RESEARCH METHOD CHAPTER 2

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THE TOOLS OF RESEARCH

- Tools are chosen to facilitate research tasks
- Some researchers need special tools indigenous to particular discipline
- The concern here is with the general tools of research that the majority of researchers, regardless of discipline and situation, typically need to derive meaningful and insightful conclusions from the data they collect
- Be careful not to equate *tools* of research with the *methodology* of research
- Phrases such as “library research”, “statistical research” suggest basic confusion

THE TOOLS OF RESEARCH

- They suggest a failure to understand the nature of formal research, as well as a failure to differentiate between tool and method
- The library is merely a place for locating or discovering certain data that will be analysed and interpreted later in the research process
- Likewise, statistics merely provide ways to summarise and analyse data, thereby allowing us to see their nature more clearly

THE TOOLS OF RESEARCH

- ***Research tool*** = specific mechanism or strategy the researcher uses to collect, manipulate, or interpret data.
- ***Research methodology*** = general approach the researcher takes in carrying out the research project; to some extent, this approach dictates the particular tools the researcher selects.

THE TOOLS OF RESEARCH

- Statistics is always ancillary to basic research
- However to insist the use of statistics will deny valid research in non-quantitative investigation

THE TOOLS OF RESEARCH

There are six general tools of research:

1. The library and its resources
2. The computer and its software
3. Techniques of measurement
4. Statistics
5. The human mind
6. Language

1. The Library and Its Resources

- Scholar should know its principal resources and understand its classification system, and find the shortest route to the information it contains.
- *You learn the library by using the library*
- Libraries have manual
- Learn where the various holdings are located
- Catalogue is the heart of the library – books , films, filmstrip, tapes, phonograph records, microfilm, maps, pictures, slides, CDs, …

