Kwame Nkrumah University of Science & Technology, Kumasi, Ghana

SCI 352:Research Design and Implementation 2018/2019

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Department: Theoretical and Applied Biology
Faculty & College: Biosciences, Science

Course Outline

1. Introductory Lecture and Learning Outcomes
2. Concept and Characteristics of Research
3. Basic Types and Approaches to Research
4. Scientific Methods and Steps in Conducting Research
5. Data Analysis & Interpretations
6. Scientific Communication and Writing
7. Poster Presentation
8. Literature Search and References
9. Intellectual Property Rights

Class expectations

- To attend all lectures and on time
- Once lecture begins you will not be allowed to enter the lecture room
- To answer questions pertaining to the course of study during lectures
- To revise previous lecture notes prior to the next lecture

❖ Do NOT use your cell phone in class. It should be *placed on* silence or switched off as you enter the lecture room

Course Learning Outcomes

At the end of this course, students would be able to:

- ✓ Understand the concept and characteristics of research, explain the rationale for conducting research
- ✓ Distinguish the types and approaches to research associated with solving contemporary Biological/environmental science problems

Course Learning Outcomes

- ✓ Demonstrate the steps in conducting scientific research
  - ✓ Identify a research problem
  - ✓ Critically examine the problem
  - ✓ Generate research objectives
  - ✓ Design research in alignment with the objectives
  - ✓ Conduct research study (either by survey or experiment)
  - ✓ Collect, manage, analyze and interpret data

Course Learning Outcomes

- ✓ Communicate scientific research effectively in a professional environment through different forms
- ✓ Critique scientific publications
- ✓ Discuss ethical issues encountered in conducting research and understand the art of patenting an invention

Course Learning Outcomes

- ✓ Restate the concept and importance of proposal writing and develop a research proposal
- ✓ Know the importance of referencing, the different referencing styles and how to use at least one referencing style and software
  - ✓ format used in KNUST (College of Science)

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Requirements for the Course

- **Attendance**

  - will be taken at each lesson
  - Absenteeism is **NOT** an acceptable excuse for incomplete assignments
- **Assessments**
  - Group/ Individual Assignments & Presentations
  - Unannounced quizzes
  - One project/term paper

Interactive and interesting class
NO ONE is permitted to be 'laid-back'

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CONCEPT AND CHARACTERISTICS OF RESEARCH

Intended Learning Outcomes

By the end of this session, students will be able to:

- Understand the concept of research
- Understand the rationale for conducting research
- Explain the characteristics research

Defining research

- … is a search for knowledge in any branch of knowledge

"Research is creating new knowledge."
… Neil Armstrong

- … is a process of investigation or inquiry

The Concept of Research

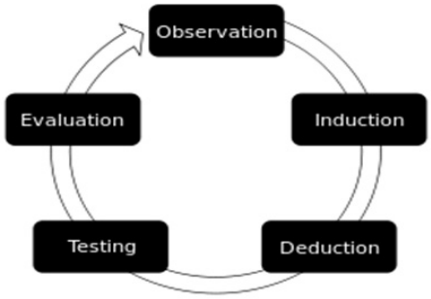
- It's not just a trip to the library
  - to pick up a stack of materials, or
  - picking the first five hits from a computer search
- It is a journey from the known to unknown

Research is a hunt for the truth !

Definition of Research

systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles, or theories, resulting in prediction and possibly ultimate control of event

Definition of Research



Why is research important?

- Students
  - Enhances knowledge
  - Clarifies confusion
  - Have proper understanding of a subject
  - Learn about methods and issues
  - Understand published work
  - Understand the rationale and origin of study
  - Know area of interest
  - Create a balance between the collaborative and individual work

Why is research important?

- Mankind
  - Helps understand society and culture
  - Know the truth (a way to prove lies and to support truths)
  - Increased awareness
  - An aid to business success
  - Means to find, gauge and seize opportunities
  - Up to date technology
  - Make right choices for a career

Why is research important?

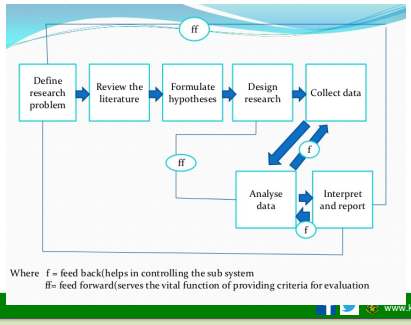
- Education
  - Leads to great observations
  - Results in predications, theories and many principles
  - Improving practices
  - Develops new understanding related to learning, teaching etc.
  - Helps in initiating action and decision making
  - Brings consistency and motivates others
  - A seed to love reading, writing, analyzing and sharing valuable information
  - Nourishment and exercise for the mind

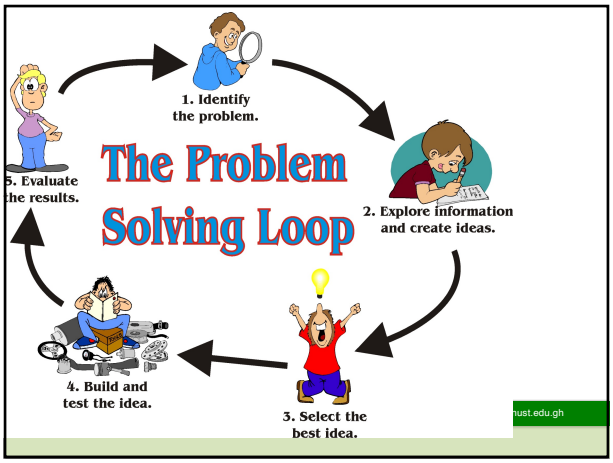
Characteristics of Research

- originates with an **observation**, **question or problem**
- usually divides the principal problem into more **manageable sub problems**
- requires **a clear** articulation of the **objective**
- is guided by the **specific research problem, question, or hypothesis**
- requires a **specific plan** of **procedure**
- requires the **collection** and **interpretation** of **data** in attempting to **resolve the problem** that initiated the research

Characteristics of Research …

- Research is, by its nature, **cyclical**; or **more exactly, helical**





Research in Science

- It is an original contribution to the existing stock of knowledge making for its advancement
- It is the pursuit of truth with the help of
  - Study
  - Observation
  - Comparison
  - Experiment

Scientific Research

- It is the systematic method consisting of
  - enunciating the problem
  - formulating a hypothesis
  - collecting the facts or data
  - analyzing and interpreting of facts
  - reaching certain conclusions

Conducting research as a Student

- It is one of the most interesting and often required features of any degree course:
  - Offers you a measure of control and autonomy over what you learn
  - Gives you an opportunity to confirm, clarify, pursue or discover new aspects of a subject or topic
  - Trains you as a **Junior Scientist**

Characteristics of a Researcher

A good scientist is one who is

- **Curious** about his world
- **Thinks outside the box**
- **Open-minded and unbiased**
- **Skilled**
- **Observant**
- **Prudent**
- **Honest**

