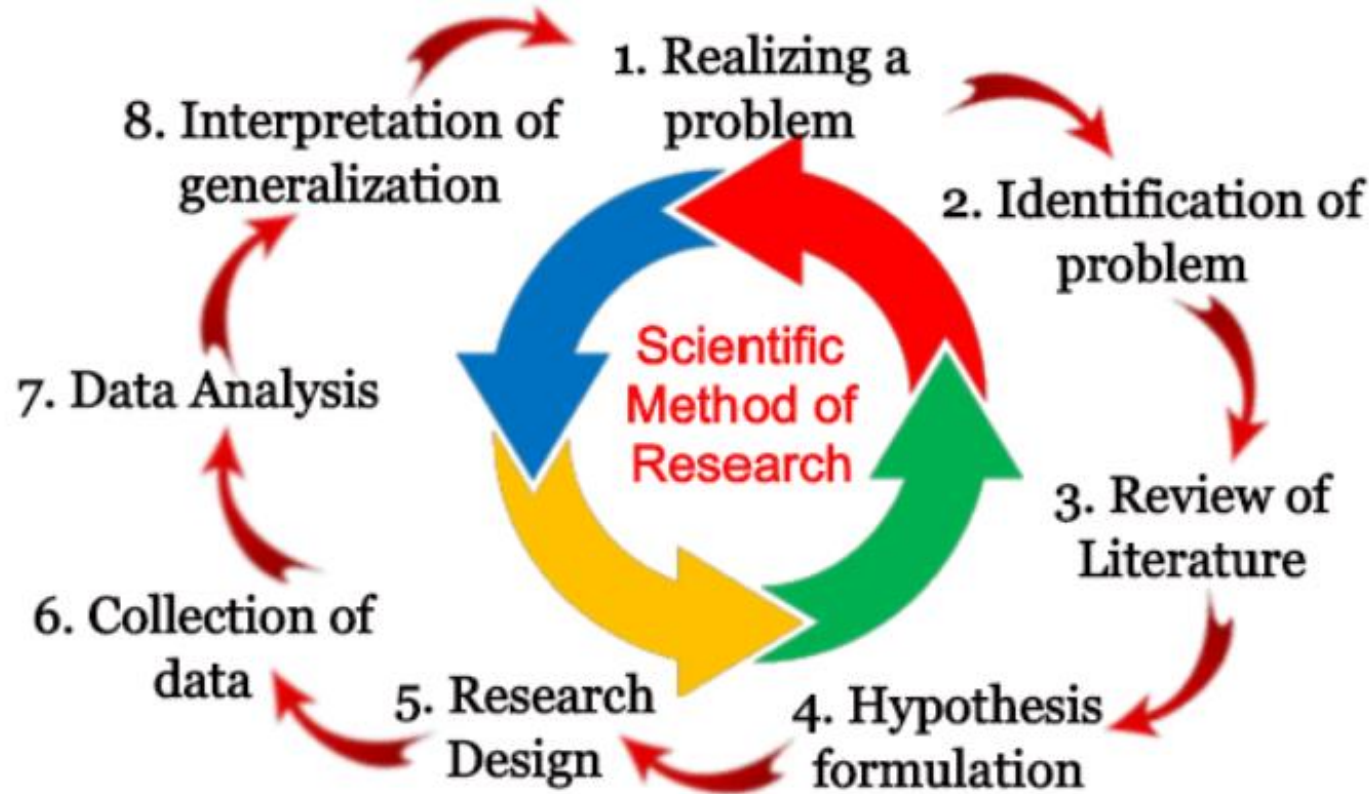
Ω Discuss the steps of Research

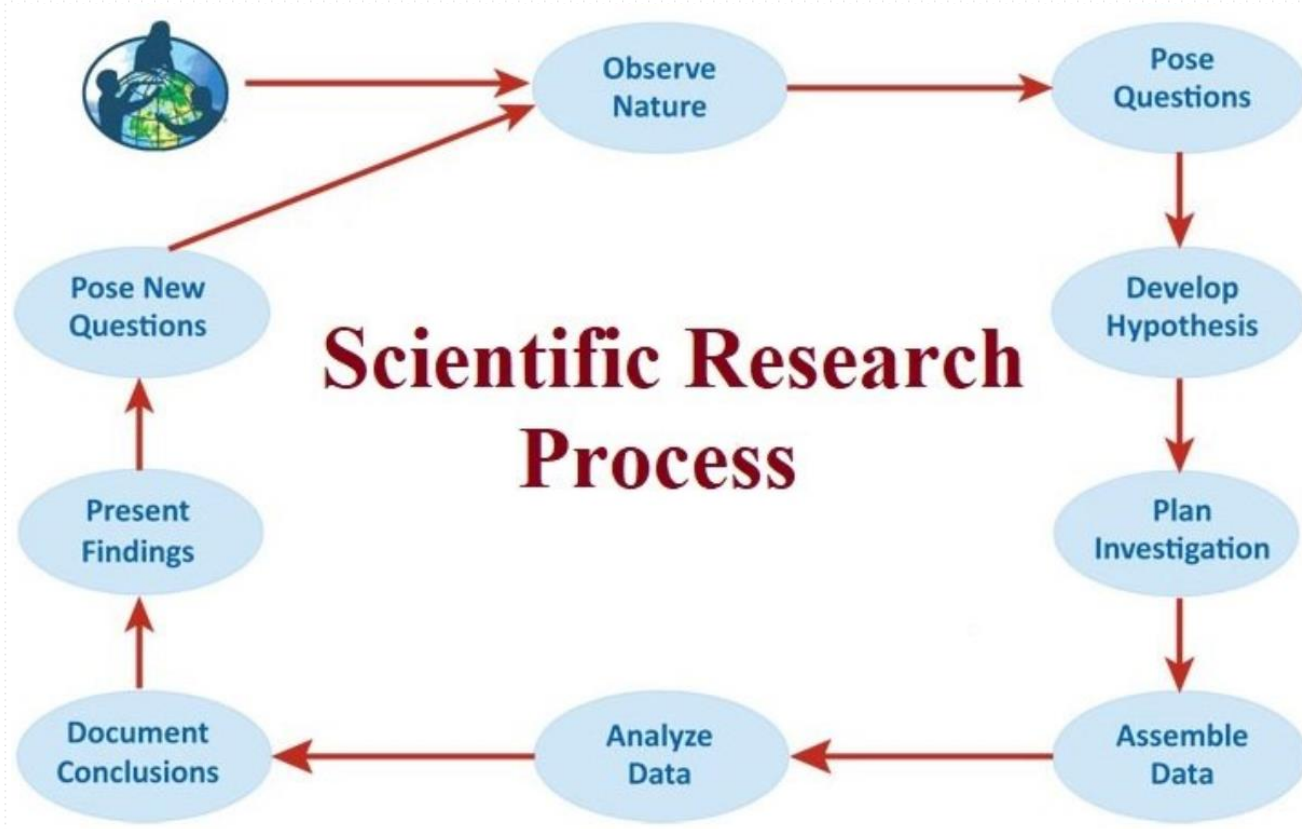What are the steps to conduct research?

Ω Note your points in your notebook

Ω Share with the rest of the class

3 Minutes

# Scientific Research Process

# Scientific Research Process

Research Process

1. Identifying The Problem

2. Reviewing Literature

3. Setting Research Questions, Objectives, And Hypotheses

4. Choosing The Study Design

5. Deciding on the sample design

6. Collecting Data

7. Processing And Analyzing Data

8. Writing The Report

# Research process

Ω **Step 1: Identify the research problem:** This involves identifying a gap in knowledge or an issue that needs to be addressed through research.



How to identify research gaps?

For early stage researchers!

Ω **Step 2: Conduct a literature review:** This involves reviewing existing research studies and publications related to the research problem to identify what has already been done and what is still unknown.

Ω **Step 3: Develop research questions or hypotheses**: Based on the research problem and literature review, the researcher formulates research questions or hypotheses that they will address through their study.



The Research Question

Ω **Step 4: Design the study:** This involves determining the research design, methods for data collection, and sampling strategy. The researcher also needs to ensure that ethical considerations are addressed.

# **Research process**

Ω **Step 5: Collect data:** This involves collecting data using the selected research methods, such as surveys, experiments, interviews, or observation.

# Research process

Ω **Step 6: Analyze data:** This involves analyzing the collected data using appropriate statistical or qualitative analysis techniques to answer the research questions or test the hypotheses.

