Introduction to Research in Computing

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Workshop I

January 21, 2008

Sponsored by:

Genius?

- “You don't have to be a genius to do well in graduate school. You must be reasonably intelligent, but after a certain point, I think other traits become more important in determining success.”

  "Everything I wanted to know about C.S. graduate school at the beginning but didn't learn until later." by Ronald T. Azuma, v. 1.08, 2003

Which traits?

- Traits
  - Mental toughness
  - Self-reliance
  - Desire to excel
  - Commitment to scholarship
- The successful graduate student is one who possesses both the intellectual abilities and the necessary personal characteristics.

Traits

- "In sum, graduate work takes initiative, independence, perseverance, acceptance of responsibility, and a general freedom from emotional conflict and anxiety. The benefits of going to graduate school, especially a top-ranked school, are enormous, but they demand a high price in sweat and anxiety...Succeeding in graduate school requires years of single-minded dedication, much energy, individual initiative, and responsible independent study. We wish you well!" (Fretz and Stang, 1980).

Traits

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Do you have those traits?

- Yes
  - Great! You are going to finish in no time.

Do you have those traits?

- Yes
  - Great! You are going to finish in no time.
- No
  - Did you truly believe those who said yes?

Essential Features in Research

- Read scientific literature
- Work independently
- Use of careful and reproducible techniques
- Oral communication
- Written communication
- Meaningful and focused research question
  - Strive to produce a significant finding
- State of the art environment
- Professional meetings

Two aspects

- Technical
  - Understanding scientific method
  - In depth knowledge on the topic
    - Understanding of the issues
  - State of the art
  - Lab skills
- Soft skills
  - Time management abilities
    - Courses vs research
  - Good communication skills
    - Oral
    - Written
  - Problem solving
  - Working under pressure

How do you know things?

- You know
  - The world is round.
  - It is cold on the dark side of the moon.
  - Vitamin C prevents colds.
- How do you know things?
  - At some point everybody knew that the world was “flat”.

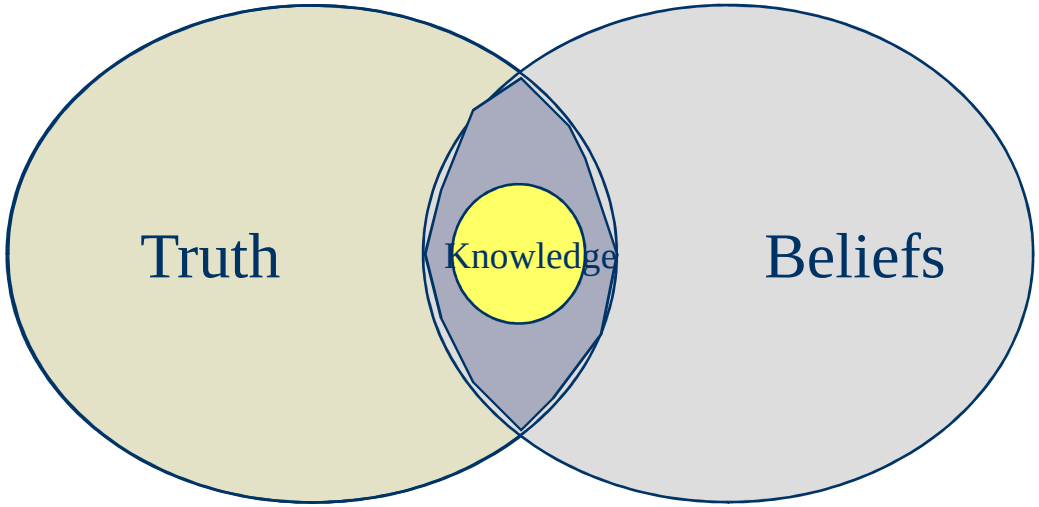
Example

Maguey worm: are two varieties of edible caterpillars that infest maguey and Agave tequilana plants. ….
They are also considered delicious deep fried or braised, seasoned with a spicy sauce and served in a tortilla.

Questions

- Are worms “really”good or bad to eat?
  - How do you know what is really true?
- Looking for reality
  - Tricky business
  - **Epistemology** or **theory of knowledge** is the branch of philosophy that studies the nature, methods, limitations, and validity of knowledge and belief.

Preposition



The four canons of science

- Determinism
  - The universe is orderly
  - All events have meaningful, systematic causes
- Empiricism
  - The best way to find out how the world works is to make observations.
- Parsimony
  - Facing with two competing theories that do an equally good job of handling a set of empirical observations, we should prefer the simpler one.
- Testability
  - Theories can be tested.
    - Confirmable or disconfirmable using current available research techniques.

Pelham & Blanton, 2003

Knowing about the world

- Authority
- Intuition
- Logic
- Observation

How would you know if eating worms is good for you?

How do we find out?

- Scientific Discovery
  - Law
    - Universal statement of the nature of things that allows reliable predictions of future events
  - Theories
    - General statement about the relation of two or more variables
  - Hypotheses
    - Predictions about specific events that are derived from one or more theories.