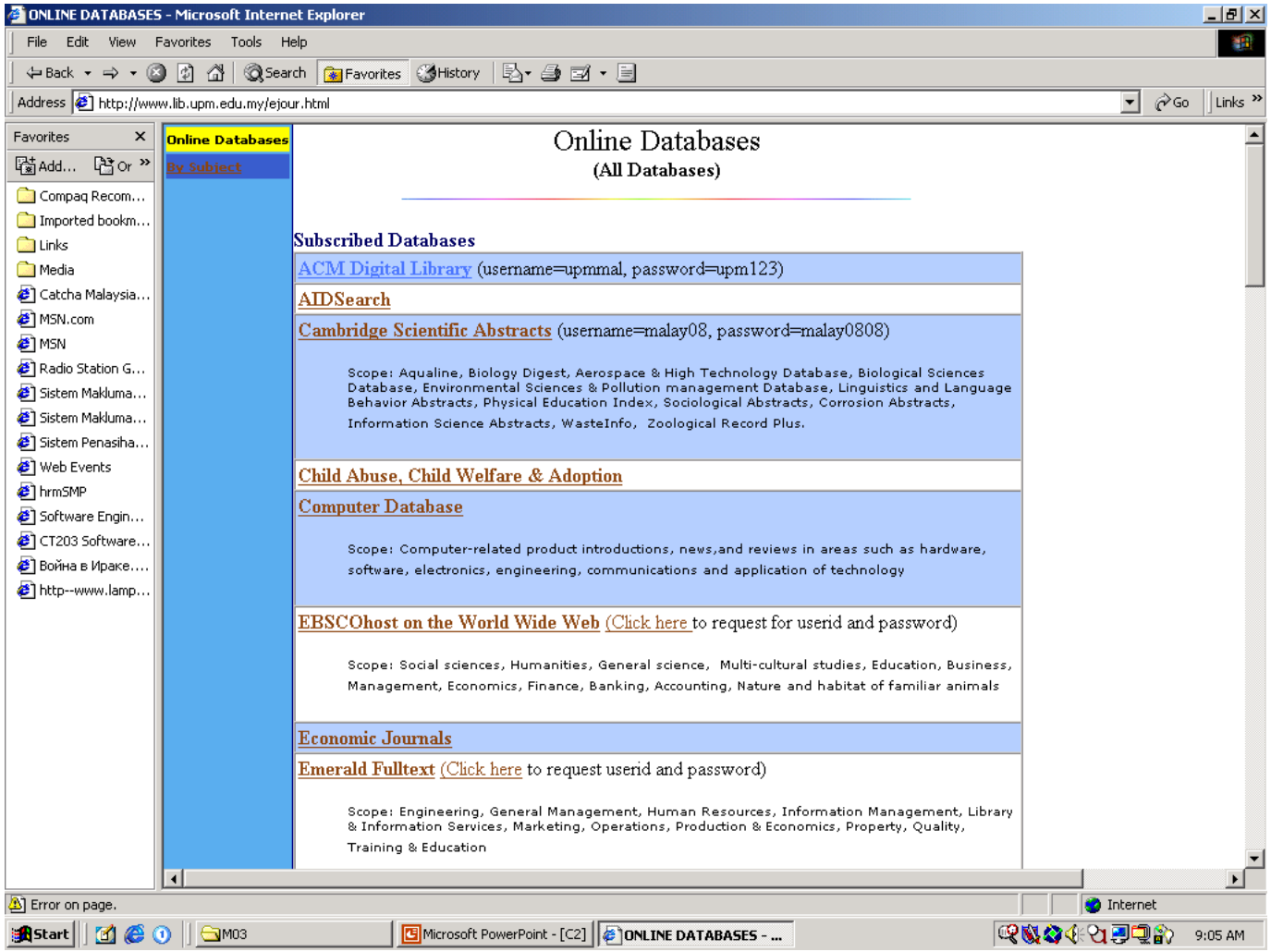
The Treasury of Knowledge

- Many student researchers died a pauper but lived in a house in which a treasure was hidden
- Usual approach is to overwhelm with multitude of titles hoping students will diligently seek out, but usually does not happen
- They need to know where the master keys that will unlock the total resources – locate the relevant in the shortest time