Thus; a Research Scientist

- Develops the ability to **critically analyze problems**
- **Finds solutions** and **raise other questions**

The Objectives of Research

- The purpose of research is to **find answers to questions through the application of scientific procedures**
- Each research study has its own specific purpose

The Objectives of Research

- There are **4 general** objectives for a research:
  - To explore a phenomenon or gain new insight into it (explorative / formulative research)
  - To accurately portray the characteristics of a particular situation or a group (descriptive research)
  - To determine the frequency with which something occurs (diagnostic research)
  - To test a hypothesis and/or establish a relationship

General objectives of research

1. To explore a phenomenon or gain new insight into it (explorative / formulative research)
   - –Review or synthesize existing knowledge
   - –Explain new phenomenon
   - –Generate new knowledge
   - –Construct or create new procedures or systems

General objectives of research…

2. To accurately portray the characteristics of a particular individual, situation or a group (descriptive research)
   – Investigate existing situations or problems
3. To determine the frequency with which something occurs (diagnostic research)
   – Explore and analyze more general issues
4. To test a hypothesis and/or establish a relationship

General objectives of research…

A research objective could be a combination of any of the above!

Ultimately, a research objective must provide solutions to problems

Opportunities from Research

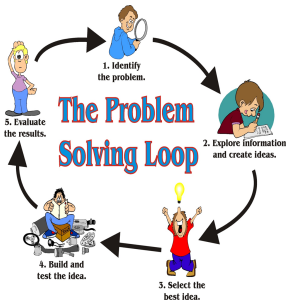
The outcome of innovative research is an **intellectual property**

- Because your product, process or technology can be
  – Patented
  – Commercialised

Business incubation exist to nurture your ideas

Facts about Research

- Is an academic activity
- A scientific approach guided by
  - a research problem, question or hypothesis
- Originates with a question
- It involves a specific plan and procedure



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In summary
Research encompasses the following

- ✓ Defining and redefining problems
- ✓ Formulating hypothesis or suggested solution
- ✓ Collecting, organizing, evaluating and interpreting data
- ✓ Making deductions and Reaching conclusions
- ✓ Lastly, carefully testing the conclusions

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Wrap-up

- Empirical
  - (Direct observation and experience)
- Clear and concise
- Logical
  - (Valid procedures and principles in line with objectives)
- Analytical/Standardized
- Collection and Interpretation of data
- Systematic/Methodical
- Dynamic and Flexible
- Replicable (Validity)
- Helical

Remember: Research must be relevant

Semester Project

As a Biological Scientist in a consultancy firm, you have been hired by top Management to come up with how **one named** biological/environmental problem can be solved. Using research, design and implementation, develop means and strategies for this.

DURATION: **3 Weeks**

Group Activity (Project Discussion)

In your discussion consider the following:

- Creating an identity for the problem
  - Composition, Features
- Affected people
  - niche identification, demographics, preferences
- Channels
  - How you hope to salvage the situation, you may want to introduce an intervention (Packaging, Advertisement, Delivery)
- Feasibility Studies
- Business Model?

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BASIC TYPES AND APPROACHES TO RESEARCH

Intended Learning Outcome

By the end of this session, students will be able to:

✓Know the various types of research and understand their applications

✓Distinguish between the various types of research

✓Understand various approaches used in research worldwide

✓Apply the types and approach of research to their research problem

Types of Research

Can be categorised based on;

- **Application/Immediate Purpose**

  Basic vs. Applied Research

- **Objectives**

  Exploratory, Descriptive, Analytical vs. Predictive

- **Methodology**

  Qualitative vs. Quantitative Research

These overlap because **Research is both dynamic and flexible**

Basic/Pure Research

- Driven by a scientist's ***curiosity*** or **interest** in a scientific question
- Conducted to **investigate issues** relevant in formulating or reformulating theories
- May not be concerned with their practical application (no obvious commercial value)
- Motivation is to expand man's knowledge, not to create or invent something

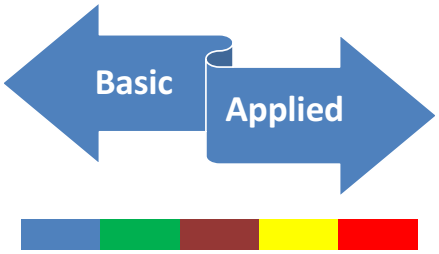
Example: What is the structure of parasite xx?

Applied Research

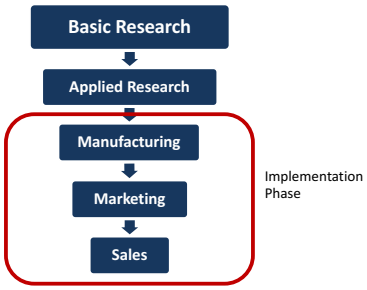
- Designed to **solve practical problems** of the modern world
- Not focused on just acquiring knowledge
- Primary goal of the applied scientist is to generate information that can improve the human condition
- Often based on Basic/Pure research

Example
Develop new strategies for reducing the burden of parasite xx

Research process ranges from basic to applied



Linear Model Research and Implementation



Types of Research Based on Objectives

Exploratory Research

- This is undertaken when few or no previous studies exist
- The aim is to look for patterns, hypotheses or ideas that can be tested and will form the basis for further research
- Typical research techniques would include
  - ✓case studies, observation and reviews of previous related studies and data

Example

Reviewing literature to find gaps in an area of research

Descriptive Research

- This can be used to identify and classify the elements or characteristics of the subject

Examples

- ✓Determine the burden of cholera among a vulnerable population
- ✓Describe the feeding habit of bats living in the Domena cave

- **Quantitative techniques** are most often used to collect, analyze and summarize data

Analytical Research

- Extends the Descriptive approach
- Suggests or **explains why** or **how** something is happening

Examples
- Determine the effect of drugs A and B on the aetiology of *Vibro cholerae*
- The effect of sunlight on the feeding habits of *Eidolon helvum*

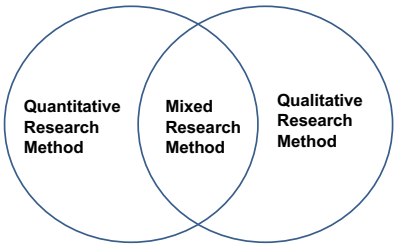
- An important feature is in
  - ✓ locating and
  - ✓identifying the different factors (variables) involved

Predictive Research

- The aim is to speculate intelligently on future possibilities
- Based on close analysis of available evidence of cause and effect

Example
- Model how increasing the dosage of drug A affects the drug sensitivity pattern in Cholera patients

Approaches of Research



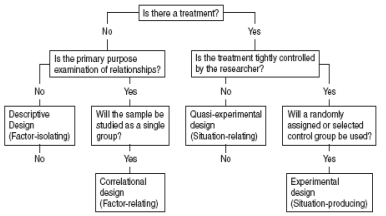
Quantitative Research Method

- Often uses postpositive claims for developing knowledge
  - (cause and effect thinking, test hypotheses or theories and make predictions)
- Objectivity is critical
- Employs strategies of inquiry such as experiments and surveys
- Collects data on predetermined instruments that yield statistics data

Types of Quantitative Method

- Descriptive
- Experimental
- Correlational
- Quasi-experimental

Figure 3-1 Decision tree matching research design to category of research question.