Hypotheses

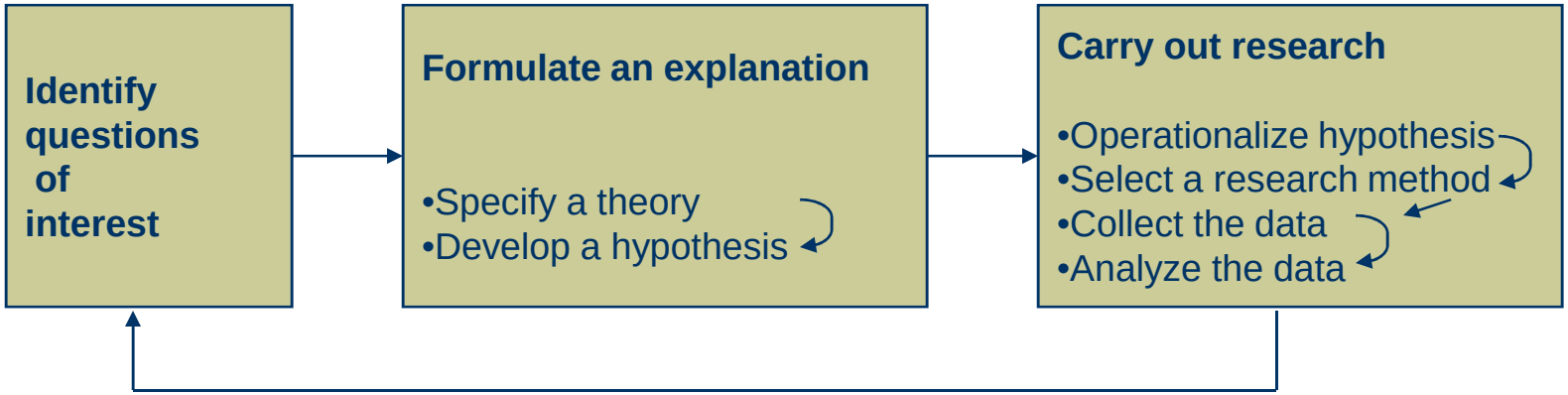
- A prediction, stemming from a theory, stated in a way that allows it to be tested.
  - Help to test the validity of theories
  - Question
    - What is the best way to study for a test?
      - Cramming the night before the exam
      - Study over several nights
  - How are questions answered?
    - Research

Research

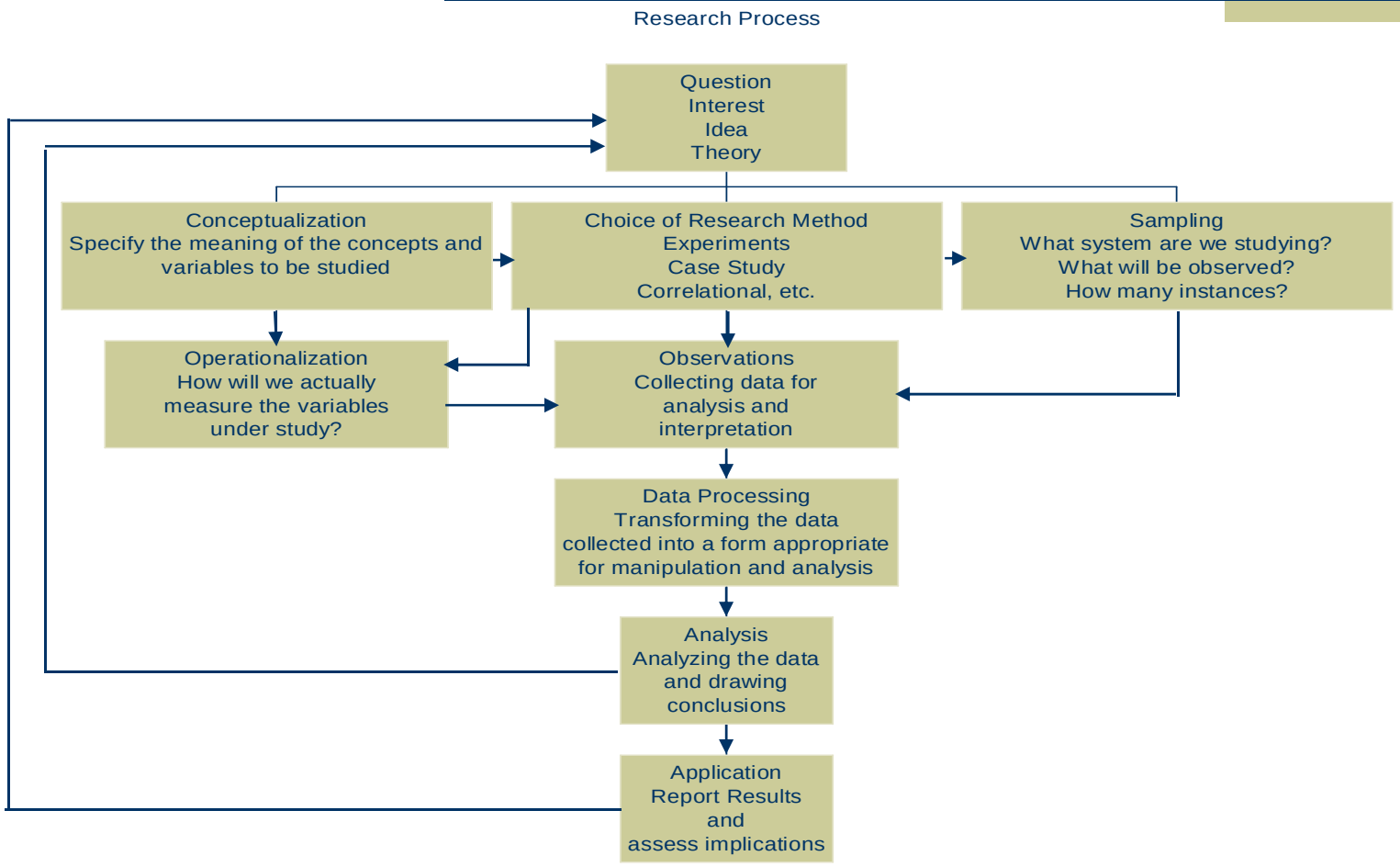
- Systematic inquiry aimed at the discovery of new knowledge.
  - Operationalization
    - The process of translating a hypothesis into specific testable procedures that can be measured and observed.

