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WOX7001 – RESEARCH METHODOLOGY

Topic 1 – Introduction to academic research

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Agenda

01 RESEARCH - BACKGROUND

02 RESEARCH SIGNIFICANCE

03 SAMPLE RESEARCH

04 RESEARCH CATEGORIES

05 CLASS ACTIVITIES

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What is research

The word research is derived from the Middle French "recherche", which means "to go about seeking", the term itself being derived from the Old French term "recerchier" a compound word from "re-" + "cerchier", or "sercher", meaning 'search'. The earliest recorded use of the term was in 1577.

Wikipedia

"act of searching closely" for a specific person or thing, from French *recercbe* (1530s, Modern French *recherche*), back-formation from Old French *recercher* "seek out, search closely"

Online Etymology Dictionary

So, the main act of research is searching

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So, in simple term research is...

To find answers about something that we are not sure of.

Whether is about a phenomenon which has happened, that is happening or has not happened, we can carry out studies or research to find the answers.

i.e. research is carried out to find out a valid answer (research results) to a problem (uncertainty).

And also,

A research is conducted using systematic methods to ensure that the information obtained is reasonable and is supported by quantitative or qualitative data.

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Why we need to search?

The common questions when we search:

How significance is my research?

How it going to contribute to the community and society?

How it going to improve the current body of knowledge or going to create new knowledge?

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How to search?

Obtain knowledge which is valid and reliable (i.e. knowledge with scientific and logical foundations)

Collect evidence in order to give an answer to any doubt or problem which arises
Correct any stereotyping, traditions and belief which are untrue

Predict the existence of a phenomenon

Explain the truth about a phenomenon.

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But then why we are calling it research, instead we are only searching??

Research is repeated searching (i.e. *re-search).*

i.e. the process of searching through what other people may have searched with the aim of uncovering what is yet to be discovered.

It may require interpreting what had been found in a new but innovative way.

Originality is a key term in research

involves thinking about things in a way that other people have not reached a conclusion that is unique.

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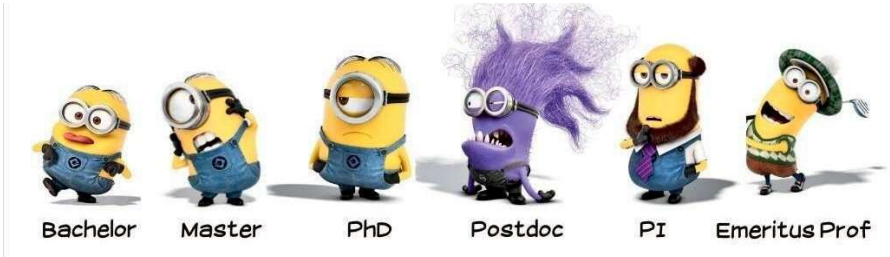
Comparison between Masters and PhD. Research



Masters

- To solve a problem using the methodology that you have learned

PhD

- Using the methodology that you have learned and experience of solving problem to produce something new

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Academic Research

Research Type

Basic/Fundamental VS Applied

Analytic VS Descriptive

Research Process

Step 1 – Question/problem

Step 2 – Objective

Step 3 – Design

Interpret the result

Research

Research Approach

Qualitative. Quantitative and Mixed Method

Research Categories

Possible - (Category A)

Processing systems - (Category B)

automated or information-processing systems (Category C)

support the activities of all other categories of research (Category D)