Qualitative Research

- Seeks to understand and interpret social and personal interactions (individuals, cultural or social organizations)
- Study of the whole and not variables
- Subjectivity is expected
- Collects open-ended responses, interviews, observations, field notes and reflections
- Identifies patterns, themes and features

Types of Qualitative Method

Case Study (also Quantitative)	Sheds light on a phenomena by studying in-depth a single case (individual, event, group or institution) example of the phenomena
Grounded Theory	Completely open minded without any preconceived ideas on the outcome of an event or situation (inductive)
Phenomenology	Describes the structures of experience through consciousness, without recourse to theory, deduction or assumptions from other disciplines
Ethnography	Identifying a culture-sharing group and studying how it developed shared patterns of behaviour over time
Historical	Systematic collection and objective evaluation of data related to past occurrences for testing hypotheses concerning causes, effects or trends of events that may explain present events and predict future events

COMPARING QUALITATIVE & QUANTITATIVE RESEARCH

Qualitative Research	RESEARCH ASPECT	Quantitative Research
Discover Ideas, with General Research Objects	COMMON PURPOSE	Test Hypotheses or Specific Research Questions
Observe and Interpret	APPROACH	Measure and Test
Unstructured. Free Form	DATA COLLECTION APPROACH	Structured Response Categories Provided
Research is intimately involved. Results are subjective	RESEARCHER INDEPENDENCE	Researcher uninvolved Observer. Results are Objective
Small samples –Often in Natural setting	SAMPLES	Large samples to Produce Generalizable Results [Results that Apply to Other Situations]

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SCIENTIFIC METHODS AND STEPS IN CONDUCTING RESEARCH

Intended Learning Outcomes

By the end of this session, students should be able to:

❖ Demonstrate the steps in conducting scientific research

✓Identify a research problem

✓Critically examine the problem

✓Generate research objectives

Intended Learning Outcomes

By the end of this session, students will be able to:

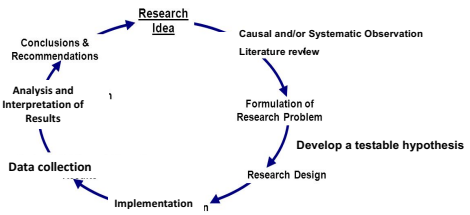
✓Design research in alignment with the objectives

✓Conduct research study either by survey or experiment

✓Collect, manage, analyze and interpret data

Steps in Conducting Research Overview

- Research process is cyclical in nature



- Research process is cyclical, **but more exactly like a chain**
  - Begins with a question and ends with another question

Seven Steps of the Research Process

- Step one: Define research problem
- Step two: Review literature
- Step three: Formulate hypotheses
- Step four: Prepare the research design
- Step five: Collect data
- Step six: Analyze data
- Step seven: Interpret and write report

Alternative Model of the Research Process

A 14-step Process*

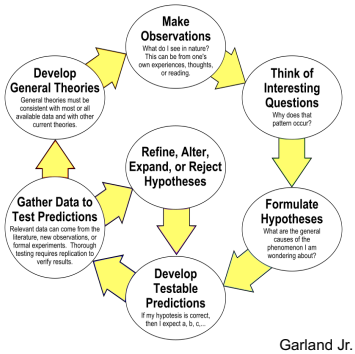
1. Choose a problem
2. Review the literature
3. Evaluate the literature
4. Be aware of all ethical issues
5. Be aware of all cultural issues
6. State the research question or hypothesis
7. Select the research approach
8. Determine how the variables are going to be measured
9. Select a sample
10. Select a data collection method
11. Collect and code the data
12. Analyze and interpret the data
13. Write the report
14. Disseminate the report

Fang et al. 2008

The Scientific Method as an Ongoing Process

Research process is cyclical in nature

- Begins with a question and ends with a question



Garland Jr. 2015

Steps in Conducting Research

- Generating Research Idea
  - ✓ Causal and/or Systematic Observation
  - ✓ Library research
  - ✓ Curiosity
  - ✓ Being inquisitive
  - ✓ Challenging the status quo
  - ✓ Being adventurous
  - ✓ Interactions with others

Steps in Conducting Research

- **Reviewing Literature**
  - ✓ Define the purpose of the literature review
  - ✓ Provide an outline for the review including key words
  - ✓ Search for relevant material (information)
  - ✓ Synthesize ideas
  - ✓ Provide references and sources of information

Literature Review

- Sources of information includes;
  - ✓ Technical reports
  - ✓ Journal articles
  - ✓ Books
  - ✓ Monographs
  - ✓ Patent
  - ✓ Newspapers
  - ✓ Internet
  - ✓ Indigenous knowledge
  - ✓ Videos
  - ✓ Pictures
  - ✓ Conference proceedings

Formulation of Research Problem

- Start by having the ideal situation in mind
  - Where are we?
  - Where should be we be?
  - Why are we not where we should be?

Steps in Conducting Research

- Develop idea into a testable hypothesis
- Research hypothesis = Scientific hypothesis
  - Statement of an expected or predicted relationship between variables
  - What the experimenter believes will happen in the research study
  - Can be directional or non directional
- Statistical hypothesis = Null hypothesis
  - States that there is no relationship between the variables

Overview of the Research Process

Research Design

- It is the **plan** or **blue print**
- Depends on;
  - Nature of research
  - Type of design method (data to analyse)
  - Subjects (consider sampling techniques, animal subjects, human participants, etc.)
  - Factors and levels
  - Respond variables
  - Exposure
  - Where experiment is being performed

Research Design

The overall strategy you choose to integrate the different components of the study in a coherent and logical way.

It refers to the **logical structure** (rather than the logistical one) or **blueprint for collection, measurement, and analysis of data.**

Determined by the type of research problem, not the other way around.

Research Design

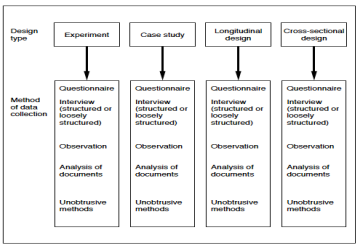
Functions to ensure that the evidence obtained enables you to effectively address research problem logically and as unambiguously as possible.

Addresses the question "*what evidence do I need to answer the question convincingly?"*

Research Design

Determines or precedes the work plan, data collection or analysis. (Analogy: *think of a building design and a building plan*)

- Research design is not related to any particular method of collecting data or any particular type of data.
- Can use either quantitative or qualitative data.