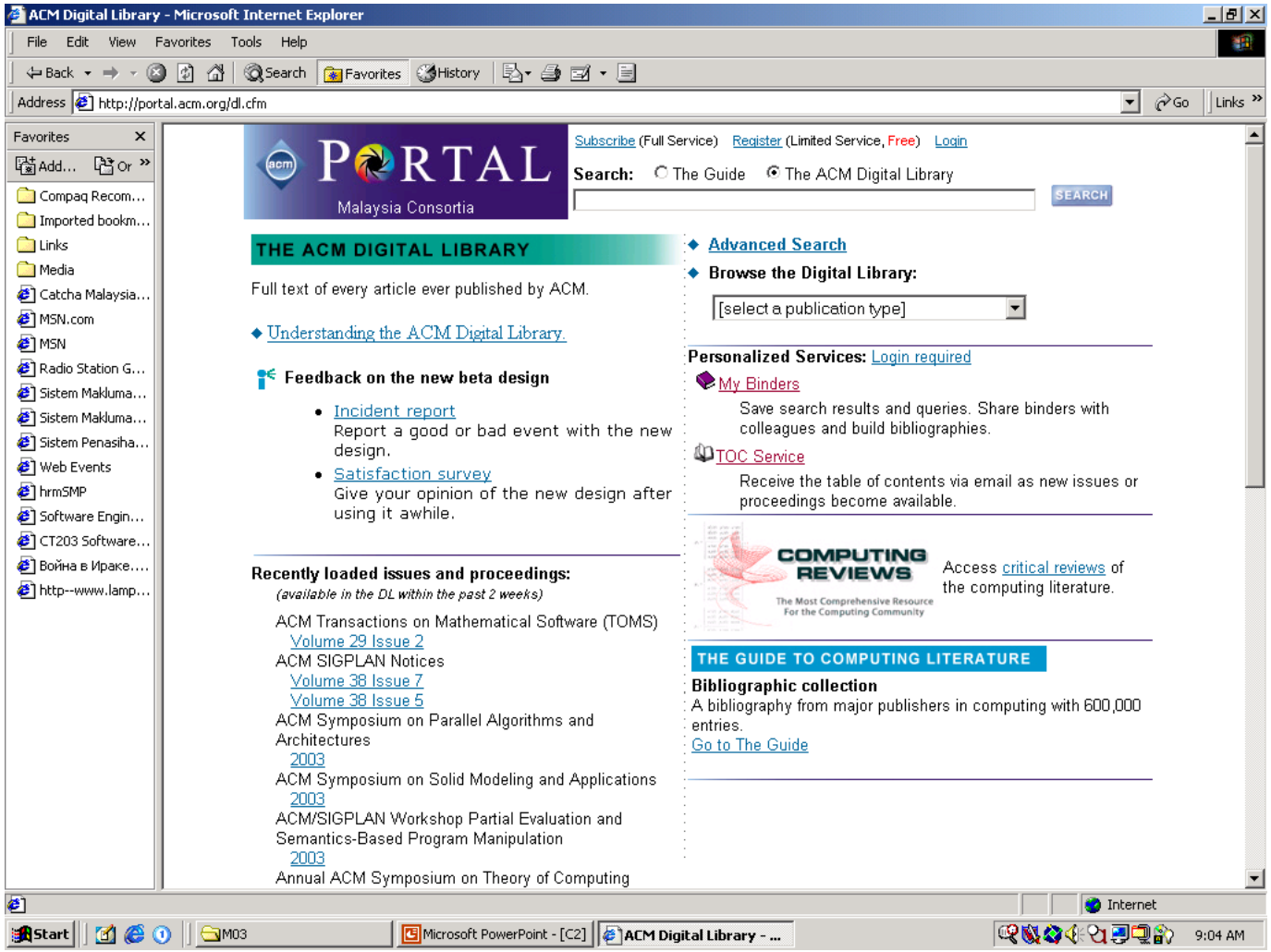
The Treasury of Knowledge

- After selecting research problem, the library is the FIRST place to clarify the dimension of the problem
- Learn what others have done in the area or in corollary investigation
- To receive ideas that help to sharpen the focus of research

Online Database



ACM Digital Library



2. The Computer and its Software – Tool of Research

a. **Taking advantage of the Internet**

The World Wide Web (WWW) is the world of knowledge.

Web browsers: Netscape, IE, etc.

Web site: journals, publishers, organisations, individuals, etc.

Search engine: google, yahoo, Alta Vista, etc.

2. The Computer and its Software – Tool of Research

b. **E-Mail**

Faster and to individual or a group of people.

Asking questions to authors, experts, etc.

Facilitate collaboration among people.

Attached file (reports, etc.)

Free e-mail platforms: yahoo, hotmail, etc.

2. The Computer and its Software – Tool of Research

c. **News**

List servers: E-discussion group.

Many groups with particular interests.

3. Measurement – Tool of Research

- Researchers strive for objectivity: not influenced by own perceptions, impressions, and biases.
- Therefore, must identify systematic way of measuring a phenomenon
- Old adage – if it exists, then it can be measured
- If it is researchable, then data must be measurable
- Many ways we can measure data
- Read just the way we usually think about measurement
- Measuring data has nothing to do with physical measurement

Quantifying

- Measurement is the ***quantifying*** of any phenomenon, ***substantial*** or ***insubstantial***, ***concrete*** or ***abstract***, and involves the ***comparison*** of the data being measured to a pre-established standard.
- Quantifying mean "*how much*", *how many*", "*to what degree*" you think of the world and its manifestations through the data observed in terms of magnitude and significance.