Scientific Method

- The approach used to systematically acquire knowledge and understanding about the phenomena of interest



The ResearchProcess

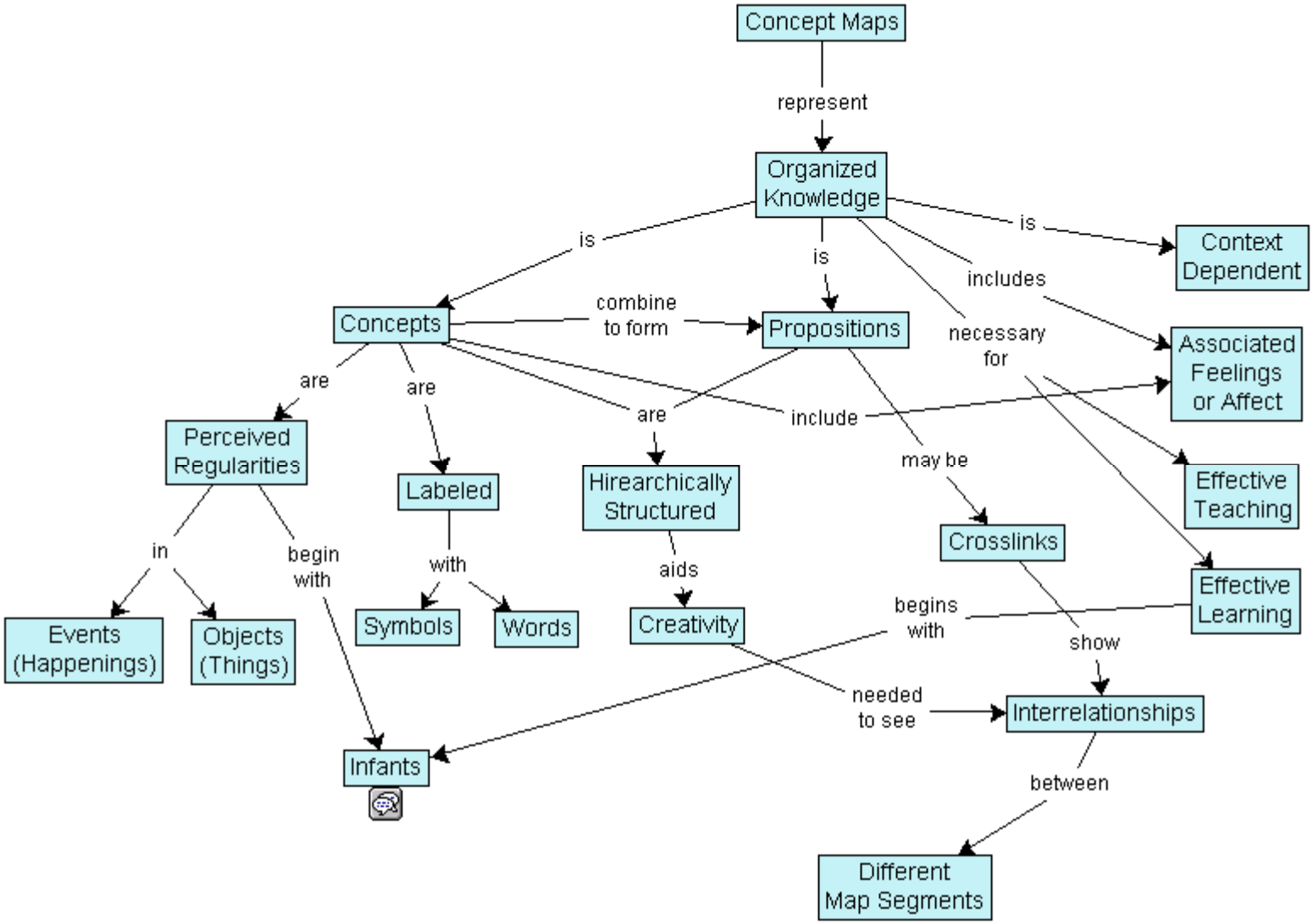


Conceptualization

- A **concept** is an abstract idea or a mental symbol, typically associated with a corresponding representation in and language or symbology, that denotes all of the objects in a given category or class of entities, interactions, phenomena, or relationships between them.
- Conceptualization – the process of coming to an agreement of the meaning of a term
- Creating a conceptual order
  - Cognitive map

Cognitive Map

- Cognitive maps are a method we use to structure and store spatial knowledge, allowing the "mind's eye" to visualize images in order to reduce cognitive load, and enhance recall and learning of information.
  - Cognitive maps can be represented and assessed on paper through a concept map, or any variety of spatial representation.