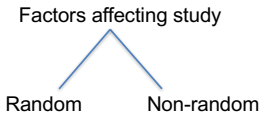
Types of Research design

Many types

- Action research design
- **Case study design**
- Causal design
- **Cohort design**
- **Cross-sectional design**
- Descriptive design
- **Experimental design**
- Exploratory design
- Historical design
- **Longitudinal design**
- **Meta-analysis design**
- Mixed-methods design
- **Observational design**
- Philosophical design
- Sequential design

Experimental/Interventional Study

- Manipulation of variables
- Introduction of a factor and responses



Observation Study

- Natural setting
  - ➢ No manipulation
- Analytical (Cohort study)
- Descriptive

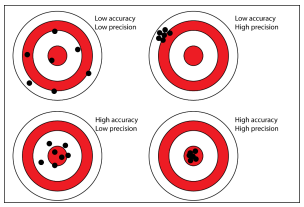
- May require technical issues such as ethical clearance

Implementation Phase of research

- Obtain all the relevant resources
  - Assemble all materials and equipment
  - Identify laboratories where analysis can be performed
  - Reagents
  - Samples
  - Feasible procedures and modifications where necessary
  - Obtain relevant skills to perform study
- Conduct study (Pretesting, Pilot work and Actual study)

Data Collection

- Variables being measured
- Instruments
- Level of measurement
- Precision and Accuracy
- Ethics



Analysis and Interpretation of Results

- Analyse data
  - (using descriptive and inferential statistics)
- State your findings
- Support with literature
  - May or may not conform or may even not exist
- Explain
- Defend

Steps in conducting Research

These steps and activities run throughout the entire research process;

- Literature review
- Planning
- Monitoring and evaluation
- Record keeping
- Asking questions

Working With a Plan

- A work plan details what has to be done to complete the research project.
- Two kinds
  - **One that helps the researcher to prepare and conduct his/her research (i.e., a plan to find the answer).**
  - One that helps the researcher to draft his/her report on the research (i.e., an outline of a draft)

Some Key Terms

The **research topic** is the subject of a proposed study. E.g.,
Illegal small-scale mining
Co-infection in children
Water pollution in Ghana, etc.

The research topic can be developed into a **research title** – a tangible idea that the research can keep focusing on and changing as the research goes on.
Begin the description of your research like: "My research/study is about …."

Research Topic Vs. Research Title

Good, sound research projects begin with straightforward, uncomplicated thoughts, easy to read and to understand.

Be brief and avoid unnecessary words such as “An approach to …”, “A study of ....”, etc.

Use single title or a double title. E.g., of a double title: “Global environmental change: understanding the role of deforestation”

DATA ANALYSIS & INTERPRETATIONS

Use of the words ‘DATA’ & ‘INFORMATION’

- **DATUM** (singular) or **DATA** (plural) refers to raw numbers or other measures, usually **discrete** and gives **objective facts** about events.

- **INFORMATION** refers to **what emerges when** data are processed, analyzed, interpreted and presented. **Information are data transformed** (contextualized, categorized, corrected, calculated, condensed) **into a message**

Data and Information

Any difference?

Data and Information

Data
The temperature of area A (measured every hour) for one-week period

Information
The number of days during the week where the temperature at area A was above 30°C.

Data Analysis and Interpretations

- Data analysis
  - An attempt by the researcher to summarize collected data.
- Data Interpretation
  - Attempt to find meaning
- How do these differ by research? traditionally?
  - Quantitative
  - Qualitative

Variables

A variable is the characteristic of interest about each individual in a research study.

An individual is one of the items examined by the researcher. This individual is not necessarily a person.

There are two main groups of variable types –

Quantitative and Qualitative

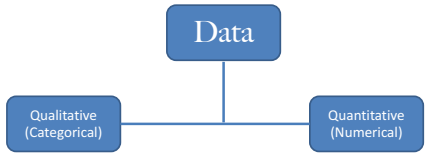
Quantitative & Qualitative Variables

Quantitative Variable
Quantitative variables are variables with numerical values for which it makes sense to do arithmetic operations (like adding or averaging).

Qualitative variables
They are variables that record to which group or category an individual belongs.

Within each main type of variable are two subgroups.

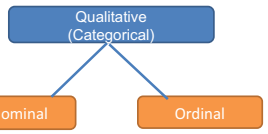
Types of Data variables



Attributes (Boy, girl, female, male)

Characteristics or traits for which numerical value can be be assigned Eg: Height, Weight
Typically known as **variables** - something that varies; takes on two or more values

Qualitative (Categorical)



- Implies the classification of an item into 2 or more categories without any extent or magnitude
- There is no particular order assigned to them
- Numbers serve only as **labels or tags** for identifying and classifying objects

Pass and fail; Rural and Urban;
What is the colour of your hair: Brown, Black, Blonde;What is your nationality

- More precise scale than the nominal scale
- The variables has been categorized or leveled with meaningful natural order
- There is no information about the interval

Eg: Pain: None, mild, Moderate, Severe
First, Second, Third, Fourth .....
Sick vrs healthy, wrong/false; right/true
There is no absolute zero

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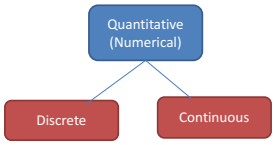
Quantitative (Numerical)



- Discrete: Quantitative variable with a **finite number of values/** have countable number of possible values
- Jumps from one value to another value but will not consider the intermediate value between the two values

Eg: How many girls can occur in a family with 4 children?
X – {0,1,2,3,4}

Continuous variable: Quantitative variable with an **infinite number of values**

Eg. Temperature can take an infinite number of values 37.5°C, 39.8°C

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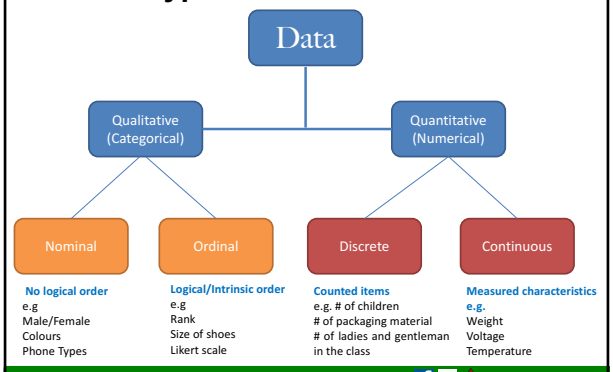
Types of Data variables



No logical order
e.g
Male/Female
Colours
Phone Types

Logical/Intrinsic order
e.g
Rank
Size of shoes
Likert scale

Counted items
e.g. # of children
# of packaging material
# of ladies and gentleman in the class

Measured characteristics
e.g.
Weight
Voltage
Temperature

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Exercise: Indicate whether the following are discrete or continuous variables

1. Number of houses in a certain block?
2. What distance can you run within 10 minutes?
3. What is your heart rate?
4. Which political party do you belong to?
5. Which parental style do you use?
6. What is your gender?
7. Marital status?
8. What is the colour of your hair?
9. How many females are in this class?
10. What is the weight of the children over a period of one month?