Quantifying

- Ultimately must result in a mathematical value
- Must distinguish between mathematical and numerical
- Mathematical means “science” or “knowledge”
- Mathematical value = ability of scale to measure the data so that we have more knowledge or understanding of the significance of the data
- Numerical = number, express data in a degree or numerical magnitude

Substantial or Insubstantial

- Things, objects are substantial – Engineer measures the span of a bridge
- Insubstantial – exists as concepts, ideas: opinion on national issues, status of Iran business, evaluation of quality
- Measured by opinion survey, KLSE index, IQ tests, questionnaires, or interviews

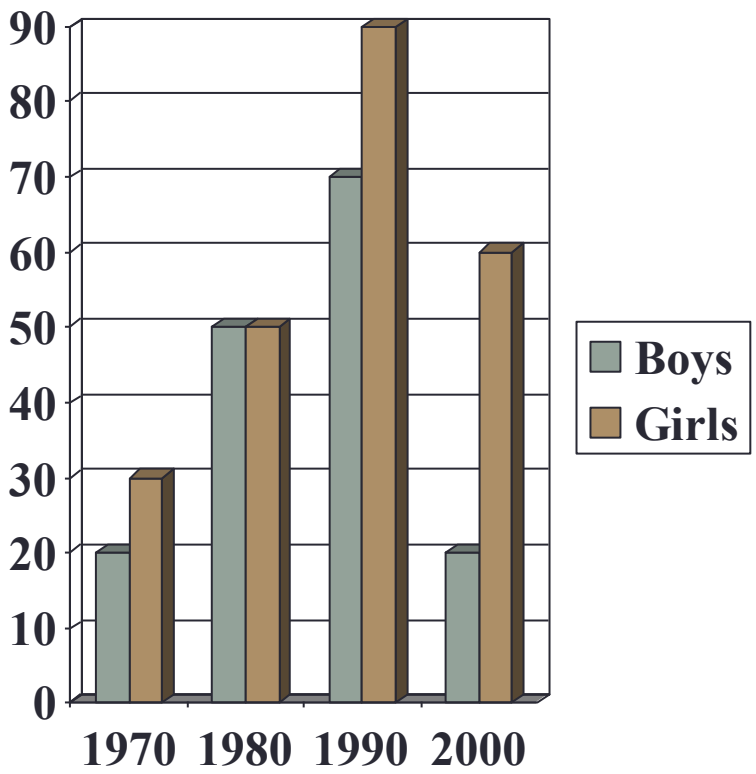
Scales of Measurement

- In 1946, Stevens suggested a hierarchy of levels of measurement, widely adopted by statisticians and researchers as means of classifying data
- Four types of measurements, *nominal, ordinal, interval*, and *ratio*

Nominal

- Nominal means “name” – can measure data by assigning name to data
- Can measure a group of children by dividing into two groups – boys and girls
- A *categorical* variable, also called a *nominal* variable, is for mutual exclusive, but not ordered, categories. For example, your study might compare five different genotypes. You can code the five genotypes with numbers if you want, but the order is arbitrary and any calculations (for example, computing an average) would be meaningless.
- We can say boys group is *larger* than girls
- Can also divide the children according to their home address
- It is elemental and unrefined, but it divides the data into discrete categories that can then be compared with each other
- It is common