# Research process

Ω **Step 7: Interpret findings:** This involves interpreting the results of the data analysis and drawing conclusions based on the findings.

# Research process

Ω **Step 8: Report results:** This involves writing up the research study in a formal report or manuscript, which includes the research problem, literature review, methodology, results, and conclusions.

# Research process

Ω **Step 9: Disseminate findings:** This involves sharing the results of the research study with other researchers, practitioners, and stakeholders through conferences, publications, or other means.

## Dissemination of Research Findings

*Any research findings need to communicated and disseminated effectively to influence optimal and timely practice and policy issues.*

**Tools and Analysis**

- Newspapers
- Radio
- TV

**General Views**

- Media **awareness** program
- To raise the media's responsiveness to the research in order to raise a positive thinking to journalists during media coverage
- To inform the media about the upcoming/ongoing process or event
- To build a lasting relationship with well-informed media
- Communication to be done before the entire project is completed (example, issue of news releases may be sent out at various stages of the project to generate interest and update the public on what's happening.)

# Research Hierarchy

Ω Also called **Research Classification Framework**.

Ω It represents the structured organization of research from broad fields to specific problems.

# Research Hierarchy

Research Discipline

→

Research Domain

→

Research Area

→

Research Topic/Title

→

Research Problem

# Research Discipline

Ω A broad field of study that encompasses various research domains.

Ω It represents a well-established academic field.

- Example: **Education, Computer Science, Engineering, Social Sciences**

# Research Domain

Ω A sub-field within a discipline, focusing on specific aspects of the broader field.