Research Type

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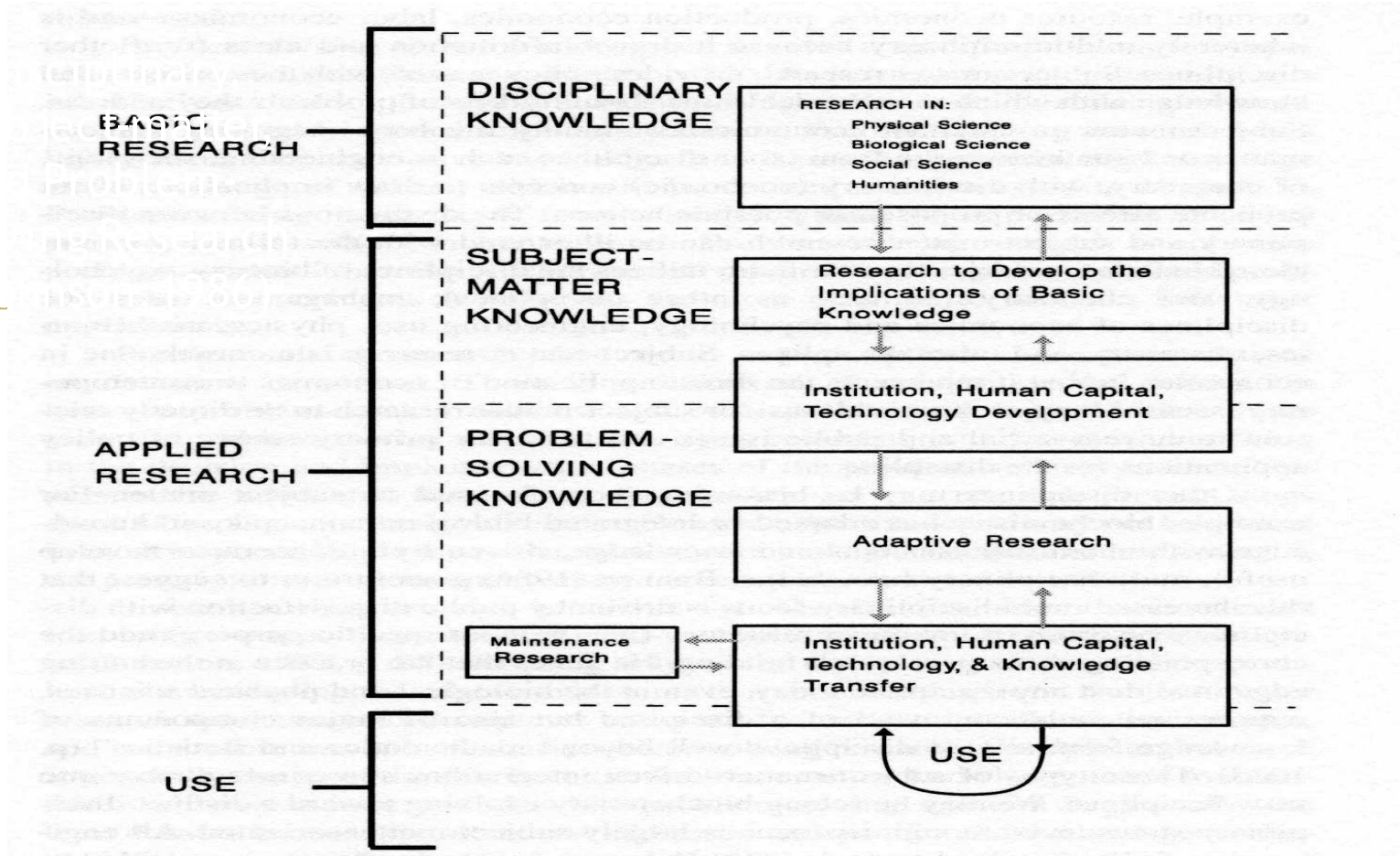

Figure 2.1. Relationship among research, knowledge, and use (Bonnen, 1986).

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Research Type – Basic vs Applied Research

- Basic – to determine or establish fundamental facts and relationships within a discipline or field of study.
- Applied – undertaken specifically for the purpose of obtaining information to help resolve a particular problem

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Basic Research - Disciplinary

- designed to improve a discipline
- dwells on theories, fundamental relationships and analytical procedures and techniques
- It is synergistic and complementary with subject matter and problem-solving research
- Provides the foundations for applied research

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Applied Research - Subject-matter research

- "research on a subject of interest to a set of decision makers"
- Tends to follow subject-matter boundaries within a discipline
- Inherently multidisciplinary, drawing information from many disciplines
- prediction model-- can u name few prediction model. So those prediction model is a design solution of something. And u will use those prediction model to resolve a problem. Then it is an applied research

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Applied Research – Problem Solving Research

- Designed to solve a specific problem for a specific decision maker
- Often results in recommendations on decisions or actions
- Problem-solving research is holistic – uses all information relevant to the specific problem

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Research Type – Analytic vs Descriptive Research

- Descriptive Research – the attempt to determine, describe, or identify something
  - The intent is often synthesis, which pulls knowledge or information together
- Analytic – the attempt to establish why something occurs or how it came to be