Exercise

No.		Nominal	Ordinal	Discrete	Continuous
1	A jug of milk holds one gallon				
2	The distance was 52.62 km				
3	Team C were 1st while Team A and B took the 3rd and 2nd position respectively.				
4	Regional capital cities in Ghana				
5	The % carbohydrate was 94.5				
6	Number of weeks in a month				
7	Names of days in the week				
8	I went to the gym at 5.00am				
9	Brands of phone				
10	Official Class Register/List				

Sources of Data

Primary and Secondary

Primary Data Sources

A primary data source is an original data source; one in which the data are collected firsthand by the researcher. The most common techniques are self-administered surveys, interviews, field observation and experiments.

Secondary Data Sources

A secondary data source refers to a data source that is already in existence (e.g. General Social Survey, national census).

Source of Data

Primary data	Secondary data
▪ Real time	◦ Past data
▪ Sure about the sources	◦ Not sure about sources
▪ Can answer research question.	◦ Refining the research problem
▪ Cost and time	◦ Cheap and no time
▪ Can avoid bias	◦ Bias can't be ruled out
▪ More flexible	◦ Less flexible

Key components of a data analysis plan

- Purpose of the evaluation
- Questions
- What you hope to learn from the question
- Analysis technique
- How data will be presented

What should be the approach?

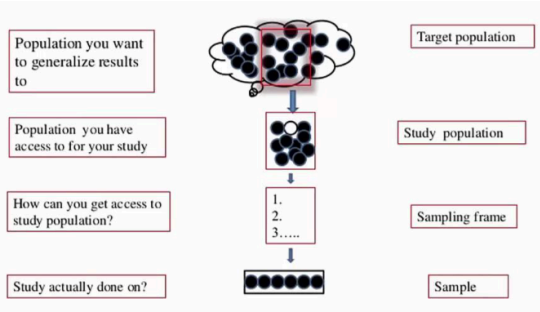
- **Think about analysis EARLY**
- **Start with a plan**
- **Code, enter, clean**
- **Analyze**
- **Interpret**
- **Reflect**
  - What did we learn?
  - What conclusions can we draw?
  - What are our recommendations?
  - What are the limitations of our analysis?

Coding

- Master sheet
  - Where all variables are named
- Dummy variables
- Coding facilitates data entry
- Requirement for many statistical softwares

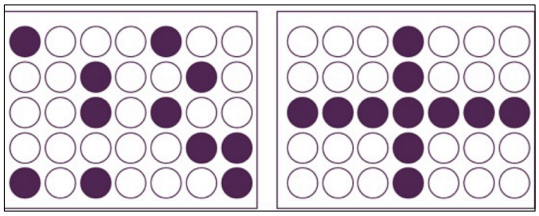
Who is to be studied?

The **study population** is the population of individuals **selected** to participate in the study.



How to sample?

Two types: Probability versus Non - Probability sampling



Probability sampling

A probability sample is one in which every element in the study population has a known **non zero probability** of being included in the sample.

probability Sampling Tech.

- Simple Random sampling
- Systematic sampling
- Stratified sampling
- Cluster sampling
- Multi-stage sampling

Simple Random sampling (SRS)

- Assures that each element in the population has an **equal chance** of being selected
- Selection is **free from bias**
- Can be calculated – sample size (n) and population size (N)

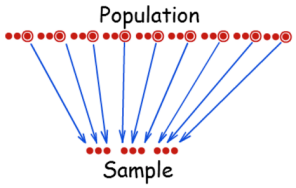
➔**Probability = n/N**

- Random sampling can be based on drawing numbers from a hat, using computer-generated or flipping a coin or throwing dice, lottery

Systematic Random sample:

The sampling interval is computed as the study population size divided by the required sample size.

- The first element is chosen at random from among the first *k* elements, then every *kth* element after that is included in the sample.



Stratified (Random) Sampling

Population is divided in homogenous, mutually exclusive subgroups (stratum/strata) and a sample is selected from each stratum

Stratified by any variable – Gender (male and female), education level (diploma, degree)

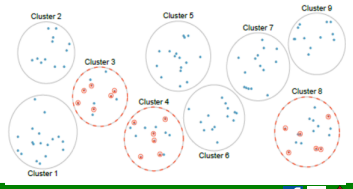
Stratified (Random) Sampling

Cluster sampling

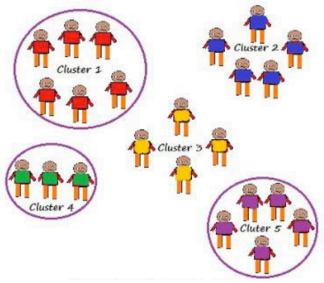
A cluster is a natural or convenient collection of elements with one or more characteristics in common.

- To reduce the cost of sampling a **population scattered** over a large geographic area

Divides the group into groups or clusters



Single Stage Cluster Sampling: In single stage cluster sampling, all the elements of a cluster are selected as a sample.



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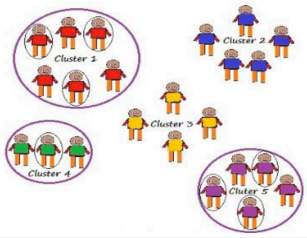
In two stage cluster sampling, first, random selection of some clusters from the given population is performed, then some **elements** from each cluster are randomly selected.



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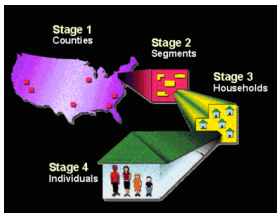
Multistage sampling:

- If you want to ensure that all subjects in the population have the same probability of being selected then a **probability proportional to their size** must be used



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Non - Probability sampling

Samples are gathered in a process that does not give all individuals in the population equal chances of being selected

Non-Probability Sampling Tech.

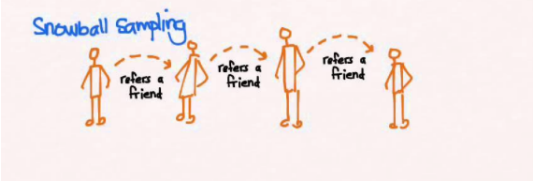
- Judgmental sampling
- Quota sampling
- Convenience sampling
- Snowball sampling

Judgment sample: This type of sample is chosen because, in the judgment of the investigator, it is 'representative' of the target population

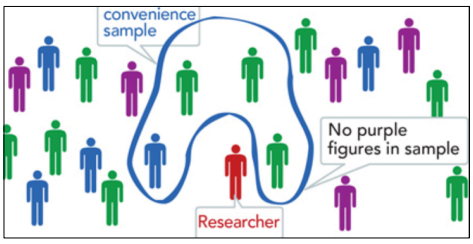
They have particular traits the researcher is interested in

- Pick students who are handsome or beautiful
- Students how have long hair
- Children who have a gap in their teeth

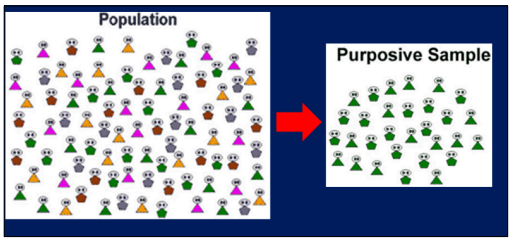
Referral or Snowball Sampling: This sampling strategy is based on **referrals** to subjects of interest.