Ω Example (within Engineering – Telecom engineering):

- Wireless Communication

- Optical Fiber Communication

- Network Security

- 5G and Beyond

# Research Area

Ω  A more specific focus within a research domain, representing a general theme of interest.

Ω  Example (within Wireless communication):

- ✓ Massive MIMO Systems
- ✓ Spectrum Efficiency Optimization
- ✓ IoT Communication Protocols
- ✓ Energy-Efficient Wireless Networks

# Research Topic

Ω **Research Topic** – A specific subject within a research area, often formulated as a research study.

Ω Examples (under Massive MIMO Systems):

- ✓ "AI-Based Beamforming Optimization for Massive MIMO in 6G Networks"

- ✓ "Interference Management in Ultra-Dense 5G Networks Using Deep Learning"

- ✓ "Energy-Efficient Resource Allocation in Massive MIMO for Smart Cities"

# Research Problem

Ω   The specific issue or challenge the research aims to address.

Ω   Examples (under AI-Based Beamforming Optimization):

"Traditional beamforming techniques in Massive MIMO are inefficient in dynamic urban environments, leading to high latency and reduced network throughput. How can AI-based algorithms optimize beamforming to enhance network performance?"
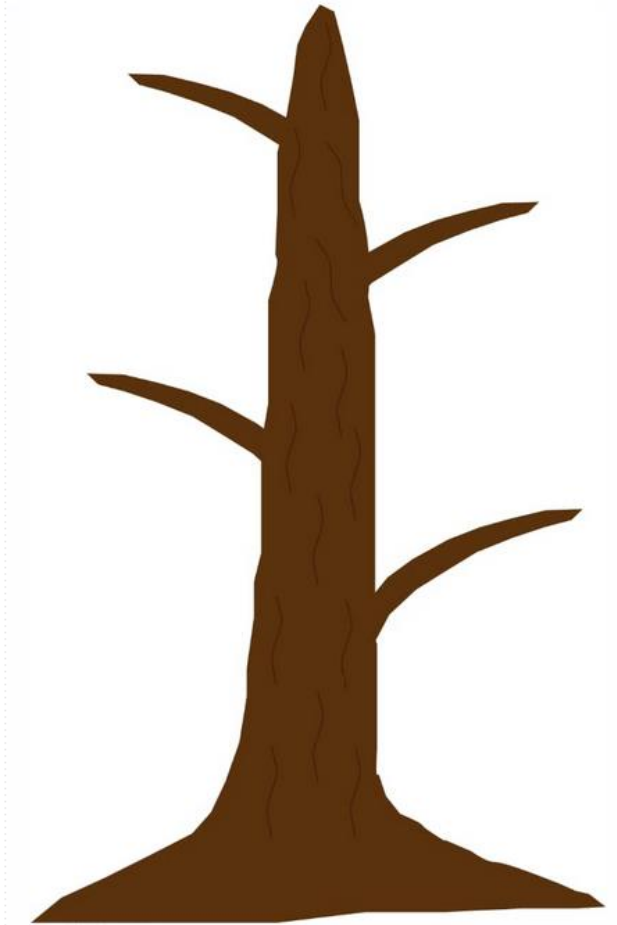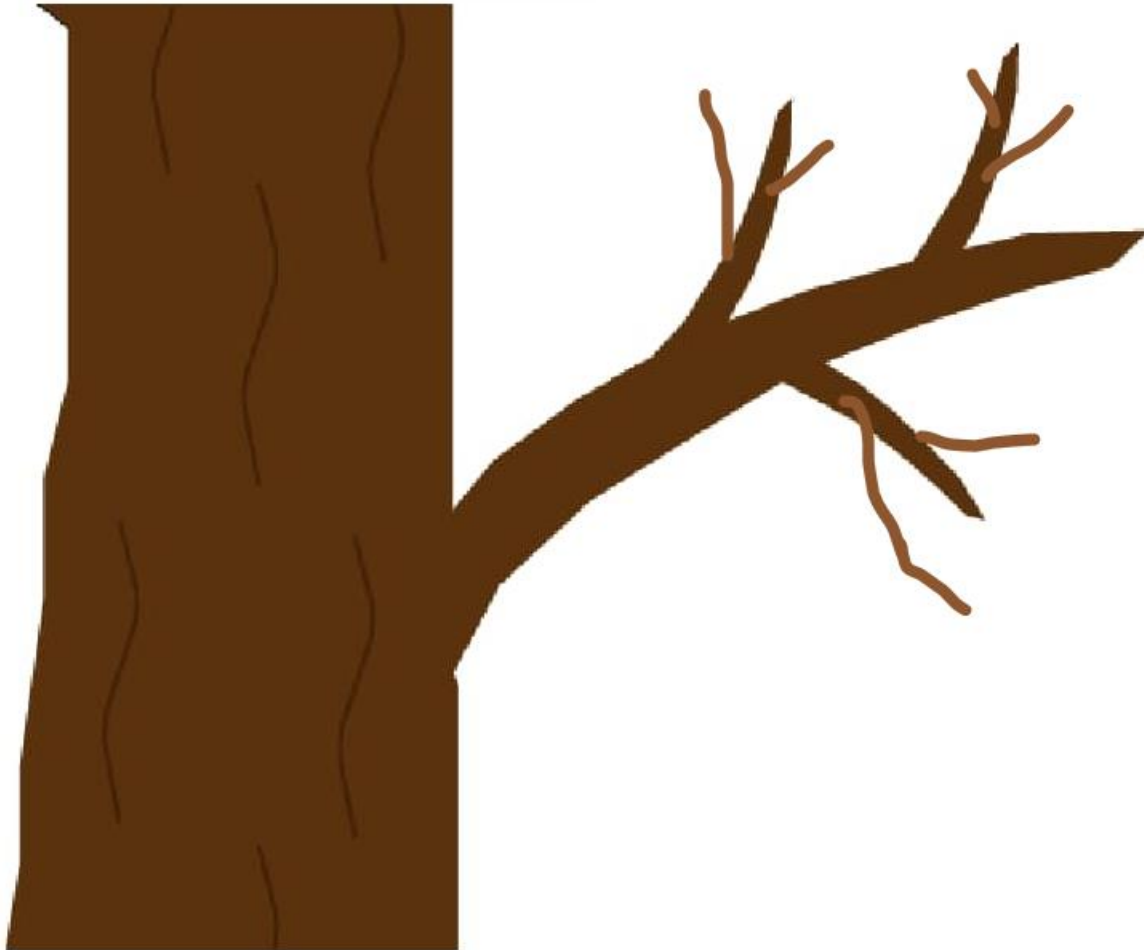
# To do research, we need a RESEARCH PROBLEM