Research Process

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Research Process

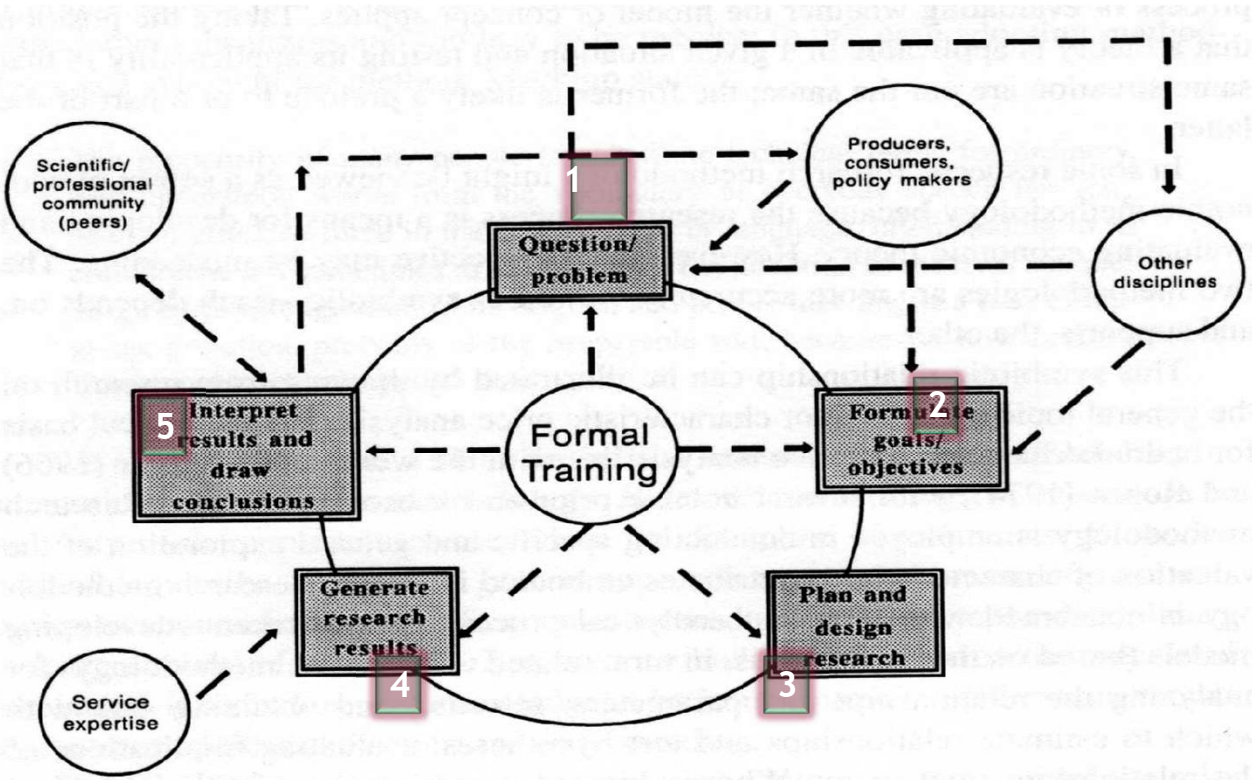

Figure 2.2. Schematic of research process.

Research Approach

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Research Approach

- Plans and procedures for research that span the steps from broad assumptions and detailed methods of data collection, analysis and interpretation.

- The selection of a research approach is also based on the nature of the research problem or issue being addressed, the researchers' personal experiences, and the audiences for the study.

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Research Approach

Qualitative

- approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem.
- The process of research involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data.

Quantitative

- approach for testing objective theories by examining the relationship among variables.
- These variables, in turn, can be measured, typically on instruments, so that numbered data can be analyzed using statistical procedures

Mixed Methods

- approach to inquiry involving collecting both quantitative and qualitative data, integrating the two forms of data, and using distinct designs that may involve philosophical assumptions and theoretical frameworks.
- The core assumption of this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone.

Research in Computer Science

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Research in Computer Science

The fundamental knowledge underlying computing research is from philosophy and Mathematics.

constrained by reasoning and formalised in logic - philosophical research.

analytic in nature and constrained by theoretically provable propositions and axioms - mathematical research.

CS research derives its power of expression from mathematics, particularly discrete mathematics.

Is constrained by what is theoretically computable.

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What CS are searching for? (sample)

Computer Scientist can study different data structures (e.g. list, linked list, queue, tree, and array) to know why they perform differently in different environments (e.g. small and large database environments).

He may then go further to propose various algorithms for implementing these data structures as well as those required for manipulating them (e.g. search, sort)

In the process, some parameters that specify the performance of each algorithm may be provided.

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What CS are searching for? (sample)

Another e.g., in the development of Artificial Neural Networks (ANN),

computer scientists study the behaviours of human neurons as described in the biological sciences.

Using this knowledge, the CS researchers produced computational models with varying configuration as structures.

The aim in proposing these models is not for solving any practical problems but to investigate all possible problem scenarios in abstract term.

Research in Data Science

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Research in Data Science

Data Science is a multi-disciplinary field that capitalizes on theories, methods, techniques, and algorithms from information technology (ICT), including visualization and machine learning.

Data Science builds upon a foundation of theories from computer science, mathematics (in particular statistics), and social sciences, etc., to enable a large variety of applications, including predictive analytics and business intelligence, data-driven sciences (big data science), and artificial intelligence.

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What DS are searching for? (sample)

Data scientist can study 8v's of big Data (e.g. velocity, volume, visualization and etc) to know why they perform differently in different environments (e.g. small and large database environments).