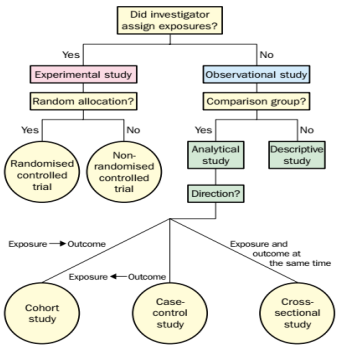


Convenience sample: A convenience sample is chosen because it is easy to obtain. Eg. including your friends in a study



A **purposive sample:** Selected based on **characteristics** of a population and the **objective** of the study.



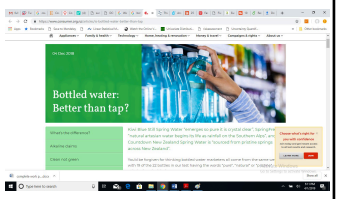


Hypothesis and Hypothesis Testing

Hypothesis

Hypothesis:

An assertion or conjecture concerning one or more populations



Hypothesis is the testable answer to a scientific question

is a test of a claim or an assumption

To prove that an assertion is true, we would need knowledge; we would have to examine the entire population.

Instead, hypothesis testing concerns how we can use a random sample to judge if it is evidence that supports the hypothesis or not.

The general idea of hypothesis testing involves:

1. Making an initial assumption
2. Collecting evidence (data)
3. Hypothesis Testing
   - *Deciding whether to reject or not reject the initial assumption*

Nature of Hypothesis

- It can be tested – verifiable or falsifiable
- It is a prediction of consequences
- It is neither too specific nor too general
- It is considered valuable even if proven false.

Hypothesis

1. Making an initial assumption

a. Based on two competing hypotheses
- Null hypothesis (H_o/HN)
- Alternative hypothesis (H_1 or H_A)

b. In statistics, we always **assume the null hypothesis** is true until proven otherwise empirically.

That is, the null hypothesis is always our initial assumption

Null vs Alternative hypothesis

- **Null Hypothesis: Ho or HN**
  - Represents a theory that has been put forward because it is believed to be true or because it is to be used as the basis for argument, but has not been proved.
- **Alternative Hypothesis: H1 or HA**
  - A statement of what a hypothesis test is set up to established.
  - Opposite of the null hypothesis
  - It is the actual **desired conclusion of the researcher**.

Null vs Alternative hypothesis

null hypothesis • no difference between phenomena	$(H_0)\ x = y$
alternate hypothesis • is difference between phenomena	$(H_{A1})\ x \neq y$ $(H_{A2})\ x > y$ $(H_{A3})\ x < y$

E.g., a clinical trial of a new drug

- H0: there is no difference between the drugs on average.
- HA1: the two drugs have different effects, on average.
- HA2: the new drug is better than the current drug, on average.
- HA3: the new is less effective than the current drug, on average.

Hypothesis testing

The hypothesis we want to test is if H_1 is "likely" true

Two possible outcomes:

- Reject H_o and accept H_1 because of sufficient evidence in the sample in favor of H_1
- Do not reject H_o because of insufficient evidence to support H_1

Very important!!

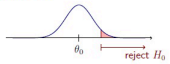
Note that failure to reject H_0 does not mean the null hypothesis is true. There is no formal outcome that says "accept H_0." It only means that we do not have sufficient evidence to support H_1.

Types of Hypothesis Testing

One tail

- H_0: $\theta = \theta_0$
- H_1: $\theta > \theta_0$.

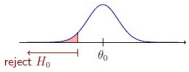
This is a one-tailed test with the critical region in the right-tail of the test statistic X.



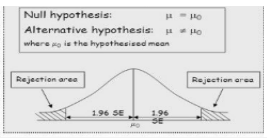
Another one-tailed test could have the form,

- H_0: $\theta = \theta_0$
- H_1: $\theta < \theta_0$,

in which the critical region is in the left-tail.



Two tail



Hypothesis Testing (p-value approach)

- In statistics, we always make one of two decisions. We either "reject the null hypothesis" or we "fail to reject the null hypothesis."
- Testing is done at a level of significance, which is based on a probability.
- The P-value approach involves determining "likely" or "unlikely" by determining the probability — assuming the null hypothesis were true
- If the ***P-value is less than (or equal to) α, then the null hypothesis is rejected in favor of the alternative hypothesis***. And, if ***the P-value is greater than α, then the null hypothesis is not rejected.***

Types of Errors

Because we are making a decision based on a finite sample, there is a possibility that we will make mistakes.
The possible outcomes are:

	H_0 is true	H_1 is true
Do not reject H_0	Correct decision	Type II error
Reject H_0	Type I error	Correct decision

	Truth	
Jury Decision	Not Guilty	Guilty
Not Guilty	OK	**ERROR**
Guilty	**ERROR**	OK

	Truth	
Decision	Null Hypothesis	Alternative Hypothesis
Do not reject null	OK	**Type II ERROR**
Reject null	**Type I ERROR**	OK

Type I error: The null hypothesis is rejected when it is true.

Type II error: The null hypothesis is not rejected when it is false.

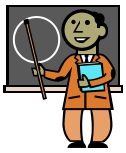
Quote of the Day

"Take advantage of every opportunity to practice your communication skills so that when important occasions arise, you will have the gift, the style, the sharpness, the clarity, and the emotions to affect other people."

-Jim Rohn

Kwame Nkrumah University of Science & Technology, Kumasi, Ghana

SCIENTIFIC COMMUNICATION AND WRITING



Intended Learning Objectives

By the end of this session, students will be able to:

- ✓Understand the need for scientific communication
- ✓Know how to effectively achieve the 3 P's of science
- ✓Present research information in the scientific world
- ✓Present research information in a publishable way
- ✓Know the basics of scientific writing and some rules to follow
- ✓Transfer research information to implement changes in field of study

Recall…

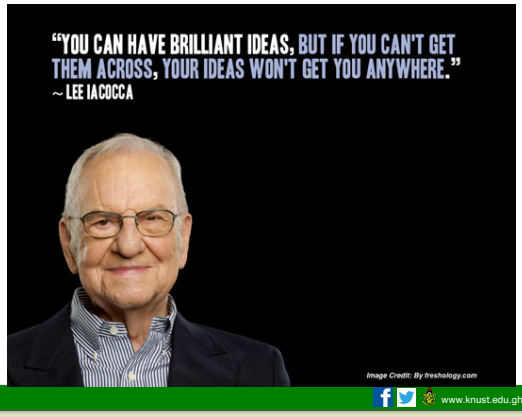
- The aim of research is to contribute to knowledge
  - add new results to the previous state of knowledge
  - form a basis for new thinking and interpretation
- Research results do not contribute to knowledge and development
  - **–unless they are communicated effectively**
- Effective communication of science is
  - – very important component of research process

Why Communication in Science?