# **Problem Identification**

Ω   Think of your area of interest (TE, SE, MTA, IDIT,…)

Ω   Think of any problem you are passionate to solve (eg. Inclusion, gender and tech, system analysis, etc)
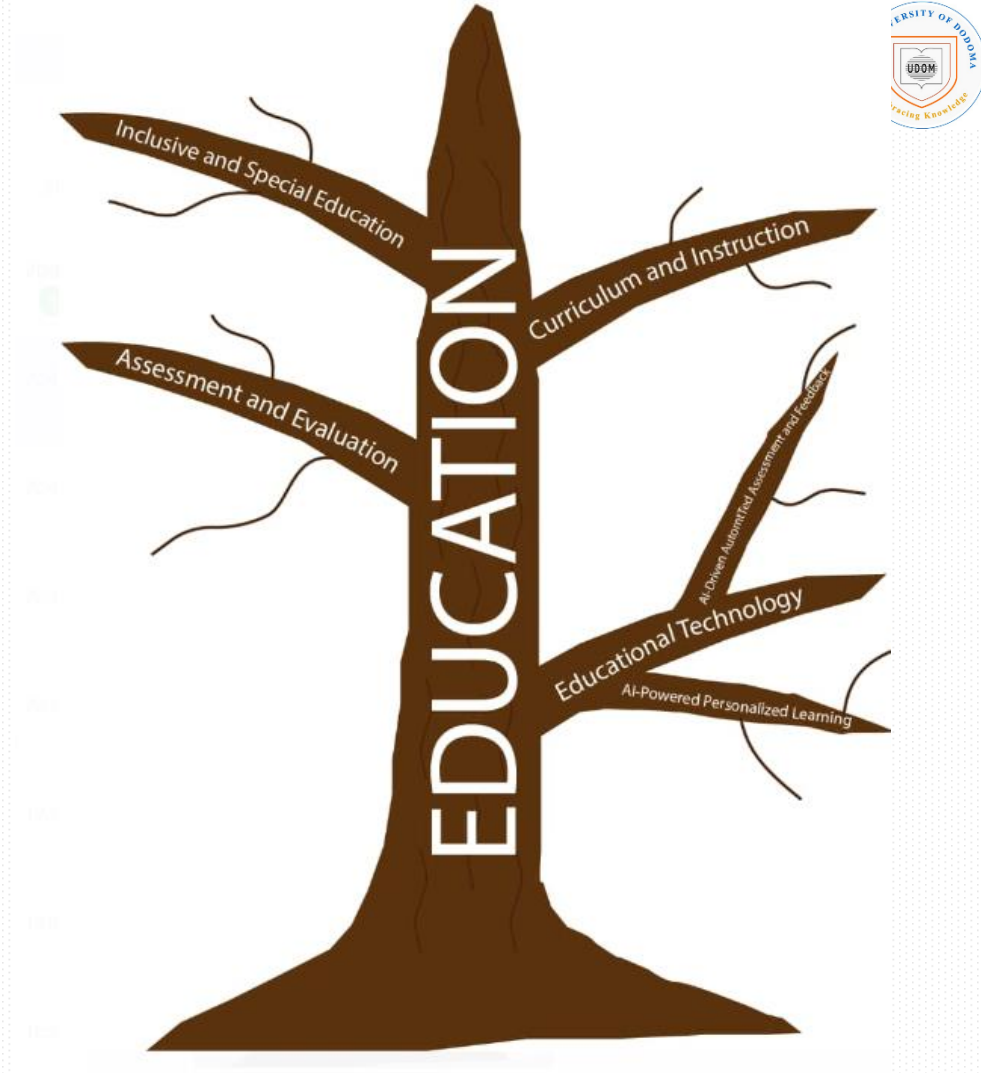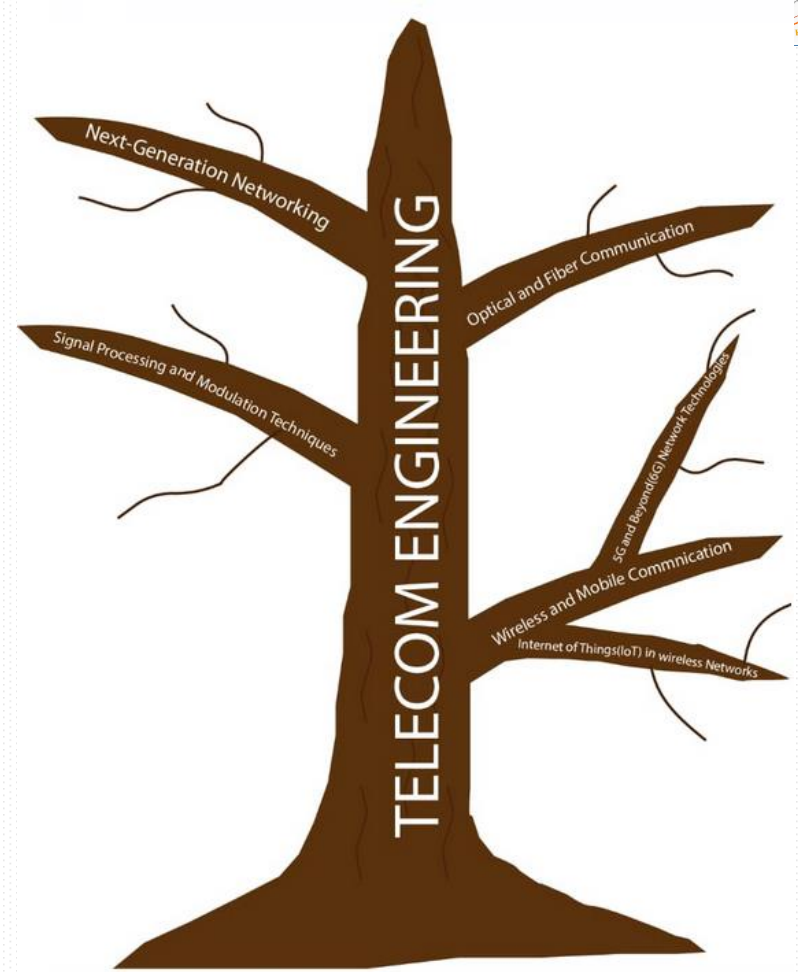
Ω   Write down why