He may then go further to propose various algorithms for implementing these architectures as well as those required for manipulating them.

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What DS are searching for? (sample)

Another e.g., in the reducing the cost of complex analytics in the cloud

data scientists study the different machine learning algorithms

Using this knowledge, the DS researchers produced non-complex analytics models with varying library usage.

Research in Cyber Security

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Research in Cyber Security

Cybersecurity is concerned with making **cyberspace safe** from threats, namely cyber threats. Is an important tool in protecting and preventing unauthorized surveillance.

Activities

technical and non-technical, intended to protect computers, computer networks, related hardware and devices software, and the information they contain and communicate, including software and data, Other elements of cyberspace, from all threats, including threats to the national security

Degree of protection

The degree of protection resulting from the application of these activities and measures

Associated fields

The associated field of professional endeavor, including research and analysis, aimed at implementing and those activities and improving their quality

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What Cybersecurity are searching for? (sample)

The cyber security research initiative is an attempt that is required to enable the country to get ahead of adversaries and produce the technologies.

These futuristic technologies can protect information systems and networks.

The initiative is a platform to work together to foster R&D to evolve transformative solutions and address critical cyber security challenges, through partnerships among academics, Industry and Govt.

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Why research is important in Cyber Security

Research is needed to ensure information sharing mechanisms for cybersecurity breaches and vulnerabilities remain effective and continue to improve.

Research and innovation in cyber-physical system development should be further prioritised to mitigate the substantial risks these systems introduce

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Research Categories

Category A

Study of or exploring on what is possible

Category B

Study of real-world phenomena or existing naturally occurring information-processing systems

Category C

Research involving creation of new useful automated or information-processing systems

Category D

Research related to creation and evaluation of tools, formalisms and techniques to support the activities of all other categories of research

Category E

Research related to social and economic impact issues of development in computing technology

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Research Categories – Category A

CS

Mathematical theory Related to work on Theorems relating to limits of computation Complexity

properties of mechanisms for cryptography

Study behavioural properties of different types of mechanisms/architectures/systems

DS

Computational theory Related to work on machine learning to limits of computation Complexity

properties of mechanisms for library

Study behavioral properties of different types of data science architectures

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Research Categories – Category B

CS

Study of different forms of computation allows us to find new ways of formulating and testing powerful models and theories for explaining and predicting natural phenomena.

To model and explain aspects of human-intelligence

Relevant to work on:

Analysis and simulation of human engineering activities

AI or cognitive science on simulation of human design processes

DS

Study different machine learning algorithms performance allow us to find new ways of formulating and testing machine learning models.

To model and explain aspects of Weather patterns

Assessing the effects of fuel energy consumption, foreign direct investment and GDP on CO2 emission: New data science evidence from Europe & Central Asia

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Research Categories – Category C

CS

The goal is to create new practically useful systems that add to the body of knowledge

Research closely related to production, analysis and evaluation of practical applications

- Proving mathematical theorems, doing numerical computations
- Translating from one language to another
- Design new machines

DS

The goal is to create new practically useful data science systems that add to the body of knowledge
Research closely related to production, analysis and evaluation of practical applications such as:

- Weather forecast, face recognition
- Generate code from requirement specifications by via natural language processing

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Research Categories – Category D

CS

Work involving processes of performing the activities/tasks in the previous categories.

- Automatic program synthesizers, code generators from a complex analysis model, creation of analysis and design methods and tools
- Tools to support exploratory design of software (e.g. most AI development environments)

DS

Research related to creation and evaluation of tools, formalisms and techniques/methods to support the various activities of research.

Tools to measure the prediction accuracy of various machine learning models
Tools to measure the Feature Binning which related to feature engineering.

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Research Categories – Category E

CS

- Research related to the study of
  - social and economic impact of computing
  - ways in which developments in computing technology have influenced social, educational, economic, legal and political processes and structures.
  - Analysis of ethical implication of impact of the new technology in jobs, opportunities, power structures, resources, etc for various social groups

DS

- Research related to the study of
  - social and economic impact of data science
  - ways in which developments in data science technology have influenced social, educational, economic, legal and political processes and structures.
  - Eg: Analysis of ethical implications of processing social media data. in the perspective of security of the information provided in the social media.

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Class Activity

Estimated time – 1 hour

Q1: In your opinion what are the possible research that could be conducted in the following domains (choose only one). And propose possible research according to each category (Category A, B, C, D and E).

a) Agriculture
b) Environmental
c) Mental Health

2. Why there is a need to conduct those research? How it going to contribute to the society?

It is a group task (5 in a group) and every group need to present your discussion outcome at the end of 30 min.

THANK YOU

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