- Important part of being a scientist because;
  - Promote
  - Publicize
  - Popularize

Researchers and Conference Presentation

- Visibility
- Reputation development
- Powerful networking tools, for sharing knowledge and skills
- Clarify your thoughts
- Professional way to get ideas
- Puts your research into a more in-depth and wider context



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Oral Communication

We may not be experts at public speaking...

…But we are all experts at listening to talks

"We rule the world by our words"
-Napoleon Banoparte

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How to prepare, structure and deliver a good talk

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Before you begin

Planning the Presentation

- An effective presentation begins with focused thinking
- You should think about the
  - Objective
  - Audience
  - Context

Define your objective

- Your objective should drive the development of your presentation
- What is the purpose of this presentation?
- What do I want my audience to do as a result?

Know your audience

- The better you **understand your listeners**, the more intentional you can **customize your presentation**
  - Is it controversial, familiar or new to this audience?
  - Who are they?
  - What do they need to know about the topic?

Pertinent questions to ask

•Who are you addressing?

•Why is your message important?

•What are your main findings?

•How can you best deliver your message and satisfy the audience's needs?

Understand your presentation's context

- Is it formal or informal?
  - Mannerism, Culture and Ethics
- Is the audience tired or alert?
- Who speaks before or after you?
- Time allocation

Oral Communication

"When a man is asked to make a speech, the first thing he has to decide is what to say"

-Gerald R. Ford

- Once you have your objective, deciding what to say to your audience isn't always easy
  - To make it easier, divide the task into 3 stages

Decide what to say

- Stage 1
  - Define the key message
  - What do you want people to remember?
  - What actions do you want them to take?
- Stage 2
  - Identify the arguments that support your message
  - Avoid excessive detail
- Stage 3
  - When is it important to get audience participation or reaction?

How to Structure a Good talk

- Be smart and familiarize with your PowerPoint
- Introductions: start broad, then get specific
- Think of your talk as consisting of episodes
- Use a home slide to make transitions effectively
- Conclusions: start with specifics, end broadly

Preparing for the presentation

Organize your presentation

- An opening
- A need or problem statement
- A solution
- A call to action

The Opening

- Good organization begins with a compelling opening
- Use a hook to get the audience attention
  - Comment
  - Question
  - Relevant
  - Statement or Quote
  - Example

The opening

- Outline the purpose of the presentation
- Describe the importance of the topic for the audience
- Preview the main points to be covered

The Need or Problem Statement

- Make it clear why the audience should care about your message
- Develop a clear need or problem that you and your audience will solve together

The Solution

- Help the audience visualize the benefits of the solution
- Phrase your solution in terms of the audience's need
- Make sure the urgency of your solution matches the need

Call to action

- Reiterate the presentation's key message
- Integrate your opening points into your closing comments
- Recommend action

Rehearse

"There are always three speeches, for every one you actually gave. The **one you practiced**, **the one you gave** and **the one you wish you gave**"

~ Dale Carnegie

Effective rehearsing

- Rehearse with equipment and visuals
- Rehearse the entire presentation
- Rehearse in front of friends or colleagues
- Concentrate on the subject not your notes

"The person being coached is not lacking, they simply need someone to tap on their microphone and turn up the volume so they can hear their own sound"

- Suzette Hinton

Visual Aids in Presentation

- Visual aids are an audio-visual communication process
- Examples; Short video clips, pictures, demonstrations, models and PowerPoints
  - a powerful tool to employ
  - Complement the presenter's voice or message

How PowerPoint can enhance your presentation?

Tips for creating PowerPoint slides

- Keep it simple
- Limit bullet points and text
- Limit transitions and animations
- Have a visual theme but avoid using PowerPoint templates

Tips for Effective PowerPoint

- Use contrasting colour schemes (design templates)

These colours contrast

These colours contrast

These colours don't contrast

These colours don't contrast

These colours contrast (harder to read?)

These colours contrast (harder to read?)

Tips for creating PowerPoint slides

- Use high quality images

Some Final Words

When Presenting

- Speak loudly and clearly
  - Learn how to pitch
- Direct your words to all aspects of the room
- Maintain eye contact with your audience
- Ask questions of your audience but not too many
  - (if applicable)
- Do not read the slides word-for-word, use them for reference

When Presenting

- Show good mannerism
- Learn how to use the pointer
- Practice your presentation before a neutral audience
  - Ask for feedback
- Be particular about the time allotted for presentation
- Leave time for questions

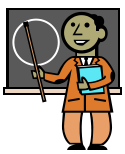
Remember

- Simplicity is the ultimate

sophistication…

-Leonardo Da Vinci

SECTION VIII: SCIENTIFIC COMMUNICATION AND WRITING



The ABC of Science Communication

•It should be

- ✓ **A**ccurate and **A**udience-adapted
- ✓ **B**rief
- ✓ **C**lear

Modes of Scientific Communication

- Written
  - Journals
  - Short communication
  - Monographs
  - Training manuals
  - Technical reports
  - Conference papers
  - Grants/proposals
  - Books
- Oral
  - Oral presentations
  - Poster presentation
  - Lecture
- Visual
  - Poster session
  - Lecture

Important Notes

- Various forms of communication have a great deal in common
  - but they differ in **purpose and audience addressed**
- Science is international
  - many of those who read or listen to a scientific presentation will be doing so in a foreign language (English)
- Science is universal

Written communication

Writing should;

- be clear
- be logical
- be factual
- use correct grammar
- use correct sentence structure
- avoid (rampant) speculation

Definitions

- *Scientific journal-* is a periodical publication intended to further the progress of *science*, by reporting new research findings specialized for different academic disciplines or sub-disciplines
- *Scientific book-* is a work of non-fiction written for a wider audience presumed to have a general education, thus authors sufficiently explain difficult topics to people who may be totally new to the subject
- *Short communication-* is for a concise, but independent and original report representing a significant contribution to science
- *Monograph-* an established body of work or writing pertaining to a specific subject. Usually written by qualified scholars having expertise in a particular subject for serious readers having interest in the same subject

Definitions

- *Scientific paper-* is a written report describing original research results
- *Technical reports-* a document that records the procedure adopted and results obtained from a scientific or technical activity or investigation
- *Training manuals-* a book or booklet of instructions, designed to improve the quality of a performed task
- *Conference papers-* refer to articles that are written with the goal of being accepted to a conference, with the aim of presenting results to the community, usually as an oral presentation, a poster presentation, or a tabled discussion
  - typically published in collections called "proceedings"

Planning

Before writing a paper, PLAN!

How do I communicate my research to my target audience?