Concept Maps
represent
Organized Knowledge
is
is
is
includes
Context Dependent
Concepts
combine to form
Propositions
necessary for
Associated Feelings or Affect
are
are
are
include
Perceived Regularities
Labeled
Hirearchically Structured
may be
Effective Teaching
in
begin with
with
aids
Crosslinks
Effective Learning
Events (Happenings)
Objects (Things)
Symbols
Words
Creativity
begins with
show
needed to see
Interrelationships
Infants
between
Different Map Segments

Exercise

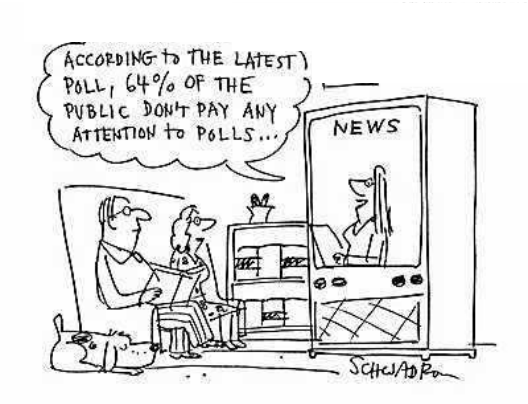
- Take a piece of paper
- Write the title of your research
- Write the question of interest associated to your research
- Draw a concept map or visual map of the concepts associated to your research work

Research Methods in Engineering and Science

- Survey
- Case Study
- Correlational Research
- Experimental Research

Survey Research

- Research in which people chosen to represent a larger population are asked a series of questions about their behavior, thoughts, or attitudes.
  - Infer how a larger group would respond



Case Study

- An in-depth, intensive investigation of an individual or small group of samples or population.
  - Emphasize detailed contextual analysis of a limited number of events or conditions and their relationships
  - Pros
    - Success in carefully planned and crafted studies of real-life situations, issues, and problems
    - Many reports on many disciplines
  - Cons
    - A small number of cases can offer no grounds for establishing reliability or generality of findings
    - Intense exposure to study of the case biases the findings

Case Study Steps

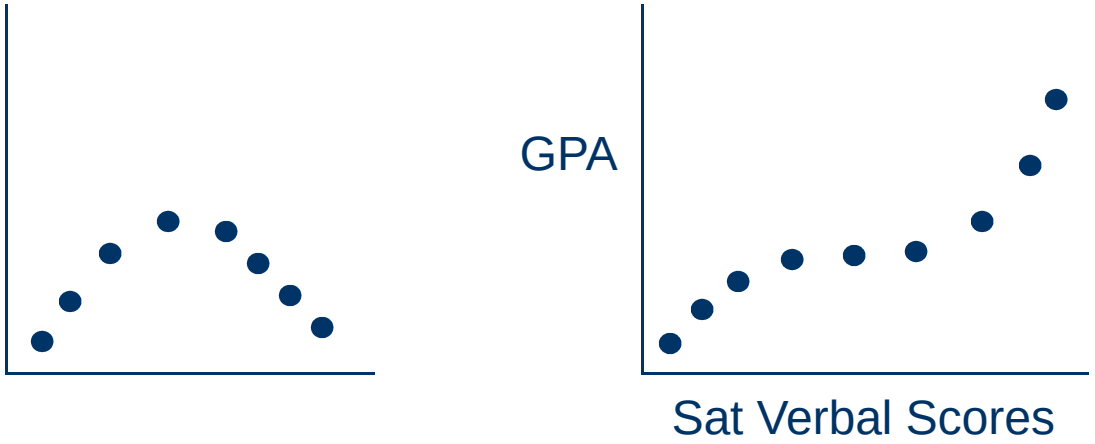
- Determine and define the research questions
  - The researcher establishes the focus of the study by forming questions about the situation or problem to be studied and determining a purpose for the study.
- Select the cases and determine data gathering and analysis techniques
  - Approaches to use in selecting single or multiple real-life cases to examine in depth and which instruments and data gathering approaches to use.
- Prepare to collect the data
  - Systematic organization of the data
  - Prevent the researcher from becoming overwhelmed by the amount of data
  - Prevent the researcher from losing sight of the original research purpose and questions.
- Collect data in the field
  - Collect and store multiple sources of evidence comprehensively and systematically
  - Patterns can be uncovered
- Evaluate and analyze the data
  - Interpretations in order to find linkages between the research object and the outcomes with reference to the original research questions.
- Report results
  - Convey to the reader evidence that all avenues have been explored
  - Establish boundaries

Correlational Research

- Variable: A measurable factor, characteristic, or attribute of an individual or a system.
- Research that examines the relationship between two sets of variables to determine whether they are associated or “correlated”
  - Linear relationship

Correlational Research

- Careful!!!