   ✓    That is a problem

Domain

Domain

Research Area
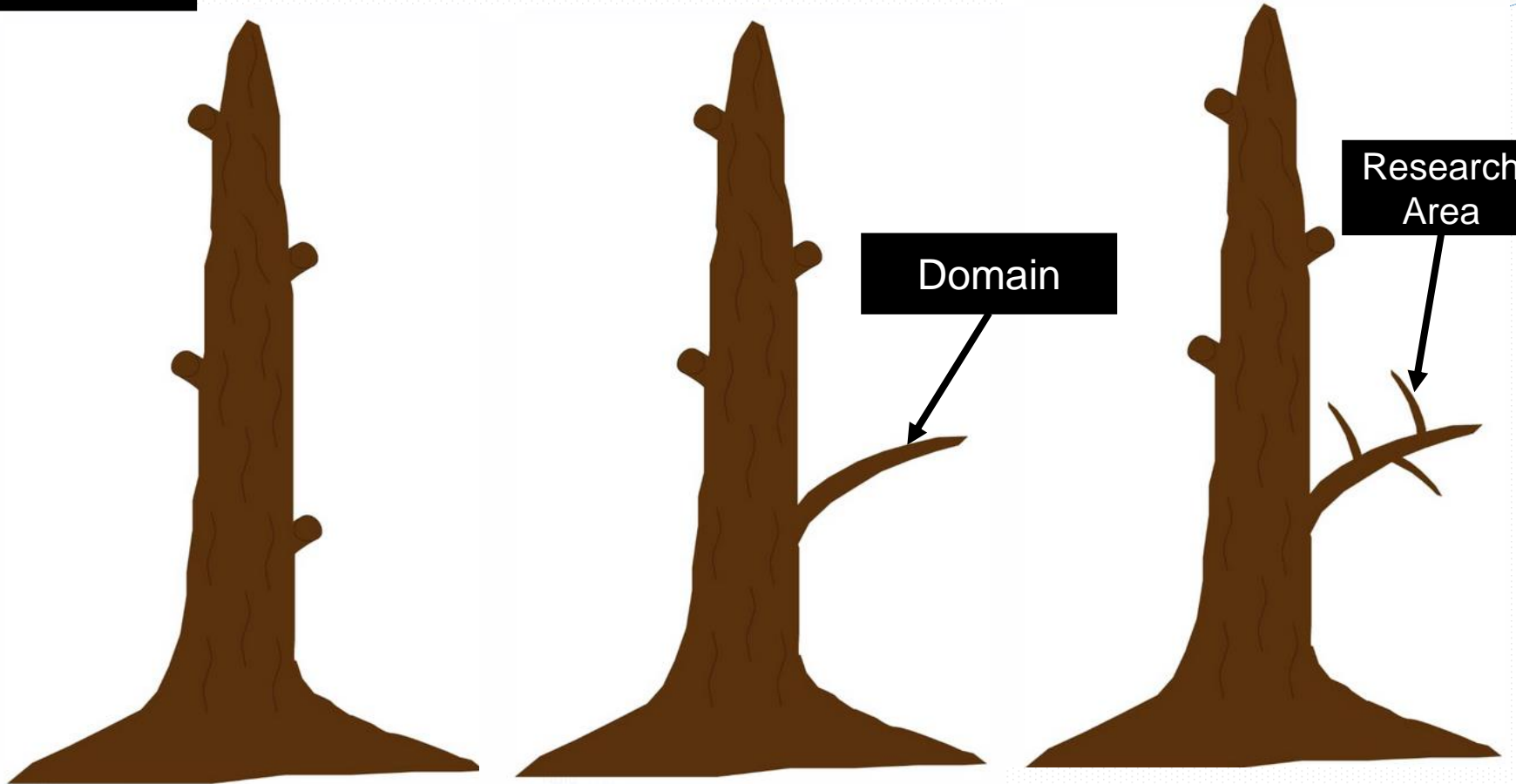
# Education

# Computer Engineering

# Telecom Engineering

# Information Systems



INFORMATION SYSTEMS

- Information Security and Privacy
- Data Management and Database