- Decide on short or more detailed paper
- Decide on your readership
  - Based on the data you have
- Decide on the best mode of communication
- Obtain the authors guidelines and study carefully
- Assess whether work is ready for submission

Planning

- Writing can start before research is even undertaken, due to structure of research papers
  - –Enables timely publication
  - –Task made easier now with WORD processing
- Consider both the practical research and the paper together (Sketch)
- Literature search saves time in planning and avoids repetition
- Writing is part of the investigation, not an unwelcome task to be taken at end

Note!!

•Keep records in notebook, not scraps of paper

•Every note must be dated and time of observation where relevant indicated

•Make duplicate copies of notes

Tips when doing Project Work

- Write an account of observations and experiments as project proceeds
  - think of report as part of investigation
- Use writing and drawing as aids to observation and description
- Share write-ups with colleagues for advice (internal peer review process)

Sections of a Scientific Paper

Title
Authors/affiliations
Abstract/summary
Keywords
Introduction/background
Patients, Materials and Methods
Results
Discussion and Conclusions
Acknowledgements
List of abbreviations
Conflict of interest
Authors contribution
References
Figures and Tables

Title page

- Title
- List of authors
- Affiliations
- Corresponding author
- Key words
- Word count (abstract and main text)

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High prevalence of common respiratory viruses and no evidence of Middle East Respiratory Syndrome Coronavirus in Hajj pilgrims returning to Ghana, 2013

Augustina Annan[1], Michael Owusu[1], Kwadwo Sarfo Marfo[1], Richard Larbi[1], Francisca Naana Sarpong[1], Yaw Adu-Sarkodie[2], Joseph Amankwa[3], Samuel Fiafemetsi[4], Christian Drosten[5,6], Ellis Owusu-Dabo[1] and Isabella Eckerle[5]

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Abstract OBJECTIVE The Middle East respiratory syndrome coronavirus (MERS-CoV) emerged in 2012 on the Arabian Peninsula and has caused severe respiratory disease with more than 800 laboratory-confirmed cases. The return of infected pilgrims to their home countries with a putative spread of MERS-CoV necessitates further surveillance.
METHODS A cross sectional study of 839 adult African Hajj pilgrims returning to Accra in Ghana, West Africa, was conducted in 2013 to assess the prevalence of respiratory symptoms as well as of MERS-CoV, human rhinovirus (HRV), respiratory syncytial virus (RSV) and influenza A virus (FLU A) infection

Sections of a Scientific Paper

Standard format of a Technical Paper;

- Title (Title page)
- Abstract
- Introduction
- Materials and Methods
- Results & Discussion
- Conclusion
- References

Title

- It should be
  - Attractive/ catchy/ **label of the paper**
  - Informative
  - Memorable
  - accessible
  - specific and concise
  - relevant to the content of the work
- Use technical terms which are familiar to most readers
- **Do not use abbreviations in title**

Abstract

- Brief summary of major points of the research in a clear and understandable form
  - objective
  - approach
  - main results
  - few sentences to emphasize important conclusions
- Normally written in the past tense,
  - but sometimes the present tense is used
- At the end of the abstract,
  - list key words that best describe your research (optional)

Introduction

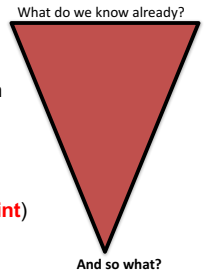
- It provides information on
  - the background of study
  - the rationale for the study
  - clear objective(s) and approach to the work
- Should persuade the reader to know
  - the importance of the topic
  - the objective of the research
- Should orient the reader by summarizing briefly the relevant literature (background)

Introduction

Convince readers that you clearly know your work is **useful**!

1. Broad information on topic
   Previous research
2. Narrower background information
   Need for study
3. Focus of paper
   Hypothesis
4. Summary of problem (**selling point**)

Overall 300-500 words



Materials and Methods

- Provides a clear and complete description for all
  - experimental
  - analytical
  - statistical procedures
- Should be logical or chronological
  - **use specific, informative language**
- Must contain enough information
  - to enable repetition of procedures in order to obtain similar results

Critical questions

- **Who** is to be studied (study population/sampling)
- **What data** are you going to collect (data collection)
- **How** are these data going to be analyzed (analysis)

Lab Techniques/Procedures

- Avoid too much or too little information
- Completely new technique (describe)
- Already published or known technique (cite reference)
- Modified technique (describe the modification)

Avoid acronyms if not necessary especially if it never occurs again in text.

Results

- Text
- Graphic material-figures and tables
- Written in the past tense
- Objective presentation of experiment results
- Summary of data
- Avoid duplication!
- Make sure %ages add up!
- Generally, no references

NOT a Discussion!

Show us don't tell us!

Rather than telling the reader that a result is interesting or significant, **show** them how it is interesting or significant

*Our study revealed a **significant** increase in the occurrence of IL10 in the study participants*

*Our study revealed a **significant** increase in the occurrence of IL10 in the study participants (p=0.0024)*

Discussion

- **Shows how good you reviewed literature!**
- Should interpret the results
  - clearly
  - concisely
  - logically
- Describe how your results relate to achieving objectives
- Cite evidence from literature that supports or contradicts your results and explain

Interpretation of results

- Did the study confirm/deny the hypothesis?
- If not, did the results provide an alternative hypothesis? What interpretation can be made?
- Do results agree with other research? Sources of error/anomalous data?
- Implications of the study for field
- Suggestions for improvement and future research?
- Relate to previous research

Conclusions or Implications

- Summarizes the main results of the research
  - Describes what they mean
- Should be based on your objectives

NOTE: This is not the place to mention new results for the first time

Characteristics of a good conclusion

- Relates to why the study was carried out
- Tells reader what the study found that was not known
- Does not introduce new information
- Precision with minimum detail
- Highlights practical use of research
- Has suggestions for future study

Acknowledgement….

- Duly acknowledge
- Don't overdo it!
- All contributors who do not meet the criteria for authorship should be listed in an acknowledgments section
  - who provided purely technical help
  - writing assistance
  - department chair who provided only general support
  - Financial and material support

References

Citations of published literatures should follow the instructions set by the journal (institution) where the write-up is to be published

- Stick to journal's style
- Try to use peer reviewed articles

Appendix

- Provides readers with supplementary material
  - may not be essential to the understanding of the paper but may be helpful
- Such materials may include
  - numerical examples
  - questionnaires
  - extensive details of analytical procedures
  - novel computer programs

Visuals

- Are used to
  - find relationships
  - emphasize material
  - present material more compactly and with less repetition
- Tables and figures
  - help make numbers meaningful and
  - convey information to the reader
- The number of tables, charts or graphs depends on
  - the amount of information you have
  - the purpose of presenting that information

Selecting the form to display

- Table
  - when exact values are important
- Graph
  - when trends or relationships more meaningful than exact values
- Distribution map
  - essential when location of data points is more important than actual values

Selecting the form to display

- Flow chart
  - when processes
  - sequences
  - Systems

  need to be presented in an organized fashion

Tables

- Generally used when exact values are important
- To allow the reader to focus on specific numbers
- The title of the table should be descriptive enough to stand alone
- Tables must be legible
- Do not 'crowd' it with too much information