- Low correlation
- Non linear relationships

Correlational Research

- Non causal
  - More study time ⟶ Good grades
  - Highly correlated
  - Cause?
    - Interest in the subject → More study time?
  - Correlational studies
    - Strength of relation between two variables
    - Does not demonstrate cause-and-effect

Experimental Research

- Experiment: The investigation of the relationship between two or more variables by deliberately producing a change in one variable in a situation and observing the effects of that change on other aspect of the situation.
- Cause-and-effect

Experimental Research

- Experimental manipulation: Change that an experimenter deliberately produces in a situation
- Treatment: the manipulation implemented by experimenter
- Experimental group: any group receiving a treatment in an experiment

Experimental Research

- In an *observational study*, measurements of variables of interest are observed and recorded, without controlling any factor that might influence their values.
  - Political Poll
- An *experiment*, on the other hand, deliberately imposes some treatment on individuals in order to observe their responses.
  - In principle, only experiments can give good evidence for causation.

Experiment example

- *New* communication protocol improves throughput in the network.
- To assess the effect, researchers measure network latency over a period of a week.
- They randomly select the day when the protocol will be used comparing the new versus the old one.
- The same machines will be used in both.
- Same size files will be sent over the network.

Design of Experiments

- Experimental units: individuals on which the experiment is done, also called subjects when the units are human beings.
  - The network
- Treatment: the specific experimental condition applied to the units.
  - protocol
- Factors: the explanatory variables, which often have levels.
  - Old vs new

Principles of Experimental Design

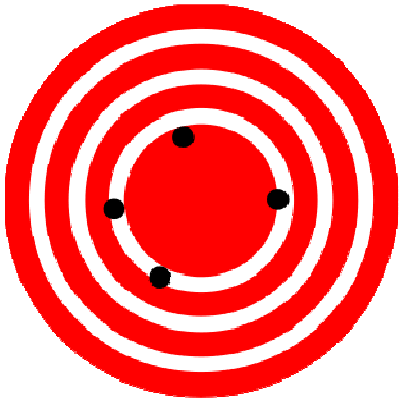
- Control
  - Researcher decides which subjects are assigned to the treatment group
- Randomization
  - Impartial and objective
- Replication
  - Reduces chance variation in the results and can help achieve statistical significance

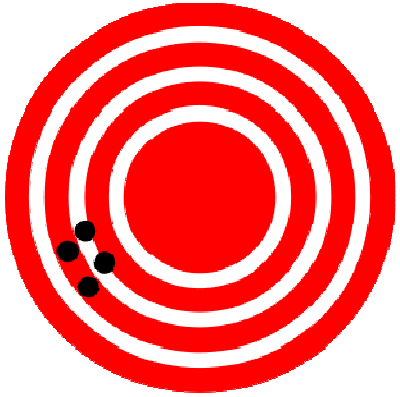
Validity

- The relative accuracy or correctness of the statements.
- Internal validity
  - Extent to which a set of research findings provides compelling information about causality
- External validity
  - Extent to which a set of research findings provides an accurate description of what typically happens in the real world.
  - Generalizability
- Conceptual validity
  - How well a specific research hypothesis maps onto the broader theory that it was designed to test.

Precision and Accuracy

- Precision
  - Consistency or repeatability of a measure or observation.
- Accuracy
  - Degree of conformity of a measured quantity to its actual value.





Literature Review

- A systematic search of formal and informal publications in order to find items relevant to your area of interest. These include books, journals, conferences papers and theses or other types of academic publications
- A literature review is a necessity.
  - Without this step, you won't know if your problem has been solved or what related research is already underway.
  - Why
    - Necessary to acquire an understanding of your topic, with it's key issues.
    - Awareness o relevant research that has already been conducted.
    - Prevent you from duplicating work already done.
    - Helps you choose/design your own methodology.

Literature Review (cont.)

- When performing the review:
  - Start searching professional journals.
  - Begin with the most recent articles you can find.
  - Keep track of relevant articles in a bibliography.
  - Don’t be discouraged if work on the topic is already underway.

Literature Review Pitfalls

- Be very careful to check your sources when doing your literature review.
- Many trade magazines are not peer reviewed.
  - Professional conferences and journals often have each article reviewed by multiple people before it is even recommended for publication.
  - The IEEE and ACM digital libraries are good places to start looking for legitimate research.

Literature Review Pitfalls (cont.)

- The Internet can be a good source of information. It is also full of pseudo-science and poor research.
- Make sure you verify the claims of any documentation that has not been peer reviewed by other professionals in the computing industry.

Taken from: Research Concepts by Chris Jones and Xiaoping Jia (minor modifications by Nayda Santiago)

How to conduct a literature search

- Define topics – Identify the problems
  - Clarify the meaning of the topic and/or particular words.
  - Identify the words and phrases that best describe your subject and how to link them together.

Decide on scope or boundary

- May need to choose a specific aspect if the area/topic is too broad.
- Depending on the topic searched, you may find too many or too little information.