- Cloud Computing and Virtualization
- Customer Relationship Management (CRM) Systems
- Enterprise Information Systems
- Enterprise Resource Planning (ERP) Systems
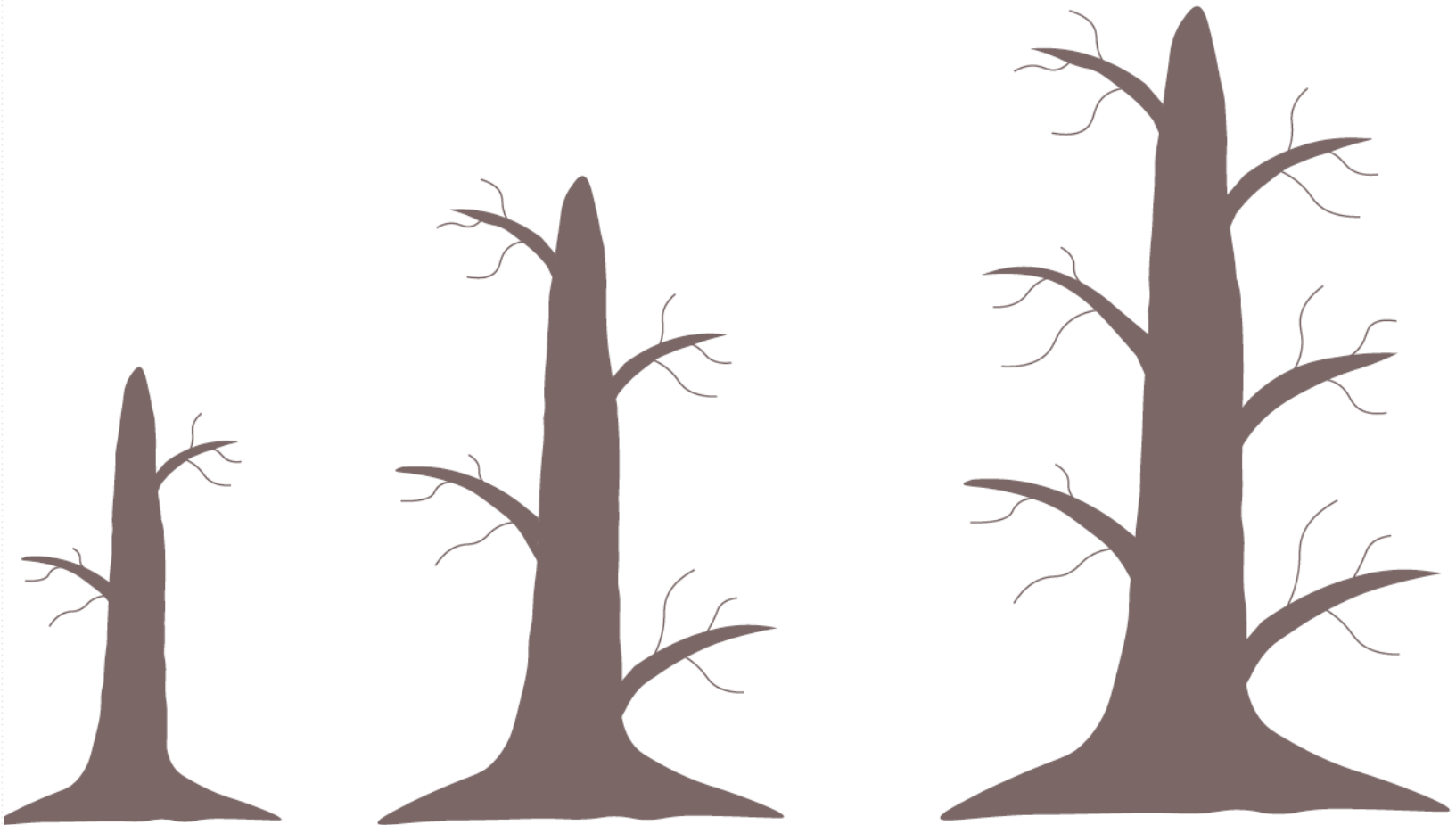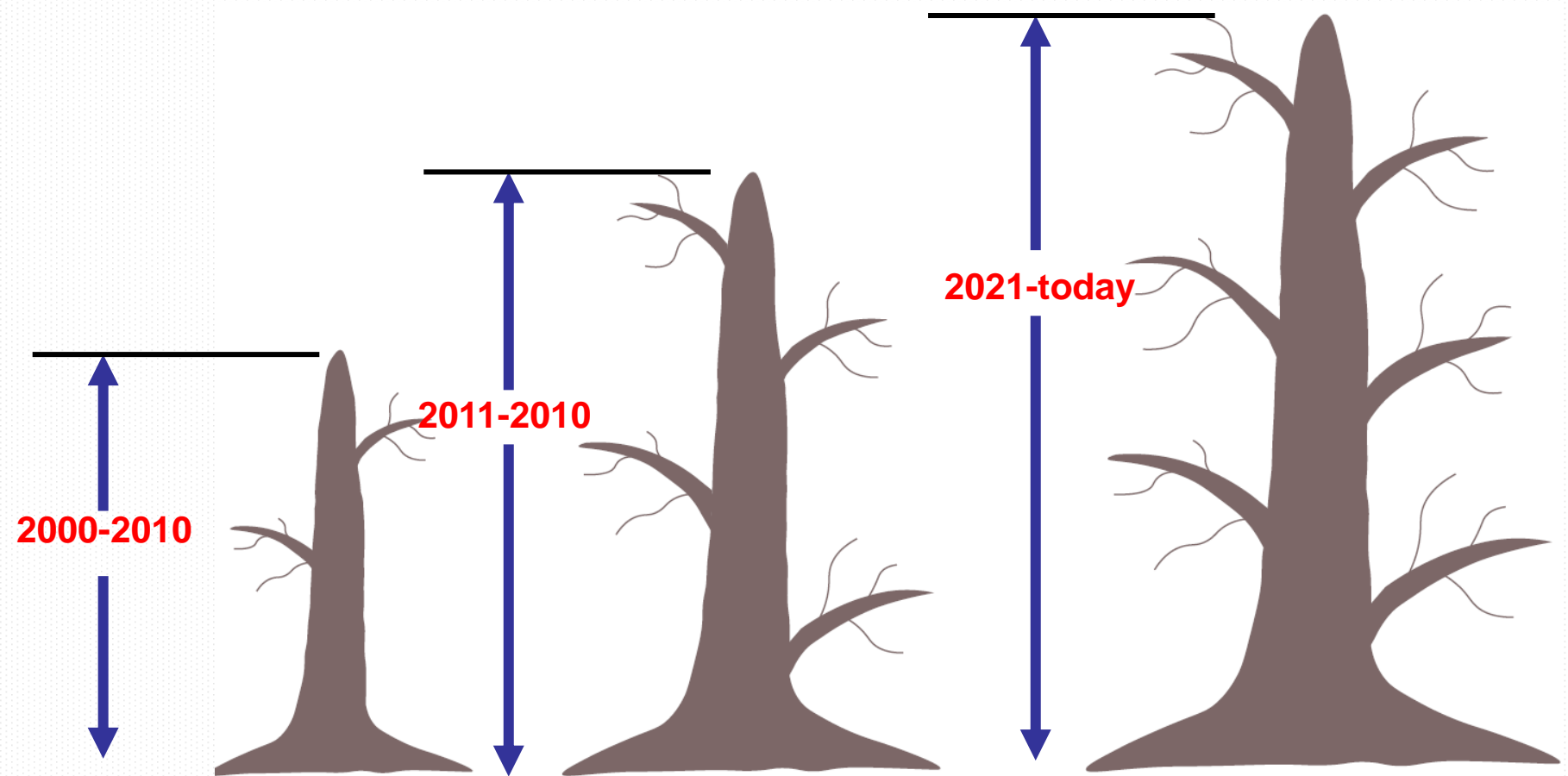
# Example

## Example Breakdown (Education as a Discipline)

- **Discipline:** Education
  - **Domain:** Educational Technology
    - **Area:** AI in Education
      - **Topic:** The Role of AI in Personalized Learning
        - **Problem:** Limited research on AI-driven personalized learning strategies for students with disabilities.