Nominal

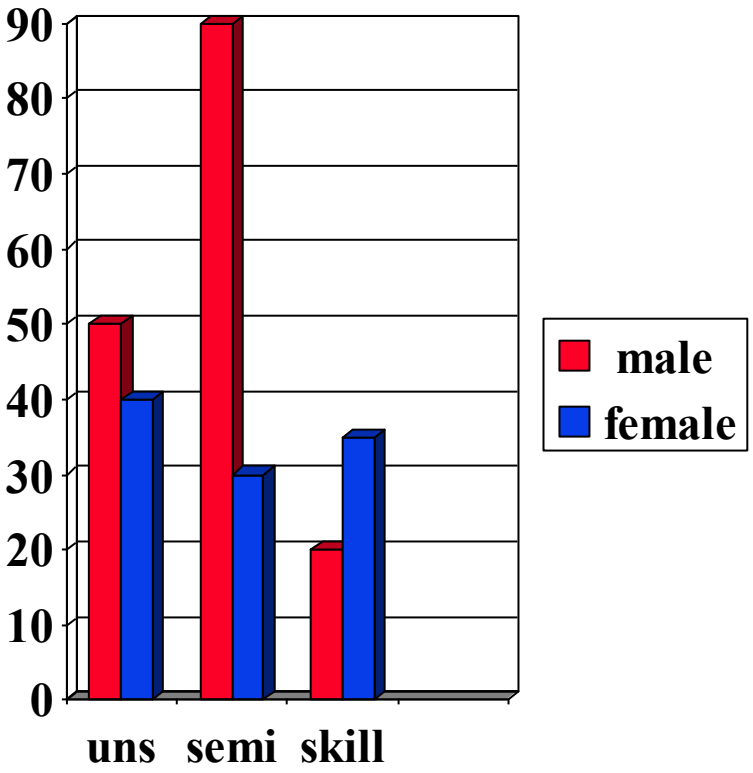


- Can be represented by graphic and statistical devices
- Bar graph – for comparative measurement
- Can locate mode, finding percentage of relationship one subgroup to another, chi square

Ordinal

- Think of the quantity being measured in terms of the symbol < and >, higher or lower, greater or lesser, younger or older
- Always an asymmetrical relationship
- Level of education grossly on ordinal, unschooled, primary, secondary, college, graduate
- Work force, unskilled, semi-skilled, skilled

Ordinal



- A *ordinal* variable, is one where the order matters but not the difference between values. For example, you might ask patients to express the amount of pain they are feeling on a scale of 1 to 10. A score of 7 means more pain that a score of 5, and that is more than a score of 3. But the difference between the 7 and the 5 may not be the same as that between 5 and 3. The values simply express an order. Another example would be movie ratings, from * to *****.
- Expand range of statistical techniques
- Mode, median, percentile rank, test by chi square, indicate relationship, rank correlation

Interval

- A *interval* variable is a measurement where the difference between two values is meaningful. The difference between a temperature of 100 degrees and 90 degrees is the same difference as between 90 degrees and 80 degrees.
- Two features : 1) equal units of measurement ; 2) zero point established arbitrarily
- Most familiar of interval scale is the thermometer
- What is the freezing point and the boiling point for Celsius and Fahrenheit?? 0 (100) and 32 (212)
- Common use is the *rating scale* - 5 point measurement of academic teaching effectiveness
- Can determine mode, mean, std deviation, t-test, F-test, product moment correlation

Ratio

- A *ratio* variable, has all the properties of an interval variable, and also has a clear definition of 0.0. When the variable equals 0.0, there is none of that variable. Variables like height, weight, enzyme activity are ratio variables. Temperature, expressed in F or C, is not a ratio variable. A temperature of 0.0 on either of those scales does not mean 'no temperature'. However, temperature in Kelvin is a ratio variable, as 0.0 Kelvin really does mean 'no temperature'. Another counter example is pH. It is not a ratio variable, as pH=0 just means 1 molar of H+. and the definition of molar is fairly arbitrary. A pH of 0.0 does not mean 'no acidity' (quite the opposite!). When working with ratio variables, but not interval variables, you can look at the ratio of two measurements. A weight of 4 grams is twice a weight of 2 grams, because weight is a ratio variable. A temperature of 100 degrees C is not twice as hot as 50 degrees C, because temperature C is not a ratio variable. A pH of 3 is not twice as acidic as a pH of 6, because pH is not a ratio variable.
- A scale that measures in terms of equal intervals and absolute zero point of origin
- Difference between interval and ratio: thermometer, we cannot say 80^{o}F is twice as warm as 40^{o}F, because it does not originate from point of absolute zero. If it is, then we cannot measure temperature below zero