Define topics in terms of keywords

- Think of words that may be used as an alternative for your topic.
- Combine your words: this may help retrieve only the meaning you want.
- Think of possible changes in terminology when looking for older material.
- Set limitations for your search: publication date, language, etc.

Draw up a list of sources/databases

- These include the library or the internet (online catalogues).

Conduct your searches

- Search through each source/database. Start with the most recent publication and work your way back.
- Keep a record of your searches. These should include the publication year of every document.
- Record all useful references. This will enable you to provide an accurate bibliography at the end of the project.

Read Them

- Requires assessment, discrimination and judgment.
- Leave time between readings for thoughts and note taking
- Increase the understanding of the data you are collecting.

Evaluate Sources

- Is the article written by a professional and published by a respectable organization?
- What are the credentials of the author?
- Is the article published in a “refereed journal”?
- Webs
  - What is the domain of the site (.com, .org, .edu,etc.)?
  - Why was the web created?
  - Who created the web page? Is he an expert on the subject?
  - When was the page last updated?

Time Management

- Plan
  - Failing to plan is planning to fail
  - The key to optimizing your use of time is PLANNING AHEAD.
- Provide short term and long term goals.
- What do you want to achieve on a daily, weekly, and yearly basis?

Time Management

- Modified from “Time Management” , a presentation from Kathleen Riepe, University of Wisconsin-Parkside, 2002

Important points

1 The Present
2 86,400
3 Tick When I Should Tock?
4 Am I Working My “A’s” Off?
5 Conquer Procrastination
6 Pacing
7 Take the Offensive With a Planner
8 Be Realistic in your Expectations
9 Is The Jar Full?

1. The Present

Yesterday is History
Tomorrow's a Mystery
But Today is a Gift
That's Why They Call it
The Present

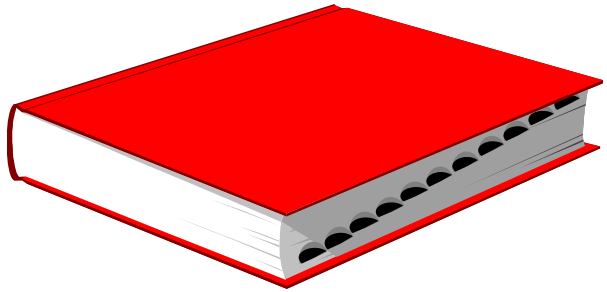
Time is a Non Renewable Resource.

Once it is gone, it is gone.

You will never see this moment again.

What does research say?

A Fordham University Study of first year students found the following:



- On weekdays students spent **TWICE** as much time on leisure activities as on studying.
- On weekends students spent **SIX TIMES** as much time on leisure activities as on studying.

What's your "LQ"
Leisure Quotient?

- Sometimes we just don't realize how much time we spent in non productive ways.
- Here are some examples of leisure:
  - Chat
  - Listening to CD's
  - Watching tv
  - Daydreaming
- What others can you think of?

Exercise: Finding your LQ

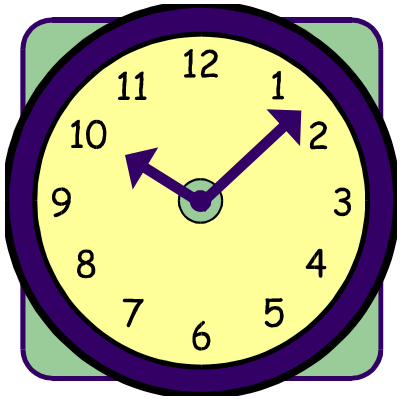
- **Keep a close record each day of how much time you spend on leisure activities.**
- **Divide this number by 960* minutes to get your "LQ".**
  - ***960 minutes equals 16 waking hours per day.**
  - **Leisure activities are important to help you recharge, but too much can be detrimental.**

2. Eighty Six Thousand Four Hundred

- Picture this:
  - Each day your bank deposits **$86,400** in your checking account.
  - There's just one catch.
  - You have to spend it all in one day.
  - You can't carry over any money to the next day.

What would you do?

- DUH?
- You'd spend it all, Right?



24 hours per day

X

60 minutes per hour

X

60 seconds per minute

=

86,400 Seconds

Every Second Counts

- Spend every second in an efficient and productive way
- If you fail to use the day's deposits, the loss is yours.

To Realize the Value of:

- **ONE YEAR, ask a student who failed a grade.**
- **ONE MONTH, ask a mother who gave birth to a premature baby.**
- **ONE WEEK, ask the editor of a weekly newspaper.**
- **ONE DAY, ask a daily wage laborer with kids to feed.**
- **ONE HOUR, ask the lovers who are waiting to meet.**
- **ONE MINUTE, ask a person who missed the train.**
- **ONE SECOND, ask a person who just avoided an accident.**
- **ONE MILLISECOND, ask the person who won a silver medal in the Olympics.**