# Research grows and dies

# Research grows and dies



2000-2010

2011-2010

2021-today

# Activity 2

Ω   Think of your own Research Discipline

Ω   Think of your own Research Domain

Ω   Think of your own Research Area

Note Down your thinking

Present to the rest of the class

5 Minutes

# Examples of Possible Research Title in Various Disciplines at the College of Informatics and Virtual Education

# a) Information Systems specialist

Ω   Studying the impact of new technology on the information systems of an organization

Ω   Analyzing the security of information systems to identify potential vulnerabilities and risks

Ω   Designing and implementing new information systems for an organization

Ω   Evaluating the effectiveness of existing information systems and recommending improvements

Ω   Developing and implementing strategies to ensure the efficient and effective use of information systems.

# b) Computer networks and Information Security Engineers

Ω   Intrusion Detection and Prevention Systems: Developing and testing new techniques to detect and prevent network intrusions.

Ω   Secure Communication Protocols: Researching and developing new protocols for secure communication between network devices.

Ω   Cloud Computing Security: Investigating security challenges in cloud computing environments and developing effective security mechanisms to mitigate these challenges.

Ω   Network Security in Internet of Things (IoT) Environments: Analyzing security risks associated with IoT devices and networks and developing novel security solutions to ensure secure data transmission and privacy protection.

# c) Multimedia Technologists

Ω   Designing and developing multimedia content such as video, audio, and interactive media for educational or marketing purposes

Ω   Developing and implementing multimedia solutions for businesses, organizations, and government agencies

Ω   Creating visual and audio effects for film, television, and video game production

Ω   Conducting research on the latest multimedia technologies and trends

Ω   Collaborating with other professionals such as graphic designers, animators, and programmers to create multimedia content.

# d) Computer Engineers

Ω   Developing computer hardware and software systems

Ω   Designing and implementing computer networks

Ω   Conducting research on new computer technologies and applications

Ω   Testing and evaluating computer systems to ensure their reliability and functionality

Ω   Providing technical support for computer systems.

# d) Computer Scientists

Ω   Conducting research on computer algorithms and data structures

Ω   Developing new software applications and tools

Ω   Analyzing and solving complex computing problems

Ω   Collaborating with other professionals to develop and implement new computing solutions

Ω   Teaching computer science courses at the college or university level.

# e) Health Informatician

Ω Analyzing and organizing healthcare data to improve patient outcomes and reduce costs

Ω Developing and implementing electronic health records (EHRs) and other health information systems

Ω Collaborating with healthcare professionals to design and improve clinical decision support systems

Ω Conducting research on the use of technology in healthcare delivery and outcomes

Ω Ensuring compliance with privacy and security regulations for healthcare data.

# f) Business Information Systems

Ω Analyzing business processes and information systems to identify areas for improvement

Ω Developing and implementing new information systems to improve business efficiency and effectiveness

Ω Providing technical support for business information systems

Ω Conducting research on new technologies and applications for business information systems

Ω Developing and implementing training programs to help employees use business information systems effectively.

# g) Telecommunications

Ω Designing and implementing telecommunications networks, such as cellular networks and satellite systems

Ω Testing and evaluating telecommunication systems to ensure their reliability and functionality

Ω Analyzing and solving complex telecommunications problems

Ω Conducting research on new telecommunication technologies and applications

Ω Providing technical support for telecommunication systems.

# h) Instructional Designer

Ω Designing and developing instructional materials such as e-learning courses and training programs

Ω Analyzing learner needs and developing instructional strategies to meet those needs

Ω Collaborating with subject matter experts to develop course content

Ω Evaluating the effectiveness of instructional materials and making improvements as necessary

Ω Conducting research on new instructional technologies and techniques.

# **Activity 2**

Ω Think of your own Research Discipline

Ω Think of your own Research Domain

Ω Think of your own Research Area

Ω Think of your own Research Topic

Ω Think of your own Research Problem

Note Down your thinking

Present to the rest of the class

5 Minutes

# Homework for Lecture 1

Ω Watch the following three videos

1. Intro to Res: https://youtu.be/btZE1COWF5o?si=J3i-eGnCD2XN_6Gt

2. Res Process: https://youtu.be/07nYgNTWz7Q?si=KqwzGkOMmvWX164o

3. Res Design: https://youtu.be/LpmGSioXxdo?si=aU7KLqIbzW6A6EZc

Ω Using your notebook, note three (3) new terms/words from each video that you come across as you watch the videos [You will present 9 new words from the 3 videos]

Ω Be ready to share with the rest of the class

1 week

# END OF LECTURE 1

# Next Lecture: Unpacking the Research Process (Steps)

# Activity 6: Individual

Ω Use your smartphone/tablet

Ω Go to Google and search for
# www.menti.com

Ω Open the first link

3 Minutes

Ω Enter the code: **1141 4145**

Ω Respond to the question

What have you learned today?

3 Minutes