Ratio

- True *zero* as “the total absence of the quantity being measured”, cannot measure minus distance
- Can be used for determining the geometric mean, the harmonic mean, the percent variation and all other inferential statistical analysis

Measurement Summary

OK to compute....	Nominal	Ordinal	Interval	Ratio
frequency distribution.	Yes	Yes	Yes	Yes
median and percentiles.	No	Yes	Yes	Yes
add or subtract.	No	No	Yes	Yes
mean, standard deviation, standard error of the mean.	No	No	Yes	Yes
ratio, or coefficient of variation.	No	No	No	Yes

Measurement Summary

- If you can say that:
- one object is different from another, you have a *nominal* scale
- One object is bigger or better or more of anything than another, you have an *ordinal* scale
- One object is so many units (degrees, inches) more than another, you have an *interval* scale
- One object is so many times as big or bright or tall or heavy as another, you have a *ratio* scale

Validity and Reliability

- Two very important considerations
- Validity is concerned with the soundness, the effectiveness of the measurement instrument
- Example, a standardize test, what does the test measure? Does it, in fact, measure what it is supposed to measure? How well, how comprehensively, how accurately does it measure?
- Scale that measure professor's availability, "always available" – what does "always" mean?

Types of Validity

- 1) Face validity – relies on subjective judgement – must answer two questions. i) Is the instrument measuring what it is supposed to measure? ii) Is the sample being measured adequate?
- 2) Criterion validity – employs two measures; the second as criterion (reliable and valid), check against the accuracy of the first measure
- 3) Content validity – equate to face validity – accuracy with which an instrument measures the factors or situations

Type of Validity

- 4) Construct validity – concept that can be directly observed or isolated, the measuring instrument must be able to discriminate, or differentiate the construct
- 5) Internal validity – the freedom from bias in forming conclusion in view of the data
- 6) External validity – can the conclusion drawn from a sample be generalized to other cases

Validity and Reliability

- Validity looks to the end results – are we really measuring what we think we are measuring?
- Reliability – what accuracy does the measure (test, instrument, inventory, questionnaire) what it is intended to measure?

4. Statistics as a Tool of Research

- All tools are MORE suitable for some purposes than for others.
- Example : screw driver was designed to INSERT and remove screws – BUT people often used it for punching holes, scratch away paints, etc…..misuse……
- So, too, with statistics
- Statistics can be a powerful tool when used correctly (for specific kind of data & research questions)
- BUT can be misleading when applied in other contexts.

4. Statistics as a Tool of Research

- More useful in some academic disciplines than in others.
- REMEMBER, the statistical values obtained are never the end of research nor the final answer to research problem.
- The final question is "What do the data indicate" not what is their numerical configuration.
- Statistics give information about the data BUT a conscientious researcher is not satisfied until the MEANING of this information is revealed.

The Lure of Statistics

- Statistics can be like the voice of a bevy of sirens to the novice researcher
- Subjecting data to statistical routines may hire novice researchers into thinking they had made substantial discovery – only calculated numbers that help in interpretation – CANNOT capture the nuances of the data

The Lure of Statistics

- Researcher must discover the meaning of the data and its relevance to the research problem – Any statistical process is merely ancillary to the central quest.

- Even the most sophisticated statistical procedures can never make amends for poorly conceived research study.

Primary Function of Statistics

1) Describe the data
2) Draw inference from the data

- Descriptive Statistics summarize the general nature of the data, average, variability, closeness of two or more characteristics, etc.

Primary Functions of Statistics

- Inferential Statistics help in making decision about the data: decide whether the differences observed between two groups in an experiment are large enough to be attributed to the experimental intervention rather than to a once-in-a-blue-moon fluke.

- Both involve summarizing data in some ways and create entities that have no counterpart in reality.

- Example : students work 24, 22, 12, and 16 hours per week. The average is 18.5 but NO student work exactly 18.5 hours/week.

Primary Functions of Statistics

- Human being has limited capacity of memory
- Statistics help condense overwhelming body of data into information that mind can comprehend.
- Help researchers “see” patterns and relationships that might otherwise go unnoticed.
- Help the human mind comprehend disparate data as an organized whole.