3. Am I trying to Tick when my Body Wants to Tock?

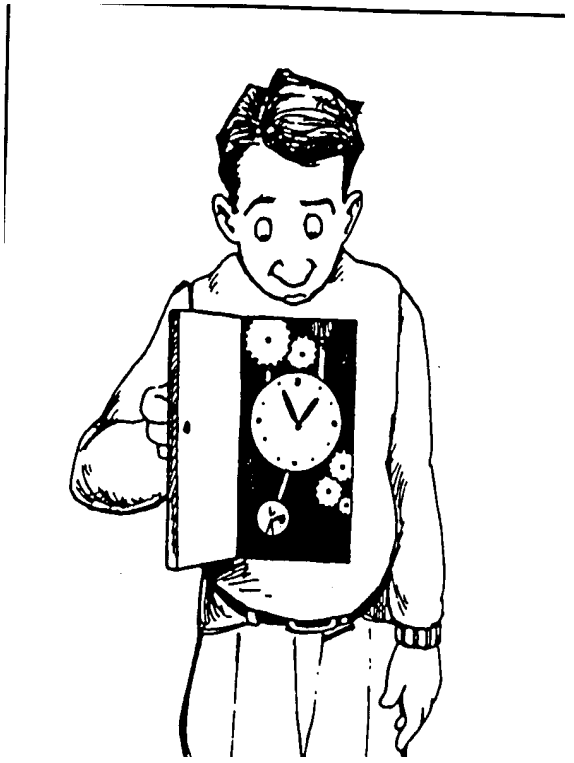
Circadian Rhythms

Circadian rhythms are important in determining the sleeping and feeding patterns of all animals, including human beings. There are clear patterns of brain wave activity, hormone production, cell regeneration and other biological activities linked to this daily cycle.

About every 24 hours our bodies cycle through metabolic and chemical changes.

These Circadian Rhythms are reset by sunlight each morning.

Whether you are a “Morning Person” or a “Night Owl” is determined by these cycles.



Maximize your Efficiency

Work *With* Your Body Cycles-not *Against* Them

- If we learn to listen to our bodies, we can work with these natural rhythms instead of fighting them.
- We can make more efficient use of our time by scheduling certain activities at certain times of the day.

Cognitive Tasks
8am - 12 noon*

Cognitive, or mental, tasks such as reading, calculating, and problem solving are performed most efficiently in the morning.

*If you are a Night Owl, shift these times about 3-4 hours later in the day.

Short term memory
6 am - 10 am

Short term memory tasks such as last minute reviewing for tests are best performed early in the morning.

***If you are a Night Owl, shift these times about 3-4 hours later in the day.**

Long term memory
1 pm - 4pm*

Longer term Memory tasks such as memorizing speeches and information for application are best performed in the afternoon.

*If you are a Night Owl, shift these times about 3-4 hours later in the day.

Manual Dexterity
2 pm to 6 pm*

You are most efficient at tasks involving the use of your hands such as keyboarding and carpentry in the afternoon and early evening.

***If you are a Night Owl, shift these times about 3-4 hours later in the day.**

Physical Workouts
4 pm to 9 pm *

Because of Circadian Rhythms it is best to engage in physical activity in the evening when your large muscle coordination is at its peak.

Studies show you will *perceive* the workout to be easier in the evening.

Exercising about 5 hours before bedtime improves the quality of sleep.

***If you are a Night Owl, shift these times about 3-4 hours later in the day.**

Student Lag, aka Jet Lag

- Are you creating the equivalent of jet lag by keeping an inconsistent sleep schedule?
  - Do you get up at about the the same time each morning?
  - Do you almost always get 7-9 hours of sleep per night?
  - If you answered no to any of the questions, you are compromising your body's efficiency.

4. Am I Working My “A’s” Off?

How would prioritize this list of daily tasks?

Write the underlined word of the tasks which would be on your

"A" List
"B" List
"C" List

Buy laundry detergent.
Write a eight page essay for English.
Prepare for a Biology quiz.
Dust the videos on the bookcase.
Review for midterm test that counts for 50% of grade.
Schedule an appointment with a Professor.
Complete a journal entry.
Email a high school friend on another campus.
Shop for a new pair of athletic shoes.
"Armor-al" the dashboard of the car.

Are you working your "A's" Off?
or
Do You Have C-Fever?