5. The Human Mind – Tool of Research

- Statistics can tell us the centre, the spread, relationship of data BUT cannot interpret and arrive at a logical conclusion or meaning.
- Only mind can do.
- Mind is the most important tool.
- Nothing equals its powers of comprehension, integrative reasoning and insight.

The Human Mind

- Strategies to make use of the human mind to better understand include :

1. Deductive logic
2. Inductive reasoning
3. Scientific method
4. Critical thinking
5. Collaboration with others

How is Knowledge Discovered?

- Planning begin with an understanding of the manner in which knowledge is discovered – the sole aim of research
- Mankind have devised only THREE ways to seek the unknown
- I. Deductive Logic
- II. Inductive Reasoning
- III. Scientific Method

Deductive Logic

- Up to the Renaissance, most problem solving using deductive logic, methodology identified by Aristotle
- Relied upon logical reasoning and began with a major premise
- Premise is a statement similar to Axiom that seemed to be self-evident and universally accepted truth – Man is mortal, superman and ultraman are not, earth is flat

Deductive Logic

- The terror that gripped Columbus's sailors was a fear supported by deductive logic
- Premise – earth was flat, Reasoning – flat surface would have boundaries (the edges), the ship would come to the edge and would fall off.
- The logic was sound, the reasoning accurate, the conclusion valid
- The whole proposition went wrong because the major premise was incorrect – reasoning began with preconceived idea that seemed to be true

Inductive Reasoning

- Result of an interest in humanism – new approach to unsolved problems
- Emphasis on the world and its phenomena
- New way of thinking known as inductive reasoning, begin with an observation NOT preconceived conclusion
- Seeking truth by looking at the world around them, ask questions and nature responded in the form of observable facts

Inductive Reasoning

- True researcher looks at the facts only, and as a result of observing them only draws conclusions as to what they apparently say
- Never be exactly sure what the fact do indicate
- An inductive thinking process
- Example – group of neurologists, A,B,C, and others sought the answer, How long can a person have a “flat EEG” and still recover

Inductive Reasoning

- They observed actual 3000 cases
- They noted that in all cases where the flat EEG persisted for 24 hours or more, not a single recovery occurred
- All the facts pointed to the same conclusion; it is tragically unlikely that a recovery might take place with those exhibit flat EEG tracing of 24 hours or more
- Of course, cannot rule out the unexplored cases

Origin of Scientific Method

- But fact is fact, those who seek knowledge must translate it into meaning
- When facts are assembled and studied dispassionately, they frequently suggest hitherto (until this time) the undiscovered truth – the scientific method – "the method that searches after knowledge"
- Gained real impetus during 16th century such as Paracelsus, Leonardo, Copernicus, …

Scientific Method

- Truth is sought by
  - Identifying the problem that defines the goal of one's quest
  - Positing a hypothesis that, if confirmed, resolves the problem
  - Gathering data relevant to the hypothesis
  - Analyzing and interpreting the data to see whether they support the hypothesis and resolve the question that initiated the research.

Scientific Method

- Application of the scientific method often involves both deductive and inductive reasoning.
- Researchers may develop a hypothesis either from a theory (deductive logic) or from observations of specific events (inductive reasoning).
- Then, using deductive logic, they make predictions about the patterns they are likely to see in the data *if* the hypothesis is true.
- And often, using inductive reasoning, they generalize from data taken from a sample to describe the characteristics of a larger population.

Critical Thinking

- During LR don’t just accept research findings and theories at face value.
- Scrutinize for faulty assumptions, questionable logic, weaknesses in methodology, inappropriate statistical analyses, and unwarranted conclusions.
- Good researchers engage in critical thinking.
- Involves evaluating information or arguments in terms of their accuracy and worth.

Critical Thinking

- Take a variety of forms, depending on the context.