"A" LIST

1 ***Midterm test that counts for 50% of grade.***

2 ***Write a eight page essay for English.***

"B" LIST

3 **Prepare for a quiz in Biology.**

4 **Schedule an appointment with a Professor.**

5 **Complete a journal entry.**

"C" LIST

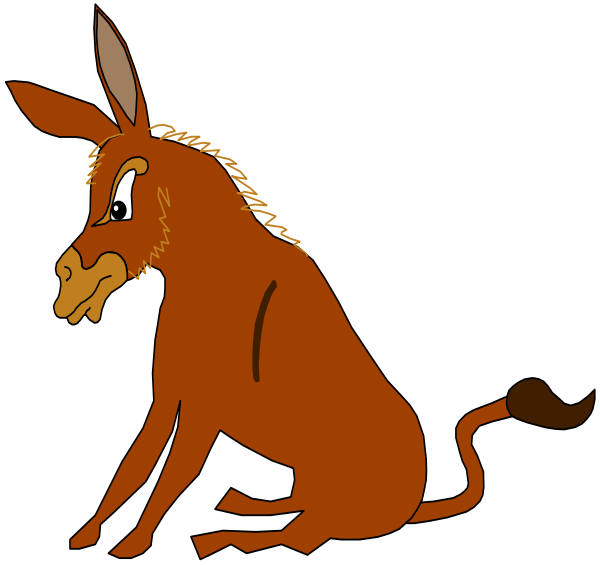
6 **Buy laundry detergent.**

7 **Dust the videos on the bookcase.**

8 **Email a high school friend on another campus.**

9 **Shop for a new pair of athletic shoes.**

10 **"Armor-al" the dashboard of the car.**



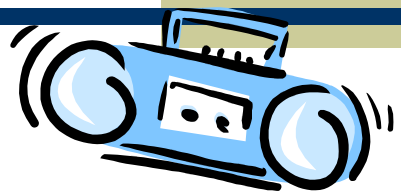
“C” Fever

- Have you ever noticed?
  - **That the videos must be alphabetized before you can settle in to review for a test.**
  - **That rumpled pile of clothes left in the corner since Thursday night just has to get folded and put away before you can start that English essay.**
- If so, you may be suffering from “C” Fever

5. Conquer Procrastination

- **Why is "C" fever as common as the cold?**
  - **The "A" tasks may :**
    - **Produce minimal endorphins**
    - **Be too lengthy**
    - **Be too difficult**
    - **Be too threatening because of the possibility of failure**
    - **Be too threatening because of the possibility of success**

It’s All about Endorphins - The Feel Good Hormone



- **Develop a Conditioned Response to the Tasks you Procrastinate**
- **Set a goal to complete a task/project**
- **After completing the task, reward yourself with something that is pleasurable for you**
- **The body releases endorphins- the feel good hormone**
- **Over time with repetition, you will come to associate feeling good with completing a task/project**
- **You won’t procrastinate as much**

6. Pacing

Athletes know the phenomenon of running with someone ahead of them to increase their times.

The same effect can be achieved with studying and completing schoolwork.

Because work expands or contracts to fit the time allotted, make pacing work for you by doing the following:

Estimate the time needed to complete a task.

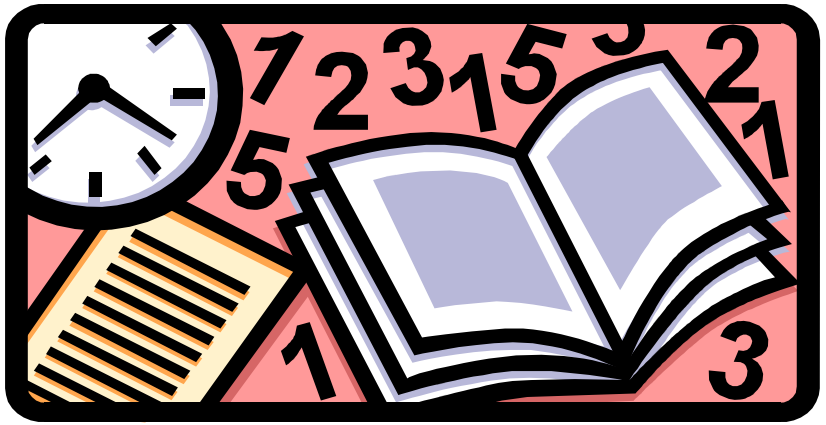
Subtract 15% from that estimate.

Set a timer to help you reach the goal of completing the task in reduced time.

7. Take the Offensive with a PLANNER

A planner helps you:

See the big picture



Be time efficient

Record deadlines, appointments, etc.

8. Be Realistic

- Examine your schedule.
- Be realistic about what you can accomplish.
- Don’t try to juggle too many things.
- Don’t set yourself up for failure.

9. Is The Jar Full?

- **Stephen Covey in his book, *First Things First,***
- **"Okay, time for a quiz." He reached under the table and pulled out a wide-mouthed gallon jar. He set it on the table next to a platter with some fist-sized rocks on it. "How many of these rocks do you think we can get in the jar?" he asked.**

ROCKS

- **IS THE JAR FULL?**

Gravel

- **IS THE JAR FULL?**

Sand

- **"Is this jar full?"**

Water

- **Is the Jar Full?**
- **What is the point?**
  - **“If you work really hard you can always fit some more things into your life."**

No, that is not really the point

The point is this:

Put the Big Rocks in First

Here are the 9 Main Points you have written to remind you how to Manage Your Time

1 The Present
2 86,400
3 Tick When I Should Tock?
4 Am I Working My “A’s” Off?
5 Conquer Procrastination
6 Pacing
7 Take the Offensive With a Planner
8 Be Realistic in your Expectations
9 Is The Jar Full?

Care and Feeding of Advisors

- Ideas for meetings with advisors
  - When's our next meeting?
  - What's my goal to have done by then?
  - Who to turn to for help?
- Remember: advisors want results !

What leads to success

- Passion
- Work
- Good
  - Practice
- Focus
- Push
  - Shyness
  - Self-doubt
- Serve
- Ideas
  - Listen
  - Observe
  - Be curious
  - Ask questions
  - Problem solve
  - Make connections
- Persist
  - Failures
  - Criticism
  - Rejection
  - Pressure

Richard St. John, Stupid, Ugly, Unlucky and RICH: What really leads to success

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