1. Verbal reasoning – Understanding and evaluating the persuasive techniques found in oral and written language.
2. Argument analysis – Discriminating between reasons that do and do not support a particular conclusion.
3. Decision making – Identifying and judging several alternatives and selecting the best alternative.
4. Critical analysis of prior research.

Critical Analysis of Prior Research

- Evaluating the value of data and research results in terms of the methods used to obtain them and their potential relevance to particular conclusion.
- Consider these questions

1. Was an appropriate method used to measure a particular outcome?
2. Are the data and results derived from a relatively large number of people, objects, or events?
3. Have other possible explanations or conclusions been eliminated?
4. Can the results obtained in one situation be reasonably generalized to other situations?

Critical Thinking

- Example in Computer Science??

Collaboration with Others

- More heads are better than one.
- A researcher has certain perspectives, assumptions, and theoretical biases – not to mention holes in knowledge about subject matter – that limit research approaches of a project.
- Need to bring colleagues who have perspectives, backgrounds, and areas of expertise somewhat different – more cognitive resources to tackle research problem and how to find meaning.

Collaboration with Others

- Can be equal partners or
- Simply offer suggestions and advice.
- Graduate students themselves are the key players.
- Typically they are assigned an advisor or advisory committee.
- Prudent (careful) student selects committee that will make genuine contribution.

6. Language as a Tool of Research

- Human kind's greatest achievements – facilitate communication and think effectively.
- Can think more clearly and efficiently when can represent thoughts with specific WORDS and PHRASES
- Words, even a simple one, can

1. Reduce world's complexity
2. Facilitate generalization and inference drawing in new situation.
3. Allow abstraction of the environment
4. Enhance the power of thought

The Value of Knowing Two or More Languages

- Not all significant research is reported in English
- Well known researchers and theorists, Jean Piaget and Lev Vygotsky wrote in French and Russian, respectively.
- Many new discoveries are reported in the native language of the researcher.

The Importance of Writing

- All researchers must be able to use language with a degree of skill and accuracy to produce Research Report – clear and coherent
- Clear thinking precedes clear writing – writing can be a productive form of thinking itself – when writing ideas down on paper.

1. Must identify the specific ideas you do and do not know about your topic.
2. MUST clarify and organize thoughts sufficiently to communicate them to your readers.
3. May detect gaps and logical flaws in your thinking.

The Importance of Writing

- Writing about a topic actually enhances the writers understanding of that topic.
- If wait until all thoughts are clear before start writing, you may NEVER begin.
- Begin with a TITLE and PURPOSE statement
- Commit title to paper, keep it in plain sight as you focus your ideas.
- Title can provide focus and direction
- Clear and concise statement, “The purpose of this study is….” you are on your way.

Writing to Communicate

1. *Say what you mean to say* – Precision is of utmost importance – choose words and phrases carefully so that you communicate the exact meaning, not vague approximation – clear, concise, effective sentences and combine these sentences into unified and coherent paragraph.

2. *Keep your primary objective in writing your paper in mind at all times, and focus discussion accordingly* – Novice researchers try to include everything they have learned – everything you say MUST relate directly or indirectly to your research problem.

Writing to Communicate

3. *Provide an overview of what you will be talking about* – Your readers can more effectively read your work when they know what to expect as they read – overview and order, topics relationship.
4. *Organize your ideas into general and more specific categories*. Use headings and subheadings a simple way to make scheme crystal clear.
5. *Provide transitional phrases, sentences, or paragraphs that help your readers follow train of thought* – give signal when change course of discussion.
6. *Use concrete examples to make abstract ideas more understandable.*

Writing to Communicate

7. *Use appropriate punctuation* – help communicate meanings.
8. *Use figures and tables when such mechanisms can more effectively present or organize your ideas and findings.*
9. *At the conclusion of a chapter or major section, summarize what have been said* – things that are the most important.
10. *Anticipate that you will almost certainly have to write multiple drafts* – revise several times – novice